BIOCHEMISTRY

Final Document of Ad-Hoc BOS Biochemistry for AC meeting

DEPARTMENT OF BIOCHEMISTRY

Semester wise proposed distribution of Core & Elective Papers 3 Year Degree course in Biochemistry (Self financed)

COURSE STRUCTURE

Sem.	**C**		**Elective**			
I	**BCH-I.C-1** Molecules of Life	**BCH-I.C-2** Cell Biology	--------	--------	--------	--------
II	**BCH-II.C-3** Protein chemistry	**BCH-II.C-4** Biophysics	--------	--------	--------	--------
III	**BCH-III.C-5** Enzymology		**BCH-III.E-1** Tools & Techniques in Biochemistry	**BCH-III.E-2** Microbiology	**BCH-III.E-3** Bioethics and Bio-safety	**BCH-III.E-4** Plant Biochemistry
IV	**BCH-IV. C-6** Metabolism of Biomolecules		**BCH-IV.E-5** Human physiology	**BCH-IV.E-6** Nutritional Biochemistry	**BCH-IV.E-7** Hormone: Biochemistry and Function	**BCH-IV.E-8** Advanced Cell Biology
V	**BCH-V.C-7** Molecular biology		**BCH-V.E-9** Concepts in genetics	**BCH-V.E-10** Regulation of gene expression	**BCH-V.E-11** Genetic Engineering and Biotechnology	**BCH-V.E-12** Bioinformatics
VI	**BCH-VI.C-8** Immunology		**BCH-VI.E-13** Biochemical correlation of Diseases	**BCH-VI.E-14** Clinical Biochemistry	**BCH-VI.E-15** Environmental Biochemistry	**BCH-VI.E-16** Industrial Biochemistry

PARVATIBAI CHOWGULE COLLEGE OF ARTS & SCIENCE

(AUTONOMOUS)

DEPARTMENT OF BIOCHEMISTRY (SELF FINANCED)

APPROVED SYLLABUS FOR SEMSESTER I

COURSE TITLE: MOLECULES OF LIFE (THEORY)
COURSE CODE: BCH-I.C-1
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

This paper provides basic foundation on biomolecules of life with reference to their properties, and biological functions. The course also provides detailed knowledge on how cellular structure and function arise as a result of the properties of cellular macromolecules.

LEARNING OUTCOMES:

Students will understand the importance of proteins, carbohydrates, lipids and nucleic acids and their role in living organisms. It will also help to understand the clinical significance of vitamins.

BCH-I.C-1(THEORY) **Total hours: 45**

Unit 1 The foundations of biochemistry **No. of Hours: 2**

Cellular and chemical foundations of life

Unit 2 Water **No. of Hours: 3**

Unique properties, weak interactions in aqueous systems, ionization of water, water as a reactant and fitness of the aqueous environment

Unit 3 Carbohydrates **No. of Hours: 10**

Monosaccharides: structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, stereochemistry: mutarotation, anomers, epimers and enantiomers, formation of disaccharides, reducing and non-reducing disaccharides, Polysaccharides: homo and hetero-polysaccharides, structural and storage polysaccharides

Unit 4 Proteins **No. of Hours: 8**

Types of amino acids and their chemistry, derivatives of amino acids and their biological role. Introduction to biologically important peptides. Polypeptides and proteins.

Unit 5 Lipids **No. of Hours: 7**

Various classes of lipids and their distribution, storage lipids, structural lipids in membranes, lipids as signal molecules, cofactors and pigments

Unit 6 Nucleic acids **No. of Hours: 10**

Structures and chemistry: DNA structures and their importance, different types of RNA, unusual DNA structures, other functions of nucleotides: source of energy, component of coenzymes, second messengers.

Unit 7 Vitamins **No. of Hours: 5**

Structure and active forms of water soluble and fat soluble vitamins, deficiency diseases and symptoms, hypervitaminosis.

BCH-I.C-1: MOLECULES OF LIFE (PRACTICALS)

COURSE TITLE: MOLECULES OF LIFE (PRACTICALS)
COURSE CODE: BCH-I.C-1
MARKS: 25 MARKS
CREDITS: 1
TOTAL HOURS: 30

1. Introduction to safety measures in laboratories	1P
2. Preparation of solutions (normal, molar, ppm , %)	1 P
3. Mutarotation of sugars	2P
4. Determination of pKa of acetic acid and glycine	2 P
5. Qualitative tests for carbohydrates, lipids, amino acids, proteins and nucleic acids	5 P
6. Preparation of TLC plates and separation of amino acids and sugars by thin layer chromatography	3 P
7. Estimation of vitamin C	1 P

REFERENCES

- Nelson, D. L. & Cox, M.M. (2000), Lehninger's Principles of Biochemistry (3rd Edition),Worth Publishers, New York, USA.
- Stryer, L. (1995). Biochemistry, W.H. Freeman and Co., New York, USA.
- Jain, J.L (1999), Fundamentals of Biochemistry, S.Chand and Company, Ltd., New Delhi.
- Murray, R.K., Granner, D.K., Mayes, P.A. & Rodwell, V.W. (2003), Harper's Illustrated Biochemistry, McGraw-Hill Companies.
- Donald Voet, Judith G. Voet & Charlotte W. Pratt, Principles of Biochemistry, John Wiley & Sons.
- S. Sadasivam and A. Manickam (1996), Biochemical Methods, New Age International (P) Limited
- J. Jayaraman (1971), Laboratory Manual in Biochemistry, John Wiley & Sons, Limited.

PARVATIBAI CHOWGULE COLLEGE OF ARTS & SCIENCE

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DEPARTMENT OF BIOCHEMISTRY (SELF FINANCED)

APPROVED SYLLABUS FOR SEMSESTER I

COURSE TITLE: CELL BIOLOGY (THEORY)
COURSE CODE: BCH-I.C-2
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

The course will give a detailed description of the organization of the cell, the structure and functions of various organelles. The course also focuses on the communication of cells and the importance of cell division.

LEARNING OUTCOMES:

Students will have a clear knowledge on the function of each cell organelle with proper coordination and establish the concept of how proper conformations of lipids and proteins in a membrane are needed for optimum functioning.

BCH-I.C-2 (THEORY) **TOTAL HOURS: 45**

Unit 1 Introduction to cell biology **No. of Hours: 6**

Cell theory, ultra-structure of prokaryotic and eukaryotic cell; cell matrix proteins; components of extracellular matrix.

Unit 2 Ultra- structure and function of organelles **No. of Hours: 15**

Cilia and flagella; endoplasmic reticulum, golgi apparatus, lysosomes, microbodies, mitochondria, chloroplast, ribosomes, centrioles and basal bodies, nucleus, chloroplasts and peroxisomes

Unit 3 Cell wall & Plasma membrane **No. of Hours: 10**

Chemical composition, structure and functions of the cell wall and plasma membrane, monolayer, planer bilayer and liposomes as model membrane systems. Fluid mosaic model, lipid rafts, caveolae, membrane fluidity, factors affecting membrane fluidity, techniques used to study membrane dynamics – FRAP

Unit 4: Cell cycle **No. of Hours: 4**

Overview of the cell cycle; prkaryotic & eukaryotic cell cycle; events of mitotic & meiotic phases, cytokinesis.

Unit 5: Cell-Cell interaction **No. of Hours: 10**

Interactions of cells with extracellular materials: integrins, focal adhesions and hemidesmosomes; interactions of cells with other cells: selectins, the immunoglobulin superfamily, cadherins, adheren junctions and desmosomes; tight junctions, gap junctions and plasmodesmata

BCH-I.C-2 CELL BIOLOGY (PRACTICAL)

COURSE TITLE: CELL BIOLOGY (PRACTICALS)
COURSE CODE: BCH-I.C-2
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1.Examination of prokaryotic cell, eukaryotic cell and cell organelles using Photomicrographs 2P

2. Visualization of animal and plant cell using methylene blue. 2P
3. Study of cell viability using phenol red and trypan blue 1P
4. Visualization of Permanent slides of: 1P
   A. Different cell types: Epithelium, Endothelium, Muscle cells, Nerve cell
   B. Different stages of cell division
5. Identification of different stages of mitosis in onion root tip ` 1P
6. Identification of different stages of meiosis in grasshopper testis 1P
7. Isolation of chloroplast from spinach leaves and estimation of chlorophyll 2P
8. Prokaryotic cell harvesting & lysis using osmotic (salt) and Chemical (detergent) methods 3P
9. RBC and WBC count using haemocytometer 2P

REFERENCES

- Karp, G. & Harris, D. (2008) Cell and Molecular Biology – Concepts and Experiments, John Wiley & Sons Inc, New York.
- Robertis, E.D.P. & Robertis, E.M.F. (1998). Cell Biology and Molecular Biology, 8th edition, Sauder College.
- Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.
- Gupta, P.K. (1999). A Text-book of Cell and Molecular Biology. Rastogi Publications, Meerut, India.
- Verma P.S. and Agarwal V. K. (1998).Cell Biology, Genetics, Molecular Biology, Evolution and ecology. Edn.14

PARVATIBAI CHOWGULE COLLEGE OF ARTS & SCIENCE

(AUTONOMOUS)

DEPARTMENT OF BIOCHEMISTRY (SELF FINANCED)

APPROVED SYLLABUS FOR SEMSESTER II

COURSE TITLE: PROTEIN CHEMISTRY (THEORY)

COURSE CODE: BCH-II.C-3

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

The main objective of the course is to understand the importance of structure of proteins for their biological functions and the analytical techniques to isolate and characterize proteins.

LEARNING OUTCOMES

Students will be able to describe the four levels of protein structure, types of bonding and how a protein's structure relates to its cellular function. Also students will be familiar with many of the biophysical techniques used in research and industry for analyzing the structure and function of proteins.

BCH-II.C-3 (THEORY) **TOTAL HOURS: 45**

Unit 1 Protein structure **No. of Hours: 15**

Bonds in protein structure (covalent, non covalent,peptide), importance of primary & secondary structure, tertiary and quaternary structures, bond lengths and configuration, Dihedral angles, psi and phi, helices, sheets and turns, Ramachandran map; techniques used in studying 3-D structures - X-ray diffraction and NMR; motifs and domains; structures of myoglobin and haemoglobin, multimeric proteins and conjugated proteins, diversity of function.

Unit 2 Isolation and analysis of proteins **No. of Hours: 12**

Techniques to isolate and analyze proteins: salt fractionation, ion-exchange chromatography, gel permeation, HPLC, SDS-PAGE, IEF; Protein primary structure: sequencing by Edman degradation, use of enzymes and chemical reagents to obtain overlap peptides, synthesis of peptides using Merrifeld method.

Unit 3 Characterization of proteins **No. of Hours: 5**

Determination of purity, molecular weight, extinction coefficient, sedimentation coefficient, 2-D electrophoresis.

Unit 4 Enzymes **No. of Hours: 5**

Nature of enzymes: protein and non-protein (ribozyme); cofactor and prosthetic group, apoenzyme, holoenzyme; IUBMB classification of enzymes.

Unit 5 Membrane proteins **No. of Hours: 8**

Integral and membrane associated proteins, hydropathy plots to predict transmembrane domains; significance of membrane proteins; bacteriorhodopsin, myoglobin and haemoglobin: structure and function (Oxygen binding curves, cooperativity models for haemoglobin.

BCH-II.C-3 PROTEIN CHEMISTRY (PRACTICALS)

COURSE TITLE: PROTEIN CHEMISTRY (PRACTICALS)

COURSE CODE: BCH-II.C-3

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

1. Determination of the absorption maxima and molar extinction coefficient of protein sample 2P
2. Protein assay by Lowry/Bradford method 2P
3. Ammonium sulphate fractionation of crude homogenate from mung bean 1P
4. Ammonium sulphate fractionation of serum proteins 2P
5. Protein dialysis 1P
6. Solubility of proteins in distilled water and salt solutions 2P
7. Separation of proteins by SDS-PAGE (demonstration) 2P
8. Gel filtration chromatography 2P
9. Denaturation of proteins by heat 1P

REFERENCES

- Lehninger: Principles of Biochemistry (2013) 6thed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York)
- Cooper, T.G, The Tools of Biochemistry (1977; Reprint 2011) Wiley India Pvt. Ltd. (NewDelhi)
- Voet, D. and Voet, J.G.(2004). Biochemistry, 3rd Edition, John Wiley & Sons, Inc.USA.
- Plummer D. T., An Introduction to Practical Biochemistry (1998) 3rd ed., Tata McGraw Hill Education Pvt. Ltd. (New Delhi),
- S. Sadasivam and A. Manickam (1996), Biochemical Methods, New Age International (P) Limited
- J. Jayaraman (1971), Laboratory Manual in Biochemistry, John Wiley & Sons, Limited.

PARVATIBAI CHOWGULE COLLEGE OF ARTS & SCIENCE

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DEPARTMENT OF BIOCHEMISTRY (SELF FINANCED)

APPROVED SYLLABUS FOR SEMSESTER II

COURSE TITLE: BIOPHYSICS (THEORY)
COURSE CODE: BCH-II.C-4
MARKS: 75 MARKS
CREDITS: 3

COURSE OBJECTIVES:

The course will give a detailed description of the physical concepts required to study various biochemical aspects, understand the basic concepts of origin and evolution of life and bioenergetics concepts.

LEARNING OUTCOMES:

Students will have a clear understanding of thermodynamic principles which are essential to carry out the cellular reactions. It will also help them to understand the mechanism of deriving energy through bioenergetic reactions in living cells.

BCH-II.C-4 (THEORY) **TOTAL HOURS: 45**

Unit 1 The chemical basis of life **No. of Hours: 5**

Introduction, prebiotic earth, theories of origin and evolution of life; covalent bonds, non-covalent bonds: ionic bonds, hydrogen bonds, hydrophobic interactions, van der Waals forces .

Unit 2 Basic principles of biochemical studies **No. of Hours: 7**

Units of measurement; weak electrolytes- the biochemical importance of weak electrolytes, ionisation of weak acids and bases, calculation of pH, ionisation of a weak electrolyte, buffer solutions, buffer capacity, buffer action and pH of blood, measurement of pH

Unit 3 Introduction to bioenergetics **No. of Hours: 10**

Laws of thermodynamics, equilibrium constant, coupled reactions, ATP cycle, phosphoryl group transfers; chemical basis of high standard energy of hydrolysis of ATP, other phosphorylated compounds and thioesters. Redox reactions, standard redox potentials and Nernst equation, universal electron carriers.

Unit 4 Ion channels **No. of Hours: 4**

Sodium, Potassium, Calcium, Chlorine, ligand gated, Donann's equilibrium experiments.

Unit 5 Oxidative phosphorylation **No. of Hours: 7**

Mitochondrial electron transport chain: its organization and function, inhibitors of ETC and uncouplers, Peter Mitchell's chemiosmotic hypothesis, proton motive force, structure and mechanism of ATP synthesis, regulation of oxidative phosphorylation

Unit 6 Photo-phosphorylation **No. of Hours: 12**

General features of photophosphorylation, Hills reaction, photosynthetic pigments, light harvesting systems of plants and microbes; bacterial photophosphorylation in purple bacteria, green sulfur bacteria. Photophosphorylation in plants - structure of chloroplast, molecular architecture of Photosystem I and Photosystem II, Z-scheme of photosynthetic electron flow, oxygen evolving complex and action of herbicides; cyclic photo-phosphorylation and its significance; photo inhibition, evolution of oxygenic photosynthesis

BCH-II.C-4 BIOPHYSICS (PRACTICAL)

COURSE TITLE: BIOPHYSICS (PRACTICALS)
COURSE CODE: BCH-II.C-4
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Preparation of buffers	2P
2. Determination of buffering capacity	1P
3. To determine Osmolarity of solutions proteins/ sugars/ lipids/ nucleic acids using Osmometer	4P
4. Effect of detergents and other membrane active substances on cells (Erythrocytes)	2P
5. Determination of λ_{max} and Molar extinction coefficient of a given compound	2P
6. Determination of pka of Bromophenol blue	2P
7. Photooxidation of photosynthetic pigments	1P
8. Oxygen evolution (by hydrilla)	1P

REFERENCES

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York)
- Cooper, T.G, The Tools of Biochemistry (1977; Reprint 2011) Wiley India Pvt. Ltd. NewDelhi
- Voet, D. and Voet, J.G.(2004). Biochemistry, 3rd Edition, John Wiley & Sons, Inc.USA.
- Stryer, L. (1995). Biochemistry, W.H. Freeman and Co., New York, USA.
- Jain, J.L (1999), Fundamentals of Biochemistry, S.Chand and Company, Ltd., New Delhi.
- Keith Wilson and John Walker (2010), Principles and Techniques of Biochemistry and Molecular Biology, Seventh edition Cambridge University Press, UK

DEPARTMENT OF BIOCHEMISTRY

3 Year Under-Graduate Degree Programme in Biochemistry (self financed) (adhoc)

COURSE STRUCTURE

Sem	Core		Elective			
I	**BCH-I.C-1** Molecules of Life	**BCH-I.C-2** Cell Biology	--------	--------	--------	--------
II	**BCH-II.C-3** Protein chemistry	**BCH-II.C-4** Biophysics	--------	--------	--------	--------
III	**BCH-III.C-5** Enzymology		**BCH-III.E-1** Tools and Techniques in Biochemistry	**BCH-III.E-2** Microbiology	**BCH-III.E-3** Bioethics and Bio-safety	**BCH-III.E-4** Plant Biochemistry
IV	**BCH-IV. C-6** Metabolism of Biomolecules		**BCH-IV.E-5** Human physiology	**BCH-IV.E-6** Nutritional Biochemistry	**BCH-IV.E-7** Hormone: Biochemistry and Function	**BCH-IV.E-8** Advanced Cell Biology
V	**BCH-V.C-7** Molecular biology		**BCH-V.E-9** Concepts in genetics	**BCH-V.E-10** Regulation of gene expression	**BCH-V.E-11** Genetic Engineering and Biotechnology	**BCH-V.E-12** Bioinformatics
VI	**BCH-VI.C-8** Immunology		**BCH-VI.E-13** Biochemical correlation of Diseases	**BCH-VI.E-14** Clinical Biochemistry	**BCH-VI.E-15** Environmental Biochemistry	**BCH-VI.E-16** Industrial Biochemistry

APPROVED SYLLABI FOR SEMESTER III & IV

Sem	Core		Elective			
III	**BCH-III.C-5** Enzymology		**BCH-III.E-1** Tools and Techniques in Biochemistry	**BCH-III.E-2** Microbiology	**BCH-III.E-3** Bioethics and Bio-safety	**BCH-III.E-4** Plant Biochemistry
IV	**BCH-IV. C-6** Metabolism of Biomolecules		**BCH-IV.E-5** Human physiology	**BCH-IV.E-6** Nutritional Biochemistry	**BCH-IV.E-7** Hormone: Biochemistry and Function	**BCH-IV.E-8** Advanced Cell Biology

PARVATIBAI CHOWGULE COLLEGE OF ARTS & SCIENCE
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DEPARTMENT OF BIOCHEMISTRY (SELF FINANCED)
APPROVED SYLLABUS FOR SEMSESTER III

COURSE TITLE: ENZYMOLOGY (THEORY)
COURSE CODE: BCH-III.C-5
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

The course will introduce students to various theoretical and practical aspects of enzymology; and stimulate their interest in learning the structure, function and kinetics of enzyme. Serve as foundation for more advanced enzymology courses.

LEARNING OUTCOMES:

Students will have a clear knowledge to explain relationship between the structure and function of enzymes; explain how enzymes are able to increase speed of the biochemical reaction, differentiate between equilibrium and steady state kinetics and to estimate important parameters such as K_m, V_{max}, K_{cat}

BCH-III.C-5 ENZYMOLOGY (THEORY) TOTAL HOURS: 45

Unit 1 Introduction to enzymes No. of Hours: 6

Nature of enzymes - protein and non-protein
Co-enzymes, Cofactor and prosthetic group, apoenzyme, holoenzyme, ribozymes & isoenzymes
Specificity of enzymes, concept of active site
Nomenclature and Classification of enzymes

Unit 2 Features of enzyme catalysis No. of Hours: 6

Fischer’s lock and key hypothesis
Koshland’s induced fit hypothesis

Factors affecting the rate of reactions, (time, enzyme concentration, substrate concentration, pH, temperature)

Unit 3 Enzyme kinetics **No. of Hours: 8**

Enzyme activity - international units, specific activity, turnover number

Principles of reaction rates, order of reactions and equilibrium constants. Derivation of Michaelis-Menten equation and Lineweaver- Burk plot

Significance of K_m and V_{max}, K_{cat} and turnover number

Unit 4 Enzyme inhibition **No. of Hours: 8**

Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and suicide, end product)

Types of irreversible Inhibition, Allosteric inhibition

Unit 5 Mechanisms of enzyme action and regulation **No. of Hours: 6**

Mechanism of action of chymotrypsin

Regulation of enzyme activity and its importance - aspartate transcarbamoylase

Unit 6 Enzyme purification **No. of Hours: 6**

Purification of enzymes: salt precipitation; dialysis; molecular exclusion chromatography; Molecular weight determination by PAGE, SDS-PAGE

Unit 7 Applications of enzymes **No. of Hours: 5**

Enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases), enzyme immunoassay (HRPO)

Immobilized enzymes

BCH-III.C-5 ENZYMOLOGY (PRACTICAL)

COURSE TITLE: ENZYMOLOGY (PRACTICLAL)

COURSE CODE: BCH-III.C-5

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Preparation of buffers and solutions for the study of enzyme activity	1P
Enzyme assay and rate of reaction	1P
Determination of optimal pH for enzyme activity	1P
Determination of optimal temperature for enzyme activity	1P
Effect of substrate concentration and determination of Km and V_{max}	4P
Production and isolation of enzyme from any source (plant/microbial)	2P
Partial purification of an enzyme (salting out and Dialysis)	3P
PAGE- Preparation of reagents; Demonstration	2P
TOTAL	**15P**

REFERENCES

- Jain, J.L (1999). Fundamentals of Biochemistry, S. Chand and Company, Ltd., New Delhi.
- Murray, R.K., Granner, D.K., Mayes, P.A. & Rodwell, V.W. (2003), Harper's Illustrated Biochemistry, McGraw-Hill Companies.
- Nelson, D. L. & Cox, M.M. (2000). Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
- Stryer, L. (1995). Biochemistry, W.H. Freeman and Co., New York, USA.
- Zubay, G. (1993). Biochemistry (3rd Edition), WCB Publishers, Iowa, USA.
- Nicholas C.P. & Lewis S. (1999). Fundamentals of Enzymology (3rd Ed), Oxford University Press Inc. New York. USA.

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DEPARTMENT OF BIOCHEMISTRY (SELF FINANCED)
APPROVED SYLLABUS FOR SEMSESTER III

COURSE TITLE: TOOLS AND TECHNIQUES IN BIOCHEMISTRY (THEORY)
COURSE CODE: BCH-III.E-1
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

This course is designed to expose the students to the basic principles underlying some biochemical methods and techniques, their methodologies and applications.

LEARNING OUTCOMES:

To understand the principles and applications behind major biochemical methods such as chromatography, electrophoresis, centrifugation, spectrophotometry and isotopic techniques

BCH-III.E-1 TOOLS AND TECHNIQUES IN BIOCHEMISTRY (THEORY)

TOTAL HOURS: 45

Unit 1 Separation Techniques **No. of Hours: 4**

Different methods of protein precipitation: Precipitation using inorganic salts (salting out) and organic solvents, dialysis and ultra-filtration.

Unit 2 Chromatography **No. of Hours: 10**

Basic principles of chromatography: Partition coefficient, concept of theoretical plates, various modes of chromatography (paper, thin layer, column), HPLC, Molecular Sieve (Gel Filtration) Chromatography, Ion Exchange Chromatography, Affinity Chromatography, Gas Liquid Chromatography.

Unit 3 Electrophoresis **No. of Hours: 10**

Basic Principle of electrophoresis, Paper electrophoresis, Gel electrophoresis, discontinuous gel electrophoresis, PAGE, SDS-PAGE, Native gels, denaturing gels, agarose gel electrophoresis

Unit 4 Centrifugation **No. of Hours: 10**

Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient, various types of centrifuges, different types of rotors, differential centrifugation, density gradient centrifugation (Rate zonal and Isopycnic)

Unit 5 Spectrophotometry **No. of Hours: 4**

UV-Visible spectrophotometry- Principle, instrumentation and applications

Unit 6 Radioisotopes in Biology **No. of Hours: 7**

Concept of half-life, decay constant, detection - GM counter, solid and liquid scintillation counter, autoradiography

Applications of radioisotopes in Biology

BCH-III.E-1 TOOLS AND TECHNIQUES IN BIOCHEMISTRY (PRACTICAL)

COURSE TITLE: TOOLS AND TECHNIQUES IN BIOCHEMISTRY (PRACTICLAL)

COURSE CODE: BCH-III.E-1

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Estimation of proteins by Biuret and Lowry's Methods	4P
Separation and identification of amino acids by paper chromatography	2P
Precipitation of protein by salt precipitation and solvent precipitation	2P
Demonstration of gel filtration chromatography	2P
SDS-PAGE analysis of proteins	3P
Determination of pKa values of glycine and aspartate/glutamate	2P
Total	**15**

REFERENCES

- Wilson K and Walker J. 2005. Principles and Techniques of Practical Biochemistry, 6th Edition, Cambridge University Press.
- Upadhyay A, Upadhyay K and Nath N. 2009. Biophysical Chemistry: Principles and Techniques, 3rd Edition, Himalaya Publishing, New Delhi.
- Plummer D. 1988. An introduction to Practical Biochemistry, Tata McGraw Hill Publishing Company, New Delhi.
- Jayraman J. 2011. Laboratory Manual in Biochemistry. New Age International Pvt Ltd Publishers, New Delhi.
- Sadasivam S. and Manickam A. 2007. Biochemical Methods, 3rd edition, New Age International Publishers, New Delhi.

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DEPARTMENT OF BIOCHEMISTRY (SELF FINANCED)
APPROVED SYLLABUS FOR SEMSESTER III

COURSE TITLE: MICROBIOLOGY (THEORY)
COURSE CODE: BCH-III.E-2
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

This course covers topics in basic microbiology from the historical perspective to the structure and composition of microorganisms, their interactions with the environment and their impact on humans.

LEARNING OUTCOMES:

Students will understand the scope and importance of Microbiology, classification schemes, cultivation, preservation and maintenance of the microbial cultures, pathogenicity of microorganisms, precautions and measures to control the same.

BCH-III.E-2 MICROBIOLOGY (THEORY) TOTAL HOURS: 45

Unit 1 History of Development of Microbiology No. of Hours: 8

Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming.

Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Binomial Nomenclature; Classification systems of Whittaker (five kingdom) and Carl Woese (three kingdom)

Microbial Diversity: Prokaryotic (bacteria) and Eukaryotic (fungi) cell structure, organelles and their function. Viruses

Unit 2 Bacteria No. of Hours: 10

Bacterial cell: Organization and ultrastructure, Gram characteristics.

Nutritional types**:** Autotrophs, Heterotrophs, Phototrophs, Chemotrophs and obligate parasite, with examples of each type

Reproduction in bacteria - Binary fission

Respiration (aerobic and anaerobic)

Bacterial growth curve- characteristics of growth phases; diauxic growth curve

Unit 3 Fungi **No. of Hours: 8**

General characteristics of fungi: habitat, nutritional requirements, cell ultra- structure, thallus organization, cell wall structure. Pigments. Mycotoxins.

Reproduction: sexual and asexual reproduction; parasexual mechanism.

Heterokaryosis, heterothallism.

Unit 4 Viruses **No. of Hours: 5**

Structure; Bacterial, plant and animal viruses

Viral multiplication (lytic and lysogenic)

Unit 5 Cultivation of microorganisms **No. of Hours: 10**

Sterilisation, disinfection, decontamination: Principle and methods

Types of culture media: Synthetic/defined, complex, solid, liquid, enrichment, selective, differential.

Cultivation of microorganisms: Broth culture, agar plate, pour plate

Determination of viable count: Serial dilution, spread plating, determination of colony forming units (cfu) and calculation of viable count

Isolation of pure cultures: Streak plate; colony morphology

Unit 6 Maintenance and preservation of microbial cultures **No. of hours: 4**

Slant and stab cultures, periodic transfer, storage in sterile soil, overlaying with mineral oil, glycerol stocks, preservation in liquid nitrogen, lyophilisation

BCH-III.E-2 MICROBIOLOGY (PRACTICALS)

COURSE TITLE: MICROBIOLOGY (PRACTICALS)
COURSE CODE: BCH-III.E-2
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Introduction to microbiology laboratory equipments: Autoclave, millipore filters and assembly, biological safety cabinets (Laminar air flow and HEPA filter), incubators, hot air oven, microscope, pH meter	1P
Sterilization of glassware: Flasks, test tubes, petri plates, pipettes	1P
Preparation and sterilization of media (liquid and solid)	1P
Study of different shapes of bacteria using permanent slides/pictographs	1P
Determination of viable count: Serial dilution, spread plating, determination of colony forming units (cfu) and calculation of viable count	2P
Isolation of pure cultures: Streak plate; colony morphology	2P
Pour Plate Technique	2P
Gram stain of Gram positive and Gram negative bacteria	1P
Use of biochemical tests for bacterial identification: Sugar fermentations, IMViC test	3P
Decontamination and disposal of cultures	1P

REFERENCES

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- Ananthanarayan R and Paniker CKJ. 2009. Text book of Microbiology, Eight edition, University Press.
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PARVATIBAI CHOWGULE COLLEGE OF ARTS & SCIENCE (AUTONOMOUS)

DEPARTMENT OF BIOCHEMISTRY (SELF FINANCED)

APPROVED SYLLABUS FOR SEMSESTER III

COURSE TITLE: BIOETHICS AND BIO-SAFETY (THEORY)
COURSE CODE: BCH-III.E3
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

This paper aims at introducing the importance of the basic concepts of bioethics and bio-safety and their relationship with several fields such as ecology, agriculture, medicine, chemistry and advances brought about in the field of biology and medicine. The course deals with answers to ethical questions that arise in the relationships among the life sciences, biotechnology, medicine, politics, law, philosophy, theology and their importance in the field of biotechnology.

LEARNING OUTCOME:

The students will understand the importance of bioethics and biosafety procedures to be followed, with knowledge of the basic concepts, its principles, and use.

BCH-III.E3 BIOETHICS AND BIOSAFETY TOTAL HOURS: 45

Unit 1 Introduction to Bioethics **No. of Hours: 5**

Introduction
Principles of bioethics and ethical conflicts
Social and ethical issues in biotechnology

Unit 2 Bioethics in Genetic Engineering **No. of Hours: 5**

Bioethical issues in plant and animal genetic engineering.
Bioethics in IVF

Unit 3 Introduction to Biosafety **No. of Hours: 6**

- Introduction, History and Definition of Biosafety

- Biosafety Guidelines and Regulations
- Operation of Biosafety Guidelines and Regulations

Unit 4 Safety in Laboratories **No. of Hours: 3**

Hazards: Physical, Biological and Chemical

Good laboratory practices

Unit 5 International and Indian Biosafety guidelines **No. of Hours: 5**

- Biosafety Guidelines in India
- International Biosafety Guidelines: OECD, FAO, WHO, CAC

Unit 6 Biosafety levels **No. of Hours: 8**

- Levels of Physical containment
- Levels of Biological containment
- Biosafety of GMOs and GEMs
- Planned introduction and field trials of: GMOs and GEMs

Unit 7 Introduction and Protection of Intellectual Property Right **No. of Hours: 8**

- Introduction, history of Intellectual Property Rights
- Trade secrets
- Copyrights, Trademarks
- Plant variety protection (PVP)
- World Intellectual Property Organization (WIPO)
- GATT & TRIPs
- Patent status – International Scenario
- Patenting of Biological materials
- Significance of Patents in India

Unit 8 Protection of Biotechnological Inventions **No. of Hours: 5**

- Patenting of genes and DNA sequences
- Gene patents and Genetic resources
- Farmers rights
- Plant breeder's rights
- Patenting of life forms

BCH-III.E3 BIOETHICS AND BIO-SAFETY (PRACTICAL)

COURSE TITLE: BIOETHICS AND BIO-SAFETY (PRACTICAL)
COURSE CODE: BCH-III.E3
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

General safety measures and study of safety notices	2P
Study of symbols and warnings on reagent bottles	1P
Study of preventive measures and first aid during laboratory hazards	1P
Demonstration of handling of fire extinguisher	1P
Practice of GLP	1P
Case study on handling and disposal of radioactive waste	2P
Case study on handling and disposal of medical/microbial waste	2P
Study of components and design of a Biosafety laboratory	2P
Study of steps of a patenting process	3P

REFERENCES:

- Das, H.K. (2008). Text book of Biotechnology, 3rd edition. 3rd Edition, Wiley India (P) Ltd, New Delhi.
- Dubey, R.C. (1993). A Textbook of Biotechnology,1st Edition, S. Chand and Company (P), Ltd. Delhi. Hill Publishing Company Limited, New Delhi.
- Krishna, V.S. (2007). Bioethics & Biosafety in Biotechnology, New Age Publishers, Bangalore.
- Plummer, D.T. (1988). An Introduction to Practical Biochemistry, 3rd Edition, Tata McGraw
- Singh, B.D.(2003). Biotechnology - Expanding Horizons, 1st edition, Kalyani Publishers, Ludhiana.
- Thomas, J.A. & Fush R.L. (2002). Biotechnology & Safety Assessment, 3rd Edition, Academic press.

PARVATIBAI CHOWGULE COLLEGE OF ARTS & SCIENCE
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DEPARTMENT OF BIOCHEMISTRY (SELF FINANCED)
APPROVE SYLLABUS FOR SEMSESTER III

COURSE TITLE: PLANT BIOCHEMISTRY (THEORY)
COURSE CODE: BCH III.E-4
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

The course will give a detailed description of the structural organization of plant cells, overview of photosynthesis and its significance, secondary metabolites and their potentials and the role of plant hormones.

LEARNING OUTCOMES:

Students will be able to understand the biochemical processes that take place in plant such as photosynthetic reactions, importance of plant hormones and secondary metabolites to plant growth and development.

BCH III.E-4 PLANT BIOCHEMISTRY (THEORY) TOTAL HOURS: 45

Unit 1 Introduction to Plant cell structure **No. of Hours: 4**
Structural and functional organization of a plant cell

Unit 2 Photosynthesis and Carbon assimilation **No. of Hours: 10**
Structure of organelle involved in photosynthesis, Structure of PSI and PSII complexes, proton gradient and electron transfer in plants and purple bacteria, Light reaction (Cyclic and non cyclic photophosphorylation), Calvin cycle and regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration

Unit 4 Nitrogen metabolism **No. of Hours: 8**

Biological Nitrogen fixation by free living and in symbiotic association, structure and function of nitrogenase enzyme.
Nitrate assimilation: Nitrate and Nitrite reductase
Primary and secondary ammonia assimilation in plants; ammonia assimilation by glutamine synthetase-glutamine oxoglutarate amino transferase (GS-GOGAT) pathway.

Unit 5 Regulation of plant growth **No. of Hours: 6**
Plant growth hormones and their effect on plant growth and development

Unit 6 Secondary metabolites **No. of Hours: 10**
Representatives alkaloid group and their amino acid precursors, function of alkaloids.
Examples of major phenolic groups; simple phenylpropanoids, coumarins, benzoic acid derivatives, flavonoids, tannins and lignin, biological role of plant phenolics
Classification of terpenoids and representative examples from each class, biological functions of terpenoids

Unit 6 Plant tissue culture **No. of Hours: 7**
Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture.
Plant regeneration pathways: organogenesis and somatic embryogenesis.
Applications of cell and tissue culture and somoclonal variation.

BCH III.E-4 PLANT BIOCHEMISTRY (PRACTICAL)

COURSE TITLE: PLANT BIOCHEMISTRY (PRACTICLAL)
COURSE CODE: BCH III.E-4
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Induction and assay of hydrolases: proteinase /amylase/lipase during germination	3P
Extraction and assay of urease	2P
Estimation of β-carotene and ascorbic acid in fruits and vegetables	3P
Estimation of phenols and tannins in fruits and vegetables	2P
Extraction and separation of photosynthetic pigments by TLC	2P
Tissue culture of plant (explants)	3P
Total	**15**

REFERENCES

- Chawla, H.S. (2002) Introduction to Plant Biotechnology, Science Publishers Inc. USA.
- De, K.K. (2008) Plant Tissue Culture, New Central Book Agency Pvt. Ltd.
- Jha, T.B. & Ghosh,B. (2005) Plant Tissue Culture, University Press (India) Pvt. Ltd.
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- Narayanswamy S. (1994). Plant cell and Tissue Culture, Tata McGraw-Hill Education.

PARVATIBAI CHOWGULE COLLEGE OF ARTS & SCIENCE
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DEPARTMENT OF BIOCHEMISTRY (SELF FINANCED)
APPROVED SYLLABUS FOR SEMSESTER IV

COURSE TITLE: METABOLISM OF BIOMOLECULES (THEORY)
COURSE CODE: BCH-IV. C-6
MARKS: 75
CREDITS: 3

COURSE OBJECTIVE:

The aim of this paper is to understand simple concepts related to metabolism, its importance in the proper functioning of each cell and its regulation by enzymes.

LEARNING OUTCOME:

Students will understand the metabolism of biomolecules of life, their contribution to body requirements of calories and energy, and comprehend how any defect in a pathway could lead to diseases.

BCH-IV.C-6 METABOLISM OF BIOMOLECULES TOTAL HOURS: 45

Unit 1 Basic concepts and design of metabolism No. of Hours: 4

Metabolism: catabolism and anabolism, ATP as energy currency, energy relationship between catabolic and anabolic pathways, ATP cycle

Unit 2 Carbohydrate metabolism No. of Hours: 10

Glycolysis, Tri-Carboxylic Acid cycle, Pentose-phosphate pathway, Gluconeogenesis, glycogen synthesis and breakdown, glyoxylate pathway

Unit 3 Oxidative phosphorylation No. of Hours: 8

The respiratory chain in mitochondria, proton gradient powering ATP synthesis
Transfer of cytosolic reducing equivalents to mitochondria: glycerol-3- phosphate and malate-aspartate shuttle

Unit 4 Fatty acid synthesis and degradation **No. of Hours: 10**

Digestion, mobilisation and transport of cholesterol and triacyl glycerols

β-oxidation of fatty acids, ketone bodies

Biosynthesis of saturated and unsaturated fatty acids, and elongation of fatty acids

Unit 5 Amino acid metabolism **No. of Hours: 6**

Overview of biosynthesis and catabolism of amino acids; regulation of amino acid biosynthesis

Urea cycle

Unit 6 Nucleotide metabolism **No. of Hours: 7**

Biosynthesis - *de novo* and salvage pathways, degradation

BCH- IV. C-6 METABOLISM OF BIOMOLECULES (PRACTICAL)

COURSE TITLE: METABOLISM OF BIOMOLECULES (PRACTICLAL)
COURSE CODE: BCH-IV. C-6
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Alcohol fermentation by yeast	2P
Estimation of blood glucose	1P
Separation of fatty acids by TLC	2P
Isolation of lecithin and its estimation	3P
Isolation of cholesterol from egg yolk and its estimation	3P
Estimation of protein and nucleic acid by direct spectroscopy	1P
Urea estimation	1P
Uric acid estimation	1P

REFERENCES

- Gupta, P.K. (1999). A Text-book of Cell and Molecular Biology, Rastogi Publcations, Meerut, India.
- Jain, J.L (1999). Fundamentals of Biochemistry, S.Chand and Company, Ltd., New Delhi.
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- Nelson, D. L. & Cox, M.M. (2000). Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
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DEPARTMENT OF BIOCHEMISTRY (SELF FINANCED)
APPROVED SYLLABUS FOR SEMSESTER IV

COURSE TITLE: HUMAN PHYSIOLOGY (THEORY)
COURSE CODE: BCH-IV.E-5
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:
This course is designed to provide students with an understanding of the function & regulation of the human body and physiological integration of the organ systems to maintain homeostasis.

LEARNING OUTCOMES:
Students will develop in-depth insight into the function of the major organs and organ systems of the human body and will understand the unique role of each organ and organ system in maintaining constancy of the internal environment.

BCH-IV.E-5 HUMAN PHYSIOLOGY (THEORY) TOTAL HOURS: 45

Unit 1 Homeostasis and the organization of body fluid compartments No. of Hours: 8
Intracellular, extracellular and interstitial fluid, Plasma,
Homeostasis
Blood coagulation: molecular mechanism, role of vitamin K.
Anemias, polycythemia, haemophilia and thrombosis

Unit 2 Digestion No. of Hours: 6
Gastrointestinal tract, secretory functions, digestion, absorption
Liver metabolism: glycogen storage, bile secretion, detoxification
Liver function tests, jaundice, fatty liver, liver cirrhosis.

Unit 3 Muscular System No. of Hours: 5
Introduction to the muscular system

Types of Muscles, Physiology of muscle contraction

Unit 4 Respiration and Circulation **No. of Hours: 6**

The Respiratory system – organs and their function

The Circulatory system: cardiovascular and lymphatic systems- components and their function

Unit 5 Excretory system **No. of Hours: 6**

The excretory system and associated functions

Anatomy of the kidney and the nephron

Renal function tests

Unit 6 Nervous system **No. of Hours: 6**

The nervous system and associated functions

Membrane potential, Synaptic transmission, Neurotransmitters

Unit 7 Reproductive physiology **No. of Hours: 8**

Spermatogenesis and Oogenesis

Mammalian reproductive physiology – male and female reproductive system

BCH-IV.E-5 HUMAN PHYSIOLOGY (PRACTICAL)

COURSE TITLE: HUMAN PHYSIOLOGY (PRACTICLAL)
COURSE CODE: BCH-IV.E-5
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Study of the physiology systems in human using charts	1P
Determination of blood group	1P
RBC and WBC counting	1P
Differential leucocyte count	1P
Determination of Clotting time	1P
Estimation of haemoglobin	1P
Determination of ESR	1P
Determination of PCV	1P
Observation of permanent slides – Transverse section of mammalian gonads	2P
Analysis of human blood pressure and pulse rate in man	1P
Osmolarity of RBC's (Effect of different salt solutions of RBC's)	2P
Determination of glucose in urine	1P
Determination of albumin in urine	1P

REFERENCES

- Arora M.P. (2011). Animal physiology, Himalaya publishing house, New Delhi.
- Sembulingam K. & Sembulingam P. (2012). Essentials of Medical Physiology, Sixth edition., Jaypee brothers medical publishers (P) Ltd, New Delhi.
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DEPARTMENT OF BIOCHEMISTRY (SELF FINANCED)
APPROVED SYLLABUS FOR SEMSESTER IV

COURSE TITLE: NUTRITIONAL BIOCHEMISTRY (THEORY)
COURSE CODE: BCH-IV.E-6
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

The course will give a detailed description of the knowledge and understanding of human nutrition, nutritional aspects of the various classes of food with the nutritional requirements.

LEARNING OUTCOMES:

Students will acquire detailed knowledge regarding the biological basis of nutrition and the mechanisms by which diet can influence health, and understand the implications of nutritional status and nutritional disorders.

BCH-IV.E-6 NUTRITIONAL BIOCHEMISTRY (THEORY) TOTAL HOURS: 45

Unit 1 Introduction to Nutrition and Energy Metabolism No. of Hours: 6
Defining Nutrition, role of nutrients, Unit of energy, Biological oxidation of foodstuff, measurement of energy content of food, Physiological energy value of foods
Antioxidants and their role
Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances (RDA) for different age groups
Basal Metabolic Index (BMI)

Unit 2 Dietary Carbohydrates No. of Hours: 8
Dietary requirements and source of carbohydrates, Hormonal regulation of blood glucose, hypo- and hyper-glycemic disorders

Fibre and its significance in diet

Unit 3 Dietary Lipid **No. of Hours: 8**

Essential Fatty Acids (EFA); Functions and deficiency

Significance of: a) Mono- and Poly-unsaturated fatty acids, b) Saturated fatty acids, c) Omega fatty acids, d) Phospholipids, e) Triglycerides, f) Cholesterol.

Unit 4 Dietary Proteins **No. of Hours: 8**

Essential and Nonessential amino acids, Food source, Nitrogen balance

Supplements – risk of imbalance and toxicity of amino acids

Protein deficiency: Protein energy malnutrition (PEM) – Kwashiorkar

Unit 5 Vitamins **No. of Hours: 8**

Fat soluble vitamins: physiological role, deficiency disorders, toxicity of Vitamin A.

Water soluble vitamins: physiological role, differential diagnosis of B12 and folate, deficiency disorders

Unit 6 Mineral metabolism **No. of Hours: 7**

Physiologic role and deficiency disorders of Macro- and micro-nutrients – calcium, magnesium, sodium, potassium, iron, phosphorus, sulphur and chlorine and trace elements

Assessment of anaemia, glycosylated Hb

BCH-IV.E-6 NUTRITIONAL BIOCHEMISTRY (PRACTICAL)

COURSE TITLE: NUTRITIONAL BIOCHEMISTRY (PRACTICLAL)
COURSE CODE: BCH-IV.E-6
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Preparation of Probiotics, microscopy and sensory evaluation	2P
Assessment of food constituents	10P

- Vitamin C
- Lycopene from tomatoes
- β-carotene from carrot
- Calcium from milk
- Phosphorus

Assessment of nutritional disorders:	3P

- Hyperglycemia
- Cholesterol
- Anaemia

REFERENCES

- Gibson R. (2005). Principles of Nutritional Assessment. Oxford University Press.
- Frazier W.C & Westhoff D.C. (2015). Food Microbiology. 5th edition. McGraw Hill Education (India) Private Limited: New Delhi
- Tiwari R.P, Hoondal G.S. & Tewari R. (2009). Laboratory Techniques in Microbiology and Biotechnology, Abhishek Publications Chandigarh (India).
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- Williams M.H, Anderson D.E, Rawson E.S. (2013). Nutrition for health, fitness and sport; McGraw Hill international edition.

PARVATIBAI CHOWGULE COLLEGE OF ARTS & SCIENCE

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DEPARTMENT OF BIOCHEMISTRY (SELF FINANCED)

APPROVED SYLLABUS FOR SEMSESTER IV

COURSE TITLE: HORMONE BIOCHEMISTRY AND FUNCTION (THEORY)
COURSE CODE: BCH-IV.E-7
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

The course will give a detailed description of the roles of the endocrine system in maintaining homeostasis, integrating growth and development, and the different mechanisms of action of hormones.

LEARNING OUTCOMES:

Students will understand the physiological actions of hormones, the relation to human disorders and the consequences of under- and over-production of hormones.

BCH-IV.E-7 HORMONE: BIOCHEMISTRY AND FUNCTION (THEORY)

TOTAL HOURS: 45

Unit 1 Introduction to endocrinology **No. of Hours: 7**

Chemical classification of hormones
Functions of hormones and their regulation
Chemical signalling

Unit 2 Hypothalamic and pituitary hormones **No. of Hours: 8**

Hypothalamic hormones
Pituitary hormones eg GH, TSH, oxytocin, vasopressin
Feedback regulation cycle
Endocrine disorders – gigantism, dwarfs and diabetes insipidus

Unit 3 Thyroid hormone **No. of Hours: 6**

Biosynthesis of thyroid hormone and its regulation; its physiological and biochemical action
Pathophysiology - Goiter, Grave's disease, cretinism

Unit 4 Parathyroid hormones **No. of Hours: 6**

Role of PTH, Vitamin D and calcitonin in regulation of Ca^+ homeostatis.
Pathophysiology - rickets, osteomalacia, osteoporosis

Unit 5 Pancreatic and GI tract hormones **No. of Hours: 6**

Regulation of release of insulin, glucagon, gastrin, secretin, CCK
Pathophysiology - diabetes type I and type II.

Unit 6 Adrenal hormones **No. of Hours: 6**

Epinephrine and norepinephrine. Fight or flight response, stress response.
Pathophysiology – Addison's disease, Cushing syndrome.

Unit 7 Reproductive hormones **No. of Hours: 6**

Male and female sex hormones, Hormones during reproductive cycle, pregnancy, parturition and lactation

BCH-IV.E-7 HORMONE: BIOCHEMISTRY AND FUNCTION (PRACTICAL)

COURSE TITLE: HORMONE: BIOCHEMISTRY AND FUNCTION (PRACTICAL)

COURSE CODE: BCH-IV.E-7

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Histology of endocrine structures	2P
Glucose tolerance test	1P
Estimation of serum Ca^{2+}	2P
HCG based pregnancy test	1P
Estimation of serum electrolytes: sodium and potassium	2P
ELISA	2P
Case studies	5P

REFERENCES

- Talwar G.P, Srivastava L.M. and Moudgil K.D. (1989). Textbook of Biochemistry and Human Biology (2nd Edition), Prentice-Hall of India Private Limited, New Delhi, India.
- Nelson D.L. and Cox, M.M. (2013). Lehninger: Principles of Biochemistry, 3rd edition, Worth Publishers, New York, USA.
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DEPARTMENT OF BIOCHEMISTRY (SELF FINANCED)
APPROVED SYLLABUS FOR SEMSESTER IV

COURSE TITLE: ADVANCED CELL BIOLOGY (THEORY)
COURSE CODE: BCH-IV.E-8
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:
The course will give a detailed description of the how eukaryotic cells receive, transmit and respond to environmental signals, cellular regulation of cell cycle progression and cell death. The principal and working of the essential tools used in cell biology will also be covered.

LEARNING OUTCOMES:
Students will develop insight into the complexities of cell structure and function, the molecular controls that govern the cells' dynamic properties, and cellular interactions with the organism as a whole.

BCH-IV.E-8 ADVANCED CELL BIOLOGY (THEORY) TOTAL HOURS: 45

Unit 1 Membrane transport No. of Hours: 12
Composition and properties of cell membrane; structure of nuclear envelope; nuclear pore complex
Transport across nuclear envelope
-Simple diffusion and facilitated diffusion
-Passive transport - glucose transporter, anion transporter
-Primary active transporters - P type ATPases, V type ATPases, F type ATPases
-Secondary active transporters – Na^+ glucose symporter
-Ion channels: voltage-gated ion channels (Na^+/K^+ voltage-gated channel)

Unit 2 Membrane potentials and nerve impulses No. of Hours: 4
Resting potential

Action potential

Propagation of action potentials

Neurotransmission

Unit 3 Cell Cycle and Programmed Cell Death **No. of Hours: 12**

Cell cycle; events of mitosis; cytokinesis;

Events of meiosis; regulation of cell division;

Apoptosis (extrinsic and intrinsic pathway)

Unit 4 Cancer Biology **No. of Hours: 8**

Development and causes of cancer; genetic basis; oncogenes, tumor viruses

Unit 5 Tools in Cell Biology **No. of Hours: 9**

Microscopy: Light microscope, Phase contrast microscope, Inverted microscope, Fluorescence microscope, Confocal microscope, Electron microscope

Centrifugation: Differential and gradient centrifugation for sub-cellular fractionation

BCH-IV.E-8 ADVANCED CELL BIOLOGY (PRACTICAL)

COURSE TITLE: ADVANCED CELL BIOLOGY (PRACTICLAL)
COURSE CODE: BCH-IV.E-8
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Identification of different stages of mitosis (in onion root tip) `	1P
Identification of different stages of meiosis (in flower buds)	1P
Study of cell viability by neutral red (viable cells) and trypan blue (non-viable cells)	1P
Identification and study of cancerous cells using permanent slides/ photomicrographs	2P
Study of plant, animal and human tumour viruses using photomicrographs	2P
Differential centrifugation for separation of cellular components	1P
Preparation of sucrose density gradient and purification of sub cellular organelles: visualization of nuclear fraction by acetocarmine stain and mitochondria by Janus green stain	5P
Study of electron micrographs of sub-cellular organelles	2P
Total	**15**

REFERENCES

- Krebs, J.E., Goldstein, E.S. & Kilpatrick, S.T. (2014). Lewin's Genes XI, Jones and Bartlett India Pvt. Ltd.
- Nelson, D. L. & Cox, M.M. (2000). Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
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- Verma, P.S. & Agarwal, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Pvt. Ltd.
- Verma, A.S., Das, S. & Singh, A. (2014). Laboratory Manual for Biotechnology, 1st Edition, S. Chand & Company Pvt. Ltd.

DEPARTMENT OF BIOCHEMISTRY

3 Year Under-Graduate Degree Programme in Biochemistry (Self financed)

COURSE STRUCTURE

Sem	Core		Elective			
I	**BCH-I.C-1** Molecules of Life	**BCH-I.C-2** Cell Biology	--------	--------	--------	--------
II	**BCH-II.C-3** Protein chemistry	**BCH-II.C-4** Biophysics	--------	--------	--------	--------
III	**BCH-III.C-5** Enzymology		**BCH-III.E-1** Tools and Techniques in Biochemistry	**BCH-III.E-2** Microbiology	**BCH-III.E-3** Bioethics and Bio-safety	**BCH-III.E-4** Plant Biochemistry
IV	**BCH-IV. C-6** Metabolism of Biomolecules		**BCH-IV.E-5** Human physiology	**BCH-IV.E-6** Nutritional Biochemistry	**BCH-IV.E-7** Hormone: Biochemistry and Function	**BCH-IV.E-8** Advanced Cell Biology
V	**BCH-V.C-7** Molecular biology		**BCH-V.E-9** Concepts in genetics	**BCH-V.E-10** Regulation of gene expression	**BCH-V.E-11** Genetic Engineering and Biotechnology	**BCH-V.E-12** Bioinformatics
VI	**BCH-VI.C-8** Immunology		**BCH-VI.E-13** Biochemical correlation of Diseases	**BCH-VI.E-14** Clinical Biochemistry	**BCH-VI.E-15** Environmental Biochemistry	**BCH-VI.E-16** Industrial Biochemistry

SEMESTER: V

COURSE TITLE: MOLECULAR BIOLOGY (THEORY)

COURSE CODE: BCH-V.C-7

MARKS: 75

CREDITS: 3

COURSE OBJECTIVE: This paper provides insight on replication, transcription and translation process in prokaryotes and eukaryotes, various mutations and their repair mechanisms.

LEARNING OUTCOME: On completion of this module, students will be able to understand the nature of genetic materials and the basic concepts in Molecular Biology.

BCH-V.C-7 MOLECULAR BIOLOGY (THEORY) Total hours: 45

Unit I: Basic Concepts in Molecular Biology No. of Hours: 8

Experiments proving DNA as genetic material: S. F. Griffith's transforming principle, Avery, and Hershey and Chase Experiment; evidences for RNA as the genetic material of some viruses, Chargaff's experiments and Law; Watson – Crick Model

Unit II: Chemical Nature of Genetic Materials No. of Hours: 8

Structural components of nucleic acid: sugar, phosphate, Nucleosides & Nucleotides

Structure of DNA, Structure of RNA, Differences between DNA and RNA, Different forms of DNA (A, B, C, D, E, Z), Forces stabilizing the structure of DNA, unusual structures of DNA (palindromic, mirror repeat, hairpin bent, cruciform)

Unit III: DNA Replication No. of Hours: 8

Experimental evidence for semi-conservative DNA replication in *E.coli* - Meselson and Stahl's experiment;

The basic requirements of DNA replication: Template, DNA Polymerases: Structure and Function, Ancillary proteins associated with replication

Mechanism of replication: Initiation, Elongation and Termination

Unit IV: DNA Damage and its Repair **No. of Hours: 5**

Mutations and Types of Mutations: Spontaneous and Induced mutation, physical and chemical mutagens (ethidium bromide, alkylating agents, base analogs)

DNA Repair Mechanisms: Mismatch, photo-reactivation repair, Excision repair

Unit V: Transcription **No. of Hours: 8**

Mechanism of prokaryotic transcription- Transcription factors and machinery, formation of initiation complex, RNA polymerase enzyme, initiation, elongation and termination, RNA processing: capping, splicing, polyadenylation

Unit VI: Protein Synthesis **No. of Hours: 8**

Central dogma, the translation machinery, ribosomes, composition and assembly;

Mechanism of protein synthesis - initiation, elongation and termination; genetic code

BCH-V.C-7 MOLECULAR BIOLOGY (PRACTICAL)

COURSE TITLE: MOLECULAR BIOLOGY (PRACTICAL)

COURSE CODE: BCH-V.C-7

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Isolation of genomic DNA from prokaryotes	2P
Isolation of genomic DNA from eukaryotes	2P
Isolation of plasmid DNA from prokaryotes	2P
Agarose gel electrophoresis of DNA	2P
Elution of DNA from agarose gel	1P
Determination of molecular size of DNA by Agarose Gel Electrophoresis	1P
Mutagenesis in *E.coli* cells – UV survival or Chemical mutagens	4P
Purity of DNA by spectrophotometric method	1P

REFERENCES

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- Karp, G. & Harris, D. (2008) Cell and Molecular Biology – Concepts and Experiments, John Wiley & Sons Inc, New York.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Watson, J.D., Hopkins, N.H. et al. (2008). Molecular Biology of the Gene, Garland Publishing (Taylor & Francis Group), New York & London.
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SEMESTER: V
COURSE TITLE: CONCEPTS IN GENETICS (THEORY)
COURSE CODE: BCH-V.E-9
MARKS: 75
CREDITS: 3

COURSE OBJECTIVE: Genetics allows for the understanding of the structure and function of genes and chromosomes as well as the harmful effects of mutations which can cause various genetic disorders. Overall, this paper provides a platform for delving further into studies of Molecular Biology and Genetics.

LEARNING OUTCOME: On completion of this module, students will be able to understand the inheritance patterns and the basic principles of genetics. They will learn about the different mutations, its effects on cells and the application of the same to research.

BCH-V.E-9 CONCEPTS IN GENETICS (THEORY) Total hours: 45

Unit 1 Introduction to model organisms No. of Hours: 4

Model organisms: *Escherichia coli*, *Saccharomyces cerevisiae*, *Drosophila melanogaster*, *Caenorhabditis elegans*

Unit 2: Mendelian Genetics and deviations from Mendel's laws **No. of Hours: 8**

Mendelian Genetics: History of Mendelian genetics, First Law of Inheritance, Second Law of Inheritance, monohybrid and dihybrid cross, test cross and back cross and their significance.

Deviations: Dominance, co-dominance, incomplete dominance; Multiple alleles: ABO blood group, Rh incompatibility

Gene interaction - Epistasis: Dominant and Recessive epistasis with example; Non epistatic gene interactions

Unit 3 Genetics of bacteria and viruses **No. of Hours: 3**

Mechanism of genetic exchange - conjugation, transformation and transduction

Unit 4 Linkage and crossing over **No. of Hours: 8**

Sutton-Boveri chromosome theory of heredity

Bateson and Punnet's coupling and repulsion hypothesis, Morgan's views on linkage,

Theory of linkage; kinds of linkage: complete linkage, incomplete linkage; significance of linkage

Types of crossing over: somatic or mitotic crossing over, germinal or meiotic crossing over; mechanism of meiotic crossing over: synapsis, duplication of chromosomes, crossing over by breakage and union, terminalisation, significance of crossing over

Unit 5 **Human genetics** **No. of Hours: 8**

Pedigree analysis; human traits

Disorders due to mutant genes: PTC tasters, Huntington's chorea, tongue rolling

Disorders due to inborn errors of metabolism — phenylketonuria (PKU), alkaptonuria, sickle-cell anaemia

Disorders due to autosomal and sex chromosomal anomalies involving numerical and structural aberrations (Down's, Cri-du-chat, Klinefelter's and Turner's syndromes)

Unit 6 Chromosomal aberrations **No. of Hours: 4**

Types of structural changes (deletion, duplication, inversion, translocation, variation in chromosome morphology)

Types of numerical changes (Euploidy and Aneuploidy) - monosomy and trisomy of sex and autosomes

Unit 7 Determination of Sex and Sex Differentiation **No. of Hours: 6**

Genetically controlled sex determining mechanisms: (heterogamesis);

types: heterogametic males, heterogametic females,

genic balance mechanism,

sex determination in *Drosophila melanogaster* and man,

male haploidy or haplodiploidy mechanism,

Hormonally controlled sex determining mechanism eg Sex in Bonellia

Environmentally controlled sex determining mechanism- eg marine annelid *Ophryotrocha*

Unit 8 Population genetics **No. of Hours: 4**

Hardy-Weinberg law, Factors affecting Hardy Weinberg theory, predicting allele and genotype frequencies and exceptions to Hardy-Weinberg principle

BCH-V.E-9 CONCEPTS IN GENETICS (PRACTICAL)

COURSE TITLE: CONCEPTS IN GENETICS (PRACTICAL)
COURSE CODE: BCH-V.E-9
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Study of a Dissection microscope	1P
Study of Barr bodies in sex determination	1P
Pedigree analysis and problem solving	3P
Problem solving on Mendel's laws & Hardy-Weinberg's law	3P
Study of Mendelian traits in Human Population	3P
Karyotype analysis of chromosomal abnormalities	3P
Smear technique to demonstrate sex chromatin in buccal epithelial cells	1P

REFERENCES

- Gardner, E. J., Simmons, M. J. & Snustad, D. P. (2013). Principles of Genetics, 8th Edition, John Wiley and Sons.

- Jayaraman, K. & Jayaraman, R. (1979). Laboratory manual in Molecular Genetics, John Wiley and Sons.
- Krebs, J.E., Goldstein, E.S. & Kilpatrick, S.T. (2014). Lewin's Genes XI, Jones and Bartlett India Pvt. Ltd.
- Tamarin, R.H. (2002). Principles of Genetics, 7th Edition, Tata McGraw-Hill Publishing Company Ltd.
- Verma, P.S. & Agarwal, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Pvt. Ltd.

SEMESTER: V
COURSE TITLE: REGULATION OF GENE EXPRESSION (THEORY)
COURSE CODE: BCH-V.E-10
MARKS: 75
CREDITS: 3

COURSE OBJECTIVE: This paper provides insight on transcription, translation, genetic code and gene regulation in prokaryotes and eukaryotes.

LEARNING OUTCOME: On completion of this module, students will be able to understand the concept of operon, differences between prokaryotic and eukaryotic transcription, translation and gene regulation.

BCH-V.E-10 REGULATION OF GENE EXPRESSION (THEORY) Total hours: 45

Unit 1 Biosynthesis of RNA in prokaryotes No. of Hours: 8

RNA polymerases, sigma factor, bacterial promoters,
The three stages of RNA synthesis- initiation, elongation and termination (rho-dependent and rho-independent)
Inhibitors of transcription and applications as anti-microbial drugs

Unit 2 Biosynthesis of RNA in eukaryotes No. of Hours: 8

Transcription by RNA polymerase II, RNA polymerase II core promoters, general transcription factors, various types of RNA processing, transcription by RNA polymerase I and III.

Inhibitors of eukaryotic transcription and their applications

Comparison between prokaryotic and eukaryotic transcription

Unit 3 RNA splicing **No. of Hours: 2**

The spliceosome machinery, group I and group II introns, alternative splicing, exon shuffling

Unit 4 The genetic code **No. of Hours: 3**

Degeneracy of the genetic code, wobble in the anticodon, features of the genetic code

Unit 5 Biosynthesis of proteins **No. of Hours: 8**

Machinaries- Messenger RNA, transfer RNA, attachment of amino acids to tRNA, the ribosome

Steps: initiation, elongation and termination of translation,

Comparison of prokaryotic and eukaryotic protein synthesis

Use of antibiotics in understanding protein synthesis

Unit 6 Regulation of gene expression in prokaryotes **No. of Hours: 8**

Role of operators in prokaryotic transcription

The lactose operon, the tryptophan operon

Coordination of transcription and translation in prokaryotes- Stringent response Regulatory ribosomal proteins

Unit 7 Regulation of gene expression in eukaryotes **No. of Hours: 8**

Trans-acting molecules, Cis-acting regulatory elements,

Regulation by co- and post transcriptional processing of mRNA- splicing, mRNA editing, RNA interference (RNAi), Regulation of mRNA at translational level

Regulation through modifications to DNA

BCH-V.E-10 REGULATION OF GENE EXPRESSION (PRACTICAL)

COURSE TITLE: REGULATION OF GENE EXPRESSION (PRACTICAL)

COURSE CODE: BCH-V.E-10

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Ultraviolet absorption spectrum of DNA and RNA	2P
Determination of the melting temperature and GC content of DNA	2P
Isolation and estimation of RNA using Orcinol reagent	2P
Qualitative and quantitative analysis of DNA using spectrophotometer	3P
To study the viscosity of DNA solutions	1P
Gene expression via induction of enzyme(s) from suitable sources and confirmation by qualitative/quantitative assay/electrophoresis	5P

REFERENCES

- Krebs, J.E., Goldstein, E.S. & Kilpatrick, S.T. (2014). Lewin's Genes XI, Jones and Bartlett India Pvt. Ltd.
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- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Watson, J.D., Hopkins, N.H. et al. (2008). Molecular Biology of the Gene, Garland Publishing (Taylor & Francis Group), New York & London.
- Verma, P.S. & AgarwaL, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Pvt. Ltd.

SEMESTER: V

COURSE TITLE: GENETIC ENGINEERING AND BIOTECHNOLOGY (THEORY)

COURSE CODE: BCH-V.E-11

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES: The paper aims to introduce the students to the principles and techniques involved in Genetic Engineering. This paper will define the meaning of Genetic engineering and the methods used in Genetic engineering of genes through the use of genetic material and vehicles for suitable manipulation of genes.

LEARNING OUTCOME: On completion of this module, students will be able to understand how genes are genetically engineered and the need for the same. The practical component will train them towards performing with understanding genetic manipulations of genes.

BCH-V.E-11 GENETIC ENGINEERING AND BIOTECHNOLOGY Total hours: 45

Unit 1 Introduction to genetic engineering **No. of Hours: 2**

General features and mechanisms, applications and ethical issues of recombinant DNA technology

Unit 2 DNA modifying enzymes **No. of Hours: 3**

Nucleases- Endonucleases (Restriction enzymes recognition sequences, cleavage pattern), Exonucleases, host control restriction and modification, DNA ligases, Reverse Transcriptases, Polynucleotide kinases, Alkaline phosphatises, Nucleotidyl transferases

Unit 3 Tools/Vectors for Gene cloning **No. of Hours: 10**

Vectors - properties of ideal cloning vectors

Types of cloning vectors (with examples):

Plasmids - Properties, Classification

Vector for Prokaryotes - pBR322, pUC 18

Bacteriophage vectors: Lambda Bacteriophages –Features, Insertional vectors and Replacement vectors,M13 Bacteriophage

Cosmids, Phagemids and Phasmids

Plant vectors

Shuttle vectors - any one example)

Unit 4 DNA Insertion into Vector **No. of Hours: 3**

Ligation, Use of linkers and Adaptors, Homopolymer tailing

Unit 5 Transformation methods **No. of Hours: 8**

Competence (transformation in bacteria),

Microinjection, Lipofection, Electroporation, Macroinjection, Sonication, Silicon carbide fibre vortex, DNA co-precipitation, Ultrasonication, Laser induced

Unit 6 Identification of Recombinants **No. of Hours: 4**

Principle and importance of identification of recombinants

- Antibiotic resistance (amp, tet resistance)
- lac Z selection
- Colony hybridization

Unit 7 DNA isolation methods and analysis **No. of Hours:** 5

Principle and Isolation of Genomic DNA & plasmid DNA

Spectrophotometric analysis of DNA, Agarose gel electrophoresis, Southern blotting, Purification of DNA

Unit 8 DNA Amplification **No. of Hours: 3**

Polymerase chain reaction (Principle, components, method and applications of PCR)

Unit 9 DNA sequencing **No. of Hours: 5**

Significance and importance of DNA sequencing, Basic methods: Maxam Gilbert's method, Sanger's method. Advanced method: Shotgun method, Automatic DNA sequencer

Unit 10 Genomic / cDNA libraries **No. of Hours:** 2

Preparation of genomic library, cDNA library, Screening of Libraries

BCH-V.E-11 GENETIC ENGINEERING AND BIOTECHNOLOGY (PRACTICAL)

COURSE TITLE: GENETIC ENGINEERING AND BIOTECHNOLOGY (PRACTICAL)
COURSE CODE: BCH-V.E-11
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Plasmid DNA isolation by alkaline lysis method	2P
Plasmid DNA isolation by boiling method	2P
Plasmid DNA separation by agarose gel electrophoresis method	2P
Molecular weight determination of plasmid DNA	2P

Preparation of competent cells in bacteria	2P
Transformation in bacteria using suitable plasmid (pUC 18)	3P
Deciphering the DNA sequence from a sequencing gel photograph by Maxam and Gilbert's method and Sanger's method	2P

REFERENCES

- Jogdand, S.N. (2008). Gene Biotechnology, 2nd edition, Himalaya Publishing House, Mumbai.
- Primrose, S.B. & Twyman, R.M. (2009). Principles of Gene Manipulation and Genomics, Blackwell Publishing.
- Purohit, S.S. (2009). Biotechnology: Fundamentals and Applications, Student Edition.
- Singh, B.D. (2008). Biotechnology: Expanding Horizons, Kalyani publishers.
- Watson, J.D., Tooze, J. & Kurtz, D.T. (1983). Recombinant DNA: A short Course, Scientific American Books (WH Freeman), New York.

SEMESTER: V

COURSE TITLE: BIOINFORMATICS (THEORY)

COURSE CODE: BCH-V.E-12

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES: This paper aims at introducing the importance of the basics of computers, concept of Human Genome Project, storage of biological information and tools and techniques of bioinformatics used and their importance in the field of biotechnology.

LEARNING OUTCOME: On completion of this paper the students will be able to understand the importance of computers and networking and the various types of biological databases used for storing genetic information of various organisms and the use of various tools and techniques used for retrieving the same that maybe used in present life and be able to solve interesting and novel scientific problems.

BCH-V.E-12 BIOINFORMATICS (THEORY) **Total hours: 45**

Unit 1 Introduction to Computers in Biology **No. of Hours:** 5

Introduction to use of computers, internet and software's in biology, medicine and research

Historical developments in Biology

Unit 2 DNA, RNA and Proteins & HGP **No. of Hours:** 4

Background of DNA, RNA and Proteins, ORF

Introduction to HGP, Objectives

Ethical and Social issues

Unit 3 Introduction to Bioinformatics **No. of Hours:** 3

Definition, Scope of Bioinformatics

Components of Bioinformatics and Applications

Unit 4 Information resources **No. of Hours:** 6

Introduction, aim and objectives (NCBI, NLM, NIH, EBI and SRS)

Unit 5 Biological databases **No. of Hours:** 6

Types of biological databases

Primary databases : Gen Bank and EMBL, DDBJ

Secondary databases:Swiss-PROT, PDB & PIR

Composite databases: OWL & PROSITE

Unit 6 Structural databases **No. of Hours:** 5

PDB, MMDB, CATH & SCOP

Visualization of proteins – Cn3D and Rasmol

Unit 7 Literature databases **No. of Hours:** 3

Pubmed, MedLINE & OMIM

Unit 8 BLAST & FASTA **No. of Hours:** 4

Introduction, BLAST & FASTA and their types

Unit 9 Sequence Alignmnent tools and Phylogeny **No. of Hours:** 6

Pairwise sequences alignment

Multiple sequence alignment using Clustal-W Omega

Introduction, Definition, construction, structure and types of phylogenetic trees

Differences between cladogram and phylogenetic tree

BCH-V.E-12 BIOINFORMATICS (PRACTICAL)

COURSE TITLE: BIOINFORMATICS (PRACTICAL)

COURSE CODE: BCH-V.E-12

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Introduction to Bioinformatics & its Applications	1P
Study of Human Genome Project	1P
Usage of NCBI resources	2P
Biological data search using NCBI – Protein or amino acid sequences	1P
Biological data search using NCBI – DNA or gene sequences	1P
Biological data search using NCBI – Literature & Structure databases	2P
Database search & Pairwise sequence alignment using NCBI BLAST: BLASTp & BLASTn	2P
Multiple sequence alignment using Clustal-W	1P
Construction of phylogenetic tree using Clustal-W	1P
DNA sequence analysis to find restriction enzymes sites using NEBcutter	1P
Visualization of protein structures using Cn3D/ Rasmol	2P

REFERENCES

- Harisha, S. (2007). Fundamentals of Bioinformatics, I.K. International Publishing House, Mumbai.
- Ignacimuthu, S. (2005). Basic Bioinformatics, Narosa Publishing House, New Delhi.
- Mount, D.W. (2004). Bioinformatics – sequence and Genome analysis, CBS Publishers.
- Murthy,C.S.V. (2003). Bioinformatics, Himalaya Publishing House, Mumbai.
- Rastogi, S.C., Mendiratta, N. & Rastogi, P. (2004). Bioinformatics: Concepts, Skills and Applications, CBS Publishers.
- Xiong, J. (2006). Essential Bioinformatics, Cambridge University Press.

SEMESTER VI

COURSE TITLE: IMMUNOLOGY (THEORY)

COURSE CODE: BCH-VI.C-8

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES: This paper aims at introducing the basic concepts of the immune system and its defence mechanisms. A section on vaccination, monoclonal and polyclonal antibodies stresses on the importance of these for treatment of lethal diseases.

LEARNING OUTCOME: On completion of this module, the student will be able to understand all about the immune system and various antigen-antibody interactions involved in certain immune reactions.

BCH-VI.C-8 IMMUNOLOGY (THEORY) **Total hours: 45**

Unit 1 Immune system and Autoimmunity **No. of Hours: 10**

Types of Immunity (Innate and Acquired)

Barriers of Innate Immunity – anatomic, physiologic, phagocytic, inflammatory

Collaboration between innate and adaptive immunity

Introduction to Humoral and Cell mediated immunity

B-cells & T-cells

Maturation, Activation of B-cells and T-cells

Introduction to Autoimmunity (any one example)

Unit 2 Cells and Organs of the Immune system **No. of Hours: 8**

Cells (myeloid and lymphoid lineage)

Immuno-reactive Cells (Macrophages, Granulocytes, NK Cells)

Primary lymphoid organs (bone marrow and thymus)

Secondary lymphoid organs (spleen, lymph nodes, GALT and MALT)

Unit 3 Antigens- Antibodies and their interactions **No. of Hours: 10**

Introduction to Antigens and Antibodies

Antigen: Structure, types, classes, properties and variants, adjuvants

Antibody: structure, types, kinds, paratope, epitope, abnormal immunoglobulin, antibody diversity, functions, factors affecting antibody production.

Antigen – Antibody Interaction

Forces involved in antigen-antibody reaction

Concept of affinity, avidity, precipitation, agglutination reactions

Unit 4 MHC and Hypersensitivity **No. of Hours: 10**

Major Histocompatibility Complex (MHC)

Introduction and discovery of Human Histocompatibility complex

Structure of MHC I and II

Presence of MHC I and II on different cells and their significance

Hypersensitivity - Introduction

Hypersensitive reactions (Type I and Type II, III, IV)

Unit 5 Complement system **No. of Hours: 7**

Functions, components and activation pathways (Classical, Alternate & Lectin)

BCH-VI.E-8 IMMUNOLOGY (PRACTICAL)

COURSE TITLE: IMMUNOLOGY (PRACTICAL)

COURSE CODE: BCH-VI.E-8

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Total count of WBC & RBCs using haemocytometer	2P
Differential count of WBC	1P
Blood grouping & Rh factor	1P
Single Radial Immunodiffusion	2P
Ouchterolony's double diffusion method	2P
Immunoelectrophoresis	2P
Serological tests involving precipitations (Pregnancy & Widal)	3P
Estimation of haemoglobin by Sahali's method	1P

REFERENCES

- Arora, M.P. (2006). Cell Biology, Immunology and Environmental Biology, Himalaya Publishing House.
- Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Kuby, J (2000).Immunology, W.H. Freeman & Company
- Rao, C.V. (2011). Immunology, Narosa Book Distributors Pvt. Ltd.
- Roitt, I.M., Brostoff, J. & Male, D.K. (1993). Immunology, Mosby-Year book Europe Limited.

SEMSESTER VI
COURSE TITLE: BIOCHEMICAL CORRELATION OF DISEASES (THEORY)
COURSE CODE: BCH- VI.E-13
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES: This paper aims to make students familiar with various control and metabolic regulation and integrating mechanisms of diverse biochemical events in different metabolic processes, and to understand normal and abnormal human metabolism.

LEARNING OUTCOME: On completion of this module, the student will be able to understand how chemical and biochemical analysis are applied to the study of disease and the function and mode of action of hormones in health and disease and understand their roles in controlling various metabolic pathways.

BCH-VI.E-13 BIOCHEMICAL CORRELATION OF DISEASES Total hours: 45

Unit 1 Inborn errors of metabolism No. of hours: 6

Alkaptonuria, Phenylketonuria, Glycogen and Lipid storage diseases, clotting disorders

Unit 2 Nutritional deficiency based diseases No. of hours: 6

Kwashiorkar, Marasmus, Beri-beri, Scurvy, Pellagra, Anaemia, Night blindedness, Rickets, Osteomalacia, Osteoporosis, Wilson's disease

Unit 3 Life style diseases **No. of hours: 6**

Obesity, Cardiovascular diseases, Atherosclerosis, Diabetes mellitus-II

Unit 4 Hormonal Imbalances **No. of hours: 6**

Outline of hormone action and imbalances leading to disease - precocious puberty, hyper and hypopituitarism, Hyper and hypothyroidism.

Unit 5 Autoimmune diseases **No. of hours: 8**

Concepts in immune recognition - self and non self discrimination, organ specific autoimmune diseases – Hashimoto's thyroiditis, Grave's disease, Myasthenia Gravis, rheumatoid arthritis

Unit 6 Infectious diseases **No. of hours: 13**

Viral infection (polio, measles, mumps, influenza, HIV)

Bacterial infections (tetanus, diphtheria, tuberculosis, typhoid, cholera)

Protozoan (Plasmodium and Trypanosoma) and parasitic infections

BCH VI.E-13 : BIOCHEMICAL CORRELATIONS IN DISEASES (PRACTICAL)

COURSE TITLE: BIOCHEMICAL CORRELATIONS IN DISEASES (PRACTICAL)
COURSE CODE: BCH VI.E-13
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Determination of Serum Sodium & Potassium	2P
Physical and chemical examination of urine (sugar, protein)	3P
Blood pressure measurement	1P
Determination of serum triglycerides	1P
Glucose tolerance test	2P
Bone density measurements	2P
Case study- Clinical Characteristics, Diagnosis and Management of Nutritional deficiency based diseases, Life style diseases, Inborn errors of metabolism , Autoimmune diseases , Infectious diseases	4P

REFERENCES

- Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
- Berg, J.M., Tymoczko, J.L. and Stryer, L., Biochemistry (2012) 7th ed., W.H Freeman and Company (New York)
- Godkar, P. and Godkar, D. Textbook of Medical Laboratory Technology, 2003, Bhalani Publishing House (Mumbai).
- Murray, R.K, Granner, D.K, Mayes, P.A. & Rodwell, V.W. (2003), Harper's Illustrated Biochemistry, McGraw-Hill Companies.

SEMSESTER VI

COURSE TITLE: CLINICAL BIOCHEMISTRY (THEORY)

COURSE CODE: BCH-VI.E-14

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES: This course is designed to prepare the students for a career in clinical biochemistry and to provide them a sound knowledge of the clinical principles underlying the application of clinical biochemistry investigations in human disease.

LEARNING OUTCOME: This course equips the students with the knowledge and understanding of the scientific basis and use of the major analytical technologies and diagnostic platforms used in clinical biochemistry.

BCH-VI.E-14 CLINICAL BIOCHEMISTRY (THEORY) **Total hours: 45**

UNIT I Laboratory setup and analysis **No. of hours: 15**

Requirements of setting up of clinical laboratory, SI units in clinical laboratory, collection, preservation and handling of clinical samples

Blood: Haemoglobin, Total cell and Differential cell (TC/DC) counts, Erythrocyte sedimentation Rate (ESR); Clotting time, Glucose; Lipid profile; Urea

Serum: Proteins, Albumin/Globulin Ratio; Bilirubin; Creatinine; Uric acid; Electrolytes

Urine: Colour, odour, sediment, crystals, glucose; protein/albumin

Use of LDH, SGPT, SGOT, acid and alkaline phosphatase, amylase, lipase, cholesterol, albumin, creatinine in diagnosis of disorders

Safety measures in clinical laboratory

UNIT II Tests for diseases **No. of hours: 15**

BLOOD: Total and differential blood count, blood groups and Rh factor incompatibility, plasma proteins, types of anaemias and porphyries

LIVER: Bilirubin metabolism, types of jaundice and clinical assesment, Acute and chronic liver diseases, cirrhosis, viral, metabolic and drug induced/toxic liver diseases, liver function tests

KIDNEY: Glomrular filtration rate, Renal threshold and clearance values, disorders of kidney, renal failure and proteinuria, renal tubular disorders and renal stones, Renal function tests

HEART: Ischemic heart disease, role of enzymes and other proteins in assessment of myocardial infarction: SGOT; CPK; LDH isozyme

UNIT III Metabolic Disorders **No. of hours: 15**

Inborn errors of metabolism:

Disorders associated with carbohydrate metabolism-glycogen storage diseases, galactosemia

Protein metabolism – phenylketonuria, alkaptonuria

Lipid metabolism – Niemann – Pick disease, Tay-Sach's disease

Disorders due to chromosomal aberrations – molecular basis and symptoms of Down's syndrome, Turner's syndrome, Klinefelter's syndrome

Metabolic disorders:

Carbohydrate –Diabetes mellitus Type 1 and Type 2; Ketosis

Lipids – Dyslipidemia

Proteins – Albuminuria

Blood – Anaemia: haemolytic, pernicious, sickle cell anaemias; acidosis, alkalosis

Heart – Hypertension, Arterosclerosis

Liver – Hepatitis

Kidney –Diabetes insipidus

BCH-VI.E-14 CLINICAL BIOCHEMISTRY (PRACTICAL)

COURSE TITLE: CLINICAL BIOCHEMISTRY (PRACTICAL)

COURSE CODE: BCH-VI.E-14

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Blood Urea estimation	1P
Serum/Urine Uric acid estimation	1P
Serum creatinine	1P
Determination of Serum Sodium & Potassium	2P
Physical and chemical examination of urine (sugar, protein)	3P
Determination of Urinary calcium, inorganic phosphates, Sodium and chlorides	4P
Estimation of blood glucose	1P
Blood pressure measurements	1P
Determination of serum triglycerides	1P

REFERENCES

- Pattabiraman R.N. Text book of Biochemistry, All India Publisher distribution.
- Chatterjee M.N., Shinde, R. Text book of Medical Biochemistry, Jaypee Publishers.
- Vasudevan, D.M., Sreekumari S., Text book of Biochemistry for Medical Students, Jaypee Publishers.
- Berg, Jeremy M., Tymoczko, John L., Stryer Lubert. Biochemistry, W.H. Freemann, N. York.
- David, L.N., Michael, M.C., Lehninger, Albert, Biochemistry, Kalyani Publications, N.

SEMESTER VI

COURSE TITLE: ENVIRONMENTAL BIOCHEMISTRY (THEORY)

COURSE CODE: BCH-VI.E-15

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES: The main aim of this paper is to introduce the students to the hazards of our environment, the effects of pollution on living systems, solutions to protect the environment for sustainable development.

LEARNING OUTCOME: On completion of this module, students will be able to understand the effects of various types of pollution and gain knowledge in areas like development of biological systems for remediation of contaminated environments and environment-friendly processes such as green manufacturing technologies and sustainable development.

BCH-VI.E-15 ENVIRONMENTAL BIOCHEMISTRY (THEORY) Total hours: 45

Unit 1 Basic Ecological Concepts and Principles No. of hours: 5

Structure (biotic and abiotic components), Food chain and food webs, Ecological pyramids.
Productivity and eco-energetic (10% law)

Unit 2 Anthropogenic activities, its effects and control No. of hours: 15

Air pollution

Major air pollutants and their sources
Impacts of air pollution on human health, animals, plants and climate
Removal of gaseous contaminants: bioscrubbers, biotrickling filters and biofilters/biobeds

Water pollution

Principal forms of water pollutants and their sources
Wastewater treatment: Activated sludge process, rotating biological discs, oxidation ponds, trickling filters

Soil pollution

Major soil pollutants and their sources

Treatment of solid wastes: Hazardous, non hazardous, Composting and vermitechnology

Unit 3 Pollution Monitoring **No. of hours: 8**

Bio indicators: Concept and examples (indicators of water quality; air pollution indictors)

Applications using plant test systems and animal Test Systems

Tests for assessing Genetic damage: AMES Test

Concept and applications of molecular biology in environmental monitoring: reporter gene

Concept and applications of biosensors in pollution detection

Unit 4 Pollution abatement: Bioremediation and biodegradation **No. of hours: 10**

<u>Bioremediation</u>

Definition, mechanism of Microbial bioremediation, Microbial desulphurization of coal (indirect mechanisms), Phytoremediation

<u>Biodegradation</u>

Biodegradation of two xenobiotics: Aromatic hydrocarbons (benzene) and alkanes

<u>Biosorption</u>

Principle, Use of Fungi and Algae

Genetically engineered microorganisms: Super Bug (*Pseudomonas* sps)

Unit 5 Ecofriendly Bio-products **No. of hours: 7**

Biogas (Biomethanisation)

Bio hydrogen production: anaerobic bacteria and photolysis by photosynthetic algae

Bioplastics: Biopol and Biolac

Biodiesel, Bioethanol

BCH-VI.E-15 ENVIRONMENTAL BIOCHEMISTRY (PRACTICAL)

COURSE TITLE: ENVIRONMENTAL BIOCHEMISTRY (PRACTICAL)

COURSE CODE: BCH-VI.E-15

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Water quality by MPN method 2P

Detection of coliforms in the water sample /Routine analysis of potable water sample using Presumptive, confirmatory and confirmed tests	4P
Determination of dissolved oxygen concentration of water sample by Winkler's method	1P
Determination of biological oxygen demand (BOD) of the water sample	1P
Determination of chemical oxygen demand (COD) of the water sample	1P
Determination of TS (total solids) of the given water sample	1P
Isolation of xenobiont degrading bacteria by selective enrichment	2P
Visit to an effluent treatment plant and preparation of report	3P

REFERENCES

- Agarwal S.K. (2009). Environmental Biotechnology, APH Publishing Corporation New Delhi.
- Anjaneyulu Y. (2005). Introduction to environmental Science, BS publications, India.
- Chatterji A.K. (2009). Introduction to Environmental Biotechnology, 2nd ed, Prentice Hall of India Pvt. Ltd. New Delhi.
- Jogdand B.N. (2008). Environmental Biotechnology (Industrial Pollution Management), Himalaya Publishing House, Mumbai.
- Santra S.C. (2001). Environnemental Science, New central book agency (P) Ltd. Calcutta.
- Singh B.D. (2008). Biotechnology, 3rd edition, Kalyani Publishers.
- Thakur I.S. (2006). Environmental Biotechnology: Basic concepts and applications, I.K. International Pvt. Ltd. New Delhi.

SEMESTER VI
COURSE TITLE: INDUSTRIAL BIOCHEMISTRY (THEORY)
COURSE CODE: BCH-VI.E-16
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES: This paper is designed to introduce the students to the basic concepts in Industrial Biotechnology. The paper covers concepts in Industrial Biotechnology, mainly introducing the basics of upstream processes in fermentation technology on an industrial scale.

LEARNING OUTCOME: On completion of this module, students will be able to understand the concept of a bioprocess and its importance in today's world of fast pacing technology. They will be able to apply concepts of fermentation technology to the industrial sector and understand how large scale bioprocesses are carried out.

BCH-VI.E-16 INDUSTRIAL BIOCHEMISTRY (THEORY) Total hours: 45

Unit 1 Introduction No. of hours: 2

Scope and applications of industrial biotechnology

Unit 2 Industrial bioreactor No. of hours: 8

Fermenters: Structure of an ideal fermentor

- Parts of the fermentor and their uses – impellars, spargers, baffles, headspace, controls and sensors (temperature, pH, antifoam)
- Types of reactors (definition, description, diagram and uses) - Bubble columns, Airlift, Fluidized bed, Packed bed, Tray bioreactors, Photobioreactors

Unit 3 Fermentation media No. of hours: 5

Characteristics of an ideal fermentation medium

Types of media – crude and synthetic

Composition of fermentation media

Unit 4 Types of fermentation No. of hours: 5

Introduction to the types of fermentation processes - submerged, surface/solid state, batch, fed-batch and continuous, pilot fermentor

Unit 5 Screening of microorganisms for fermentation processes No. of hours: 6

Primary screening (Definition)

Methods of primary screening – crowded plate, auxanography, enrichment, indicator dye

Secondary screening (Definition and features)

Example of secondary screening (Giant colony method)

Unit 6 Detection and assay of fermentation products No. of hours: 6

An overview of the working principle involved in:

Physical and Chemical assays - titration and gravimetric assay, turbidity analysis and cell determination, spectrophotometric assay

Biological assays - diffusion assays, turbidometric and growth assay

Unit 7 Industrial production of biochemically important products No. of hours: 8

Organisms, fermentation media, fermentation conditions and production processes in: citric acid, vinegar and industrial alcohol

BCH-VI.E-16 INDUSTRIAL BIOCHEMISTRY (PRACTICAL)

COURSE TITLE: INDUSTRIAL BIOCHEMISTRY (PRACTICAL)
COURSE CODE: BCH-VI.E-16
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Study of a fermentor	1P
A study on the phases of growth of microorganisms during fermentation	2P
Preparation and sterilization of medium for batch fermentation process	1P
Batch fermentation	1P
Decontamination and sterilization of the fermentor	1P
Primary screening of antibiotic producing bacteria by crowded plate technique	1P
Secondary screening for antibiotic producers by Giant Colony Technique	1P
Production of wine (from pineapple or any other fruit/vegetable) using yeast	2P
Production of vinegar	2P
Estimation of total reducing sugars and acidity (total and volatile) in wine and vinegar (before and after fermentation)	1P
MIC of an antibiotic	2P

REFERENCES

- Casida L.E. (2009). Industrial Microbiology, New Age International (P) Ltd. New Delhi.
- Okafor N. (2007). Modern Industrial Microbiology and Biotechnology, Science Publishers Enfield, NH, USA.
- Patel A.H. (2012). Industrial Microbiology, MacMillan Publishers India Ltd.
- Prescott & Dunn. (1982). Industrial Microbiology, 4th edition, AVI Publishinhg Co.

- Ratlege C. & Kristiansen B. (2001). Basic Biotechnology, 2nd edition. Cambridge university press.
- Stanbury P. F, Whitaker A. & Hall. (1997). Principles of fermentation technology, 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.

Parvatibai Chowgule College of Arts and Science

(Autonomous)

<u>DEPARTMENT OF BIOCHEMISTRY</u>

THREE YEAR B.Sc. DEGREE COURSE IN BIOCHEMISTRY

B.SC. DEGREE COURSE IN BIOCHEMISTRY - COURSE STRUCTURE

(To be applicable from the academic year 2019-20)

SEMESTER	CORE		ELECTIVE			
I	**BCH-I.C-1** Molecules of Life	**BCH-I.C-2** Cell Biology	--------	--------	--------	--------
II	**BCH-II.C-3** Protein Chemistry	**BCH-II.C-4** Biophysics	--------	--------	--------	--------
III	**BCH-III.C-5** Metabolism of Biomolecules		**BCH-III.E-1** Tools & Techniques in Biochemistry	**BCH-III.E-2** Enzymology	**BCH-III.E-3** Fundamentals of Microbiology	**BCH-III.E-4** Plant Biochemistry
IV	**BCH-IV.C-6** Immunology		**BCH-IV.E-5** Human Physiology	**BCH-IV.E-6** Nutritional Biochemistry	**BCH-IV.E-7** Endocrinology	**BCH-IV.E-8** Advanced Cell Biology
V	**BCH-V.C-7** Molecular Biology		**BCH-V.E-9** Concepts of Genetics	**BCH-V.E-10** Regulation of Gene Expression	**BCH-V.E-11** Food and Industrial Biochemistry	**BCH-V.E-12** Bioinformatics
VI	**BCH-VI.C-8** Clinical Biochemistry		**BCH-VI.E-13** Introduction to Pharmacology	**BCH-VI.E-14** Intermediary Metabolism	**BCH-VI.E-15** Genetic Engineering and Biotechnology	**BCH-VI.E-16** Environmental Chemistry

Skill Enhancement Courses for the students of Biochemistry

1. Food and Fermentation Technology
2. Horticulture, Floriculture, and Landscaping
3. Bioentrepreneurship
4. Waste Management Techniques

SEMESTER I

CORE COURSE: MOLECULES OF LIFE	
COURSE CODE:	**BCH-I.C-1**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (03 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Gain an understanding of the various theories of the origin of life **CO2:** Comprehend the importance of water in the sustenance of life. **CO3:** Compare and contrast the various different biomolecules (carbohydrates, proteins, lipids, nucleic acids, vitamins), their categories as well as functions. **CO4:** Understand and apply general laboratory safety measures as well as calculate for preparation of various chemicals for experiments. **CO5:** Prepare different solutions such as buffers, reagents and stock solutions for experiments independently.

BCH-I.C-1: MOLECULES OF LIFE (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL CONTACT HOURS
MODULE 1: **The foundations of Biochemistry, Water, Carbohydrates**	**1.1 : The foundations of Biochemistry** Chemical and cellular foundations of life **1.2: Water** Unique properties of water; Weak interactions in aqueous systems; Ionization of water; Water as a reactant and fitness of the aqueous environment **1.3: Carbohydrates** Classification of carbohydrates; Monosaccharides - structures of aldoses and ketoses, the ring structure of sugars, conformations of sugars; Stereochemistry: mutarotation, anomers, epimers, and enantiomers; The formation of disaccharides; Reducing and non-reducing disaccharides; Polysaccharides: homo and heteropolysaccharides; Structural and storage polysaccharides; Glycoconjugates; Functions of carbohydrates	**02** **03** **10**	**15**
MODULE 2: **Proteins and Lipids**	**2.1: Proteins** Amino acids - structure, classification; Derivatives of amino acids and their biological role. Titration of amino acids; Introduction to biologically important peptides; Polypeptides and proteins.	**08**	

	2.2: Lipids Classification of lipids and their distribution; Storage lipids; Structural lipids; Lipids as signaling molecules, cofactors and pigments	**07**	**15**
MODULE 3:	**3.1: Nucleic Acids** Nucleotides and nucleic acids, phosphodiester bond; Nucleic acid structure and chemistry: DNA as genetic material; DNA structures and their importance, unusual DNA structures; Different types of RNA; Other functions of nucleotides: a source of energy, a component of coenzymes, second messengers. **3.2: Vitamins** Structure and active forms of water soluble and fat soluble vitamins; Deficiency diseases and symptoms; Hypervitaminosis	**10** **05**	**15**

BCH-I.C-1: MOLECULES OF LIFE (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Introduction to safety measures in laboratories	01
2.	Preparation of buffers & solutions (normal, molar, ppm, %)	01
3.	Mutarotation of sugars	01
4.	Qualitative tests for carbohydrates, lipids, proteins, and nucleic acids	04
5.	Estimation of reducing sugars by DNSA method	01
6.	Determination of pKa of amino acids	02
7.	Preparation of TLC plates and separation of amino acids and sugars by thin layer chromatography	04
8.	Determination of peroxide value of oil	01
9.	Estimation of Vitamin C	01

REFERENCES

- Nelson, D. L. & Cox, M.M. (2000), Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
- Stryer, L. (1995). Biochemistry, W.H. Freeman and Co., New York, USA.
- Jain, J.L (1999), Fundamentals of Biochemistry, S.Chand and Company, Ltd., New Delhi.
- Murray, R.K, Granner, D.K, Mayes, P.A. & Rodwell, V.W. (2003), Harper's Illustrated Biochemistry, McGraw-Hill Companies.
- Sadasivam, S. andManickam, A. (1996), Biochemical Methods, New Age International (P) Limited
- Jayaraman, J. (1971), Laboratory Manual in Biochemistry, John Wiley & Sons, Limited.
- Plummer, D.T. (1993). An Introduction to Practical Biochemistry, Sixth Reprint. Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Harvey, R.A. & Ferrier, D.R. (2011). Lippincott's Illustrated Reviews, Biochemistry Fifth Edition, Lippincott Williams and Wilkins.

SEMESTER I

CORE COURSE: CELL BIOLOGY	
COURSE CODE:	**BCH-I.C-2**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	Theory: 45 Hours (03 Lectures per week) Practical: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Demonstrate an understanding of cell communication **CO2:** Correlate the function of each cell organelle with proper coordination. **CO3:** Identify and analyze different biological cells using a compound microscope **CO4:** Prepare various plant and animal specimen for the observation of cell structures.

BCH-I.C-2: CELL BIOLOGY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: **Introduction to Cell Biology, Cell Wall and Plasma Membrane**	**1.1: Introduction to cell biology** Cell theory; ultrastructure of prokaryotic and eukaryotic cell; cell matrix proteins; components of the extracellular matrix.	**06**	**15**
	1.2: Cell wall & Plasma membrane Chemical composition; structure and functions of the cell wall and plasma membrane; monolayer; planar bilayer and liposomes as model membrane systems; Fluid mosaic model; lipid rafts; membrane fluidity; factors affecting membrane fluidity; techniques used to study membrane dynamics – FRAP.	**09**	
MODULE 2: **Ultrastructure and Function of Organelles**	**2.1: Ultrastructure and function of organelles** Cilia and Flagella; Endoplasmic reticulum; Golgi apparatus; Lysosomes; Microbodies; Mitochondria; Ribosomes; Centrioles and basal bodies; Nucleus; Chloroplasts and Peroxisomes.	**15**	**15**
MODULE 3: **Cell Cycle and Cell-cell Interactions**	**3.1: Cell Cycle** Overview of the cell cycle; prokaryotic & eukaryotic cell cycle; events of mitotic & meiotic phases, cytokinesis.	**03**	

	3.2: Cell-Cell interaction Interactions of cells with extracellular materials: integrins, focal adhesions, and hemidesmosomes; interactions of cells with other cells: selectins, the immunoglobulin superfamily, cadherins, adherens junctions, and desmosomes; tight junctions, gap junctions, and plasmodesmata	**05**	**15**

BCH-I.C-2: CELL BIOLOGY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Examination of a prokaryotic cell, eukaryotic cell and cell organelles using photomicrographs	01
2.	Visualization of animal and plant cell using methylene blue	01
3.	Study of cell viability using phenol red/trypan blue	01
4.	Visualization of Permanent slides of: A. Different cell types: Epithelium, Endothelium, Muscle cells, Nerve cell B. Different stages of cell division	02
5.	Identification of different stages of mitosis in onion root tip `	02
6.	Identification of different stages of meiosis in onion flower buds	02
7.	Isolation of chloroplast from spinach leaves	04
8.	Prokaryotic cell harvesting & lysis using osmotic (salt) and Chemical (detergent) methods	02

REFERENCES

- Karp, G. & Harris, D. (2008) Cell and Molecular Biology – Concepts and Experiments, John Wiley & Sons Inc, New York.
- Robertis, E.D.P. &Robertis, E.M.F. (1998). Cell Biology and Molecular Biology, 8th edition, Sauder College.
- Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5thedition. ASM Press & Sunderland, Washington, D.C.

- Verma P.S. and Agarwal V. K. (1998).Cell Biology, Genetics, Molecular Biology, Evolution, and ecology. 14 th edition.

SEMESTER II

CORE COURSE: PROTEIN CHEMISTRY	
COURSE CODE:	**BCH-II.C-3**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	Theory: 45 Hours (03 Lectures per week) Practical: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Comprehend the various levels of protein structure **CO2:** Explain the mechanism and significance of membrane proteins. **CO3:** Correlate the techniques used in studying protein structure **CO4:** Review enzymes and their classification system. **CO5:** Assess and compare the various methods employed in protein estimation/concentration and measuring the protein content.

BCH-II.C-3: PROTEIN CHEMISTRY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: **Protein Structure**	**1.1: Protein structure** Bonds in protein structure (covalent, non covalent, peptide), importance of primary & secondary structure, tertiary and quaternary structures, bond lengths and configuration, Dihedral angles, psi and phi, helices, sheets and turns, Ramachandran map; techniques used in studying 3-D structures - X-ray diffraction and NMR; motifs and domains; structures of myoglobin and haemoglobin, multimeric proteins and conjugated proteins, diversity of function.	**15**	**15**
MODULE 2: **Isolation & Analysis of proteins**	**2.1: Isolation & analysis of protein** Techniques to isolate and analyze proteins: salt fractionation, ion-exchange chromatography, gel permeation, HPLC, SDS-PAGE, IEF; Protein primary structure: sequencing by Edman degradation, use of enzymes and chemical reagents to obtain overlap peptides, synthesis of peptides using Merrifield method **2.2: Characterization of proteins** Determination of purity, molecular weight, extinction coefficient, sedimentation coefficient, 2-D electrophoresis	**12** **03**	**15**

MODULE 3:	**3.1 : Enzymes** Nature of enzymes: protein and non-protein (ribozyme); cofactor and prosthetic group, apoenzyme, holoenzyme; IUBMB classification of enzymes; mechanism of enzyme activity **3.2: Membrane and Transport proteins** Integral and membrane-associated proteins, hydropathy plots to predict transmembrane domains; the significance of functional proteins - bacteriorhodopsin, myoglobin, and hemoglobin: structure and function (Oxygen binding curves, cooperativity models for hemoglobin)	**06** **09**	**15**

BCH-II.C-3: PROTEIN CHEMISTRY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Determination of absorption maxima and molar extinction coefficient of protein sample	02
2.	Protein Assay (Biuret/Lowry/Bradford method)	02
3.	Ammonium sulfate fractionation of proteins	02
4.	Protein Dialysis	02
5.	The solubility of proteins in distilled water and salt solutions	02
6.	Denaturation of proteins by pH and temperature	01
7.	Separation of proteins by SDS-PAGE (demonstration)	02
8.	Gel filtration chromatography (demonstration)	02

REFERENCES

- Nelson D.L and Cox M.M (2013). Lehninger's Principles of Biochemistry, Worth Publishers, New York, USA.
- Cooper T.G (2011). The Tools of Biochemistry, Wiley India Pvt. Ltd, New Delhi.
- Voet, D. and Voet, J.G (2004). Biochemistry, 3rd Edition, John Wiley & Sons, Inc. USA.
- Plummer D. T (1998). An Introduction to Practical Biochemistry, 3rd ed., Tata McGraw Hill Education Pvt. Ltd. New Delhi.
- Sadasivam S. and A. Manickam (1996), Biochemical Methods, New Age International (P) Limited, New Delhi.
- J. Jayaraman (1971), Laboratory Manual in Biochemistry, John Wiley & Sons, Limited, New Delhi.

SEMESTER II

CORE COURSE: BIOPHYSICS	
COURSE CODE:	**BCH-II.C-4**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Explain the basic concepts of the origin and evolution of life **CO2:** Understand how cellular reactions take place in accordance with thermodynamic principles **CO3:** Describe the mechanism of the derivation of energy through bioenergetic reactions in living cells **CO4:** Elucidate energy transductions in organisms. **CO5:** Understand the concepts of buffer capacity and osmolarity. **CO6:** Demonstrate a practical understanding of spectrophotometry.

BCH-II.C-4: BIOPHYSICS (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: **The chemical basis of life, Basic principles of biochemical studies, Ion channels**	**1.1 : The chemical basis of life** Introduction, prebiotic earth, theories of origin and evolution of life; covalent bonds, non-covalent bonds: ionic bonds, hydrogen bonds, hydrophobic interactions, van der Waals forces **1.2:1.1:c principles of biochemical studies** Units of measurement; weak electrolytes- the biochemical importance of weak electrolytes, ionisation of weak acids and bases, calculation of pH, ionization of a weak electrolyte, buffer solutions, buffer capacity, buffer action and pH of blood, measurement of pH, pH meters **1.3: Ion Channels** Sodium, Potassium, Calcium, Chlorine, ligand-gated, Donnan's equilibrium experiments	**05** **06** **04**	**15**
MODULE 2: **Bioenergetics and oxidative phosphorylation**	**2.1: Introduction to bioenergetics** Laws of thermodynamics, equilibrium constant, coupled reactions, ATP cycle, phosphoryl group transfers; chemical basis of high standard energy of hydrolysis of ATP, other phosphorylated compounds and thioesters. Redox reactions, standard redox potentials and Nernst equation, universal electron carriers	**08**	

	2.2: Oxidative phosphorylation Mitochondrial electron transport chain: its organization and function, inhibitors of ETC and uncouplers, Peter Mitchell's chemiosmotic hypothesis, proton motive force, structure and mechanism of ATP synthesis, regulation of oxidative phosphorylation	**07**	**15**
MODULE 3: **Photo-phosphorylation**	**3.1: Photo-phosphorylation** General features of photophosphorylation, Hills reaction, photosynthetic pigments, light harvesting systems of plants and microbes; bacterial photophosphorylation in purple bacteria, green sulfur bacteria. Photophosphorylation in plants - the structure of chloroplast, the molecular architecture of Photosystem I and Photosystem II, Z-scheme of photosynthetic electron flow, oxygen-evolving complex and action of herbicides; cyclic photophosphorylation and its significance; photoinhibition, the evolution of oxygenic photosynthesis; Comparison of phosphorylation in mitochondria and chloroplasts	**15**	**15**

BIO-II.C-4: BIOPHYSICS (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Preparation of buffers	01
2.	Determination of buffer capacity	02
3.	To determine osmolarity of solutions proteins/sugars/lipids/ nucleic acids using osmometer	04
4.	Effect of detergents and other membrane active substances on cells	02
5.	Determination of lambda max and molar extinction coefficient of a given compound	02
6.	Determination of pKa of Bromophenol blue	02
7.	Photooxidation of photosynthetic pigments (demonstration)	01
8.	Oxygen evolution (by Hydrilla) (demonstration)	01

REFERENCES

- Nelson D.L and Cox M.M (2013). Lehninger's Principles of Biochemistry, Worth Publishers, New York, USA.
- Cooper T.G (2011). The Tools of Biochemistry, Wiley India Pvt. Ltd, New Delhi.
- Voet, D. and Voet, J.G (2004). Biochemistry, 3rd Edition, John Wiley & Sons, Inc, USA.
- Stryer, L. (1995). Biochemistry, W.H. Freeman and Co., New York, USA.
- Jain, J.L (1999), Fundamentals of Biochemistry, S.Chand and Company, Ltd., New Delhi.
- Wilson K and Walker J (2010). Principles and Techniques of Biochemistry and Molecular Biology, Seventh edition Cambridge University Press, UK.

LIST OF COMMON COURSES WITH THE DEPARTMENT OF BIOTECHNOLOGY

1. Cell Biology (Semester II)
2. Enzymology (Semester III)
3. Metabolism of Biomolecules (Semester III)
4. Immunology (Semester IV)

LIST OF BOARD OF EXAMINERS

1. **Name:** Dr. Savita S. Kerkar

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6. **Name:** Mrs. Mrunal Phadke

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Contact details: Office Phone: 0832-246 2376

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ANNEXURE A

Summary of changes incorporated in the syllabus

Semester	Course Title	Existing (Indicate only the unit where the change is proposed)	Changes proposed	Specify the reason for the change
VI	**BCH-VI.E-13**	Course titled **“Clinical Biochemistry”**	Course titled “Intermediary Metabolism”; now shifted to BCH-VI.E-14	Substituted “Biochemical correlation of diseases” to avoid repetition of course content
III/VI	**BCH-III.E-3**	Course titled **“Bioethics and Biosafety”**	Removed from syllabus; replaced with “Introduction to Pharmacology”	Removed from syllabus to include “Introduction to Pharmacology”; now shifted to BCH-VI.E-13
Course Structure			Rearrangement of courses all across the Semesters	To accommodate common courses with Department of Biotechnology; adequate placement of courses.

II	**BCH-II.C-3 Protein Chemistry**	**Module 3: 3.2: Membrane and transport proteins:** Significance of membrane proteins	Significance of functional proteins	Since syllabus includes a protein that is not a membrane protein (generalized to say functional protein)
II	**BCH-II.C-3 Protein Chemistry**	Practical 3: Ammonium sulphate fractionation of crude homogenate from Mung bean & Practical 4: Ammonium sulphate fractionation of serum proteins	Practical 3: Ammonium sulphate fractionation of proteins	Gives teacher freedom to choose protein source.
II	**BCH-II.C-3 Protein Chemistry**	Practical 7: Separation of proteins by SDS-PAGE (demonstration) & Practical 8: Gel filtration chromatography (demonstration)	Practical 7: Demonstration of SDS-PAGE Practical 8: Demonstration of Gel Filtration Chromatography	Better framing of sentence
II	**BCH-II.C-3 Protein Chemistry**	Practical 9: Denaturation of protein by heat	Practical 6: Denaturation of proteins by pH and temperature	Based on course teacher's feedback & BoS members.
II	**BCH-II.C-4 Biophysics**	Practical 8: Oxygen evolution (by *Hydrilla*)	Practical 8: Oxygen evolution (by *Hydrilla*) (demonstration)	Better framing of sentence

B.SC. DEGREE COURSE IN BIOCHEMISTRY - COURSE STRUCTURE

(To be applicable from the academic year 2019-20)

SEMESTER	CORE		ELECTIVE			
I	**BCH-I.C-1** Molecules of Life	**BCH-I.C-2** Cell Biology	--------	--------	--------	--------
II	**BCH-II.C-3** Protein Chemistry	**BCH-II.C-4** Biophysics	--------	--------	--------	--------
III	**BCH-III.C-5** Metabolism of Biomolecules		**BCH-III.E-1** Tools & Techniques in Biochemistry	**BCH-III.E-2** Enzymology	**BCH-III.E-3** Fundamentals of Microbiology	**BCH-III.E-4** Plant Biochemistry
IV	**BCH-IV.C-6** Immunology		**BCH-IV.E-5** Human Physiology	**BCH-IV.E-6** Nutritional Biochemistry	**BCH-IV.E-7** Endocrinology	**BCH-IV.E-8** Advanced Cell Biology
V	**BCH-V.C-7** Molecular Biology		**BCH-V.E-9** Concepts of Genetics	**BCH-V.E-10** Regulation of Gene Expression	**BCH-V.E-11** Industrial Biochemistry	**BCH-V.E-12** Bioinformatics
VI	**BCH-VI.C-8** Clinical Biochemistry		**BCH-VI.E-13** Introduction to Pharmacology	**BCH-VI.E-14** Food Biochemistry	**BCH-VI.E-15** Genetic Engineering and Biotechnology	**BCH-VI.E-16** Environmental Chemistry

Approved Course syllabi of Semesters III, IV, V and VI for the academic year 2020-21

Semester	Course title	Existing Content (Indicate only the unit where the change is proposed)	Changes Proposed	Specify the reason for the change
SYLLABUS				
III	Metabolism of Biomolecules BCH-III.C-5 (THEORY)	**MODULE 1** **1.2: Carbohydrate Metabolism**	**MODULE 1** **1.2: Carbohydrate Metabolism** Added topics: Fate of pyruvate & Fermentation	In section 1.2, important concepts which were taught but not mentioned in the syllabus.
III	Metabolism of Biomolecules BCH-III.C-5 (PRACTICAL)	**Previously a total 8 experiments**	**Total 9 experiments** Introduced **"**Lactic acid fermentation" for 1 Practical session **Rest experiments remain unchanged**	Addition of one more experiment no. 1 was done to increase the number of practical sessions from 14 to 15.
III	Tools and Techniques BCH-III.E-1 (THEORY)	**MODULE 3:** **3.1: Microscopic techniques**	**MODULE 3:** **3.1: Microscopic techniques** Added topic of "Application of - compound microscope, electron microscope, Scanning electron microscope and confocal" **3.2: Radioisotopes** Added the topic "Handling and safety of radioisotope"	Additional topics was included in both the sections relevant to the existing content

III	Tools and Techniques BCH-III.E-1 (PRACTICAL)	**Previously a total 6 experiments**	**Total 7 experiments** **2)** Estimation of carbohydrate by DNSA method **(2 P)** **4)** Isolation of cell organelle using density gradient centrifugation **(2 P)** **7)** Lipid isolation by reverse phase chromatography **(2 P)**	New experiments were introduced in context with theory. Certain practicals eliminated due to repetition in other courses
III	Enzymology BCH-III.E-2 (THEORY)	**MODULE 1:** **1.1: Introduction to enzymes**	**MODULE 1:** **1.1: Introduction to enzymes (8 L)** Added "Multienzyme complex"	An additional content was required in section 1.1 in context with the course.
III	Enzymology BCH-III.E-2 (PRACTICAL)	**Total 7 experiments**	**Total 7 experiments** Change in the title of Experiment 5: **5)** Partial purification of an enzyme from a suitable source, ammonium sulphate precipitation, dialysis **(3 P)** Addition of: **7)** Native PAGE **(3 P)** **8)**Zymogram **(1 P)**	Two new important experiments were included and the number of practicals were rearranged to accommodate for new experiments.
III	Fundamentals of Microbiology BCH-III.E-3 (THEORY)	**MODULE 1:** **1.1: History and Scope of Microbiology**	**MODULE 1:** **1.1: History and Scope of Microbiology (5 L)** Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Paul Ehrlich, Elie Metchnikoff, Edward Jenner in the	Course specific topic was included and rearranged in section 1.1 and 1.2 to make it more comprehensive.

		1.2: **Basics of Microscopy (3 L)**	fields of microbiology and immunology. Basics of Binomial Nomenclature; Classification systems of Whittaker (five Kingdom) and Carl Woese (three Domain). Tree of Life. **1.2: Basics of Microscopy (3 L)** Principle, design and working of light microscope (Bright-field, Dark-field, Phase-contrast, Fluorescence). Preparation of samples.	
		MODULE 2: **2.1: Cultivation of microorganisms (10 L)**	**MODULE 2:** **2.1: Cultivation of microorganisms (10 L)** Cultivation of microorganisms: Aerobic and anaerobic, Broth cultures, agar plate, pour plate. Determination of viable count: MPN, Serial dilution, spread plating, pour plating, determination of colony forming units (cfu) and calculation of viable count.	In 2.1 section, important topics were included to make it more elaborative.
		MODULE 3: **3.2: Viruses**	**MODULE 3:** **3.2: Viruses** Bacteriophage multiplication instead of “viral multiplication”	In 3.2 section, statement had to be rephrased to make it more precise

III	Fundamentals of Microbiology BCH-III.E-3 (PRACTICAL)	**Total 10 experiments**	**Total 10 experiments** Addition of "Biosafety cabinet" to Experiment 1. Change in the title of Experiment 3:, 4, 5, 7, 8, 9 3) Preparation and sterilization of liquid and solid culture media. 4) Preparation of media agar plates, butts and slants. **(1 P)** 5) Determination of viable count (soil and water sample): Serial dilution, spread plating, quantification of colony forming units (cfu) and calculation of viable count. **(3 P)** 7) Gram staining and cell morphology. **(1 P)** 9) Isolation and staining of Fungi (Rhizopus, Mucor, Aspergillus, Penicillium) by lactophenol cotton blue. **(2 P)** Change in Experiment 8 **8)** Demonstration of coliphage in water sample. **(2 P)**	Experiments were modified with more detailed content in context with the theory.
III	Plant Biochemistry BCH-III.E-4	**MODULE 1:** **1.2: Photosynthesis (10 L)**	**MODULE 1:** **1.2: Photosynthesis (10 L)**	In 1.2 section, additional content relevant to the topic was added.

	(THEORY)		Addition of the following content: Oxygenic and non-oxygenic photosynthesis; Photosynthetic pigments: Chlorophylls, Beta carotene, bacteriochlorophyll and phycoerythrobilin	
		MODULE 2: **2.1: Nitrogen Metabolism (6 L)** **2.2: Secondary Metabolites (9 L)**	**MODULE 2:** **2.1: Nitrogen Metabolism (6 L)** Addition of "formation of nodules & Urea metabolism" **2.2: Secondary Metabolites (9 L)** Added content: Economic importance & Saponins	In section 2.1 and 2.2, additional content relevant to the topic was added.
		MODULE 3: **3.1 Regulation of plant growth (7 L)** **3.2 Plant tissue culture (8 L)**	**MODULE 3:** **3.1 Regulation of plant growth (7 L)** Overview of Phytohormones. **3.2 Plant tissue culture (8 L)** Added following content: Commercial applications of plant tissue culture.	In 3.1 and 3.2 section, additional content relevant to the topic was added.
III	Plant Biochemistry BCH-III.E-4 (PRACTICAL)	**Total 7 experiments**	**Total 8 experiments** **4)** Isolation of nodule forming bacteria from root nodules **(2 P)**	Modification of the content relevant to theory topics was required for more specificity. Rearrangement of practical sessions for modifications

			5) Extraction and estimation of β-carotene from carrot **(2 P)** **6)** Estimation of phenolic compounds from mint and tulsi leaves **(2 P)** **7)** Demonstration of Callus culture **(2 P)** **8)** Effect of growth hormones on germination of seeds **(2 P)**	
IV	Immunology BCH-IV.C-6 (THEORY)			
		MODULE 2: **2.2: Antigen-Antibody Interactions (8 L)**	**MODULE 2:** **2.2: Antigen-Antibody Interactions (8 L)** Added “RIA, ELISA”	Important techniques that are core topics of immunology had to be included in section 2.2
		MODULE 3: **3.1: MHC and Hypersensitivity (5 L)**	**MODULE 3:** **3.1: MHC and Autoimmunity (7 L)** Major histocompatibility complex (MHC); introduction and discovery of human histocompatibility complex; structure of MHC I and II; presence of MHC I and II on different cells and their significance; Introduction to autoimmunity with examples; introduction to immunodeficiency types with	Section 3.1 and 3.3 had to be clubbed as 3.1. Important techniques that are core to immunology had to be included in section 3.1. “Hypersensitivity” shifted into separate unit 3.2 Previously existing 3.2 had to be

		3.2: Vaccine and Monoclonal Antibodies (5 L) **3.3: Autoimmunity and Immunodeficiency (5 L)**	examples **3.2: Hypersensitivity (4 L)** Introduction and types of hypersensitivity **3.3: Vaccine and Monoclonal Antibodies (4L)** Introduction to vaccines and types of vaccines; Polyclonal & Monoclonal antibodies (hybridoma technology)	shifted to as 3.3. Thus, no. of lectures was changed.
IV	Immunology BCH-IV.C-6 (PRACTICAL)	**Total 10 experiments**	**Total 10 experiments** Change in the title of following experiments: **5)** Preparation of serum, plasma and use of anticoagulants **(1 P)** **9)** ELISA (Demonstration) **(1 P)** **11)** Demonstration of Rapid tests (malaria or dengue) **(1 P)**	Expt 5 was made more specific. No. of hours had to be reduced for expt 9 to accommodate new expt no. 11.
IV	Human Physiology BCH-IV.E-5 (THEORY)	**MODULE 1:** **1.2: Body Fluids (9 L)**	**MODULE 1:** **1.2: Body Fluids (9 L)** Added "Lymph" Replaced topics: "thalassemia, acidosis"	In section 1.2, minor topics were replaced with more important ones.
		MODULE 2: **2.1: Muscular System (4 L)**	**MODULE 2:** Title changed to "Organ Systems I" **2.1: Skeletal and Muscular System (5 L)** Introduction to skeletal system, types	Certain important topics were included in 2.1 and 2.2 to make it more comprehensive. Accordingly the no. of lectures

		2.2: Digestive System (4 L)	of bones, composition, functions of bones. Introduction to muscular system, types of muscles, structure of muscle, Physiology of muscle contraction: proteins involved, neuromuscular junction, role of acetylcholine. Disorders of skeletal muscle: Duchenne muscular dystrophy, Myasthenia gravis, Osteoporosis, arthritis – physiological and immunological. **2.2: Digestive System (4 L)** Addition of "Peristaltic system"	were increased and decreased for section 2.1 and 2.3 respectively.
		MODULE 3: **3.1: Excretory System (5 L)**	**MODULE 3:** Title changed to "Organ Systems I" **3.1: Excretory System (5 L)** Added "Nephrosis", removed "UTI" under renal disorders	Relevant example was included.
IV	Human Physiology BCH-IV.E-5 (PRACTICAL)	**Previously a total of 10 experiments**	**Total 13 experiments** **1)** Determination of clotting time **(1 P)** **2)** Estimation of hemoglobin **(1 P)** **3)** Observation of permanent slides **–** Transverse section of mammalian gonads, muscles, nerve cells **(1 P)**	Relevant course specific practicals were included and other minor modifications were done.

			4) Analysis of human blood pressure and pulse rate in man **(1 P)** **5)** Determination of glucose and albumin in urine **(2 P)** **6)** Determination of sugar in blood **(1 P)** **7)** Determination of ESR and PCV **(2 P)** **8)** Effect of different salt solutions on RBC's **(1 P)** **9)** Liver function test **(1 P)** **10)** Kidney function tests **(1 P)** **11)** Progesterone estimation (kit based) **(1 P)** **12)** Analysis of ECG **(1 P)** **13)** Case study **(1 P)**	
IV	Nutritional Biochemistry BCH-IV.E-6 (THEORY)	**MODULE 1:** **1.2: Dietary Carbohydrates (3 L)** **1.3: Dietary Lipids (5 L)**	**MODULE 1:** **1.2: Dietary Carbohydrates (3 L)** Changed topic to "Problems associated with carbohydrate intake" **1.3: Dietary Lipids (5 L)** Introduction "Lipoproteins"	Course specific topic was included in section 1.2 and 1.3
		MODULE 2: **2.1: Dietary proteins (4 L)** **2.3: Mineral Metabolism (5 L)**	**MODULE 2:** **2.1: Dietary proteins (4 L)** Added "Protein malnutrition" **2.3: Mineral Metabolism (5 L)** Added "Psychological role of	Minor modification were made in section 2.1, 2.2 and 2.3

			macronutrients	
		MODULE 3: Nutritional Disorders and Diet Plans **3.1: Nutritional Disorders (8 L)** **3.2: Diet Plans (7 L)**	**MODULE 3:** Food allergens and Diet Plans **3.1: Food allergens (5 L)** Food allergens: gluten, milk and milk products, nuts, soy products, fish and shellfish. PEM – Marasmus and Kwashiorkar and Bulimia. **3.2: Diet Plans (10 L)** Added "Diet plans for different age groups"	Title of the module and section 3.1 was changed in accordance with the content.
IV	Nutritional Biochemistry BCH-IV.E-6 (PRACTICAL)	**Total 4 experiments**	**Total 4 experiments** **2)** Assessment of Vitamin constituents in various foods: Lycopene, - β carotene **(6 P)** **3)** Assessment of Nutritional Disorders: Anaemia, Hyperglycemia **(2 P)** **4)** Formulating a Diet Plan: Diabetes, Sports Persons, Pregnancy **(5 P)**	Experiments were rephrased to be more precise.
IV	Endocrinology BCH-IV.E-7 (THEORY)	**MODULE 1:** **1.1: Hormone, Receptor mechanism and Control system (4 L)** **1.2: Hypothalamic and pituitary**	**MODULE 1:** **1.1: Introduction to endocrine system (1 L)** Overview of organ system and their role in hormone production. **1.2: Hormone, Receptor**	An introductory section relevant to the course was included as section 1.1 thereby shifting the existing section 1.1 and 1.2 to as 1.2 and 1.3. Thus number of lecture hours

		hormones (11 L)	**mechanism and Control system (4 L)** Chemical classification of hormones, Pathways of hormone action , Regulation of hormone secretion. **1.3: Hypothalamic and pituitary hormones (10 L)** Classification of hypothalamic and pituitary hormones. Overview on ADH, GH, MSH, ACTH, Ghrelin, Oxytocin, Prolactin. Feedback regulation. Pathophysiology - gigantism, dwarfism and diabetes insipidus	was changed due to above modifications.
V	Molecular Biology BCH-V.C-7 (THEORY)	**MODULE 1:** **1.1: Nucleic Acids, bonds, types of DNAs, DNA packaging and model organisms (10 L)** **1.2: Chromosome (5 L)**	**MODULE 1:** **1.1: Nucleic Acids, bonds, types of DNAs, DNA packaging and model organisms (10 L)** Added “Chargaff’s experiments and Law” **1.2: Chromosome (5 L)** Added “prokaryotic chromosomes, plasmids”	Course specific minor modifications were included in section 1.1 and 1.2.
		MODULE 2: **2.1: Basic Concepts in Molecular Biology (8 L)** DNA/RNA as genetic material: S. F.	**MODULE 2:** **2.1: DNA/RNA as genetic material (8 L)** DNA as genetic material: Griffith’s	Title of the module and section 2.1 was rephrased in accordance with the content. Minor additions relevant to the

		Griffith's transforming principle, and Avery, Hershey and Chase Experiment proving DNA as genetic material; RNA as the genetic material of some viruses, Chargaff's experiments and Law **2.2: DNA Replication (7 L)** Experimental evidence for semi-conservative DNA replication in E.coli -Messelson and Stahl's experiment. The basic requirements of DNA replication: DNA template;DNA polymerases: Structure and function, Ancillary proteins associated with replication Mechanism of replication: Initiation, Elongation and Termination	transforming principle, and Avery, Hershey and Chase Experiment proving DNA as genetic material. RNA as the genetic material of some viruses **2.2: DNA Replication (7 L)** Experimental evidence for semi-conservative DNA replication in *E.coli* - Messelson and Stahl's experiment DNA template, Enzymes - DNA polymerases, ligase, DNA gyrase, Structure and function, Ancillary proteins associated with replication Mechanism of replication: Initiation, Elongation and Termination; Introduction to theta and rolling circle models DNA Proof reading.	course were made to the section 2.2 that was important. Content rearrangement between section 2.1 and 1.1 for more precision.
		MODULE 3: **3.1: DNA Damage and its Repair (8 L)**	**MODULE 3:** **3.1: DNA Damage and its Repair (8 L)** Addition of topic: AMES Test	Minor additions relevant to the course were made to the section 3.1
V	Molecular Biology BCH-V.C-7 (PRACTICAL)	**Previously a total of 7 experiments**	**Total 4 experiments** 1) Isolation of genomic DNA from prokaryotes and eukaryotes **(5 P)** 2) Isolation of RNA from prokaryotes **(2 P)** 3) Agarose gel electrophoresis of	Certain experiments were combined and rearranged to reduce the number of experiments for the practical thereby altering the no. of practical hours.

			genomic DNA and its elution **(5 P)** 4) Mutagenesis in *E.coli* cells – UV **(3 P)**	
V	Concepts in Genetics BCH-V.E-9 (THEORY)	**MODULE 1:** Mendelian Genetics, Model Organisms and Genetic exchange mechanisms **1.2: Model Organisms used in Genetics (3 L)** **1.3: Genetic exchange in bacteria (4 L)**	**MODULE 1:** Mendelian Genetics, Model Organisms and gene transfer mechanisms **1.2: Model Organisms used in used in study of genetics (3 L)** **1.3: Gene transfer mechanism in bacteria (4 L)**	Title of the module and section 1.2 and 1.3 was changed in accordance with the content. .
		MODULE 2: **2.1: Chromosomal Linkage and Crossing-over (9 L)** **2.2: Human Genetics (6 L)**	**MODULE 2:** **2.1: Chromosomal Linkage and Crossing-over (9 L)** Addition of “Transposable elements” **2.2: Human Genetics (6 L)** Karyotyping	In section 2.1, 2.2, important topics were included relevant to the course.
		MODULE 3: **3.1: Chromosomal Aberrations (6 L)**	**MODULE 3:** **3.1: Chromosomal Mutations (6 L)** Concept of gene doses, Barr bodies, Types of structural changes (Deletion, Duplication, Inversion, Translocation,	Certain new subtopics were added and module was rearranged. Section 3.2 title was reframed with minor punctuation changes in the content.

			Variation in chromosome morphology). Disorders – Down's syndrome, Kleinfelter's syndrome. Types of numerical changes with examples (Euploidy and Aneuploidy) - Monosomy and Trisomy of Sex and Autosomes Disorders – Turner's syndrome, Cri-du-chat syndrome. Disorders due to inborn errors of metabolism — Phenylketonuria (PKU), Alkaptonuria, Sickle-cell anaemia.	
		3.2: Determination of sex and Sex differentiation (6 L)	**3.2: Genetically controlled sex determination and differentiation (6 L)** Mechanisms:: (Heterogamesis); Types: Heterogametic males, Heterogametic females; Genic balance mechanism - Sex determination in *Drosophila melanogaster* and man; Male haploidy or haplodiploidy mechanism; Hormonally controlled sex determining mechanism - Bonellia; Environmentally controlled sex determining mechanism-	

			Ophryotrocha	
V	Concepts in Genetics BCH-V.E-9 (PRACTICAL)	**Previously a total of 7 experiments**	**Total 5 experiments** **1)** Study of Mendelian traits in Human Population **(3 P)** **2)** Pedigree analysis and problem solving **(3 P)** **3)** Karyotype analysis of chromosomal abnormalities **(3 P)** **4)** Smear technique to demonstrate sex chromatin in buccal epithelial cells (Barr bodies in sex determination) **(2 P)** **5)** Problem solving on Mendel's laws and Hardy-Weinberg's law **(3 P)** **6)** Conjugation experiment **(1 P)**	Certain experiments were combined and rearranged to reduce the number of experiments with the addition of new one for the practical thereby altering the no. of practical hours.
V	Regulation of gene expression BCH-V.E-10 (THEORY)	**MODULE 1:** Tanscription in Prokaryotes and Eukaryotes **1.1: Transcription in Prokaryotes (7 L)** **1.2: Transcription in Eukaryotes (8 L)**	**MODULE 1:** Transcription **1.1: Concept of Central Dogma (1 L)** **1.2: Transcription in Prokaryotes (7 L)** **1.3: Transcription in Eukaryotes (7 L)**	Title of the module was made specific to the content. An important concept was included as section 1.1 that is core topic for this course. Rearrangement of lecture hours due to shifting of the section 1.1 and 1.2 .
		MODULE 2:	**MODULE 2:**	Rearrangement of content

			Splicing, Translation, Gene regulation **2.1: RNA Splicing (3 L)** The spliceosome machinery, Group I and group II introns, Alternative splicing, Exon shuffling **2.2: Translation in Prokaryotes and Eukaryotes (9 L)** Ribosomes in Prokaryotes and Eukaryotes; Messenger RNA, Transfer RNA, Attachment of amino acids to tRNA, Ribosomal RNAs in Prokaryotes and Eukaryotes Comparison of Translation in Prokaryotes and Eukaryotes Inhibitors of Translation and Applications as anti-microbial drugs **2.3: Introduction to gene regulation (3 L)**	
		MODULE 3: Regulation of Gene Regulation in Prokaryotes and Eukaryotes **3.1: Regulation of Gene Expression in Prokaryotes (7 L)**	**MODULE 3:** Regulation of Gene expression **3.1: In Prokaryotes (7 L)** Concept of operon - structural and regulatory genes, Operator, promoter.	Title of the module and the sections were generalised. Minor changes were done to the sections relevant to the course.

		3.2: Regulation of Gene Expression in Eukaryotes (8 L)	Negative and positive regulation. Operon; Lactose operon, Tryptophan operon **3.2: In Eukaryotes (8 L)** Euchromatin and heterochromatin, Trans-acting molecules, Cis-acting regulatory elements. Regulation by co- and post transcriptional processing of mRNA- Splicing, mRNA editing, RNA interference (RNAi), Regulation of mRNA at translational level Regulation through modifications to DNA	
V	Industrial Microbiology BCH-V.E-11 (THEORY)	**MODULE 1:** Introduction to Industrial Biochemistry **1.2: Industrial bioreactor (8 L)** **1.3: Fermentation Media (6 L)**	**MODULE 1:** Introduction to Industrial Microbiology **1.2: Industrial bioreactor (8 L)** Added “Sterilization of bioreactors” **1.3: Fermentation Media (6 L)** Added “sterilization of media”	The course name, “Industrial Biochemistry” has been changed to “Industrial Microbiology” as per suggested by the board members due to the content of the syllabi. Title of the module was changed in accordance with the content. Minor changes were added in 1.2 and 1.3 with respect to

				sterilization because of its utmost importance.
		MODULE 2: Types of Fermentation and Screening of microorganisms **2.1: Types of fermentation (7 L)**	**MODULE 2:** Fermentation, fermentors and Screening of microorganisms **2.1: Types of fermentation and fermenters (7 L)** Added "Lab scale & industrial scale fermentors"	The title of the module and section 2.1 was changed in relevance to the content and an extra topic was included to study about the industrial level equipment.
		MODULE 3: Detection & assays of products; Industrial production of products **3.1: Detection and Assays of products (8 L)** **3.2: Industrial production of economically important products (7 L)** Citric acid, Vinegar, Industrial alcohol(Ethanol), SCP, Beer, Wine Indian fermented foods: Dosa, idli	**MODULE 3:** Fermentation products **3.1: Detection and assays of fermentation products (5 L)** Added "chromatographic method" for assays **3.2: Industrial production of economically important products (10 L)** Citric acid, Vinegar, Ethanol, SCP, Beer, Wine, Yogurt, Penicillin, Amylase, Steroids	The title of the module and section 3.1 was changed in accordance with the content. Very minor changes were done in section 3.1 whereas, many examples were added in 3.2 which were important.
V	Industrial Microbiology	**Previously a total of 10 experiments**	**Total 8 experiments** **1)** Study and handling of a fermentor **(2 P)**	Two new important expts were included and no. of practicals were reduced to accommodate

	BCH-V.E-11 (PRACTICAL)		**2)** Media preparation for batch fermentation process **(1 P)** **3)** A study on the phases of growth of microorganisms during fermentation **(2 P)** **4)** Isolation of antibiotic producing bacteria – crowded plate technique and secondary screening using giant colony technique **(3 P)** **5)** Production of wine (from fruit) using yeast **(2 P)** **6)** Production of vinegar **(2 P)** **7)** MIC of Penicillin for Gram positive bacteria (*S. aureus* or Bacillus) **(1 P)** **8)** Production of amylase in solid state fermentation **(2 P)**	for new experiments. Few experiments were rephrased for better specificity. .
VI	Food Biochemistry BCH-VI.E-14 (THEORY)	**MODULE 1:** Introduction to Food Biochemistry, microbial spoilage & other reactions **1.1: Introduction to Food biochemistry (1 L)** Definition and composition of food. **1.2: Food as a substrate for Microorganisms (4 L)** Hydrogen-ion Concentration, moisture requirement, oxidation-reduction potential, nutrient content, inhibitory substances, and biological structure.	**MODULE 1:** Introduction to Food Biochemistry and spoilage **1.1: Introduction to Food biochemistry (2 L)** Definition and composition of food. Food as a substrate for microorganisms **1.2: Spoilage of food (13 L)** Intrinsic and Extrinsic factors - Hydrogen-ion concentration, moisture requirement, oxidation-reduction potential, nutrient content,	The title of the Module was changed in accordance with the content. An important topic relevant to the course was added in section 1.1. Content from existing sections 1.2, 1.3, 1.4 was combined and the title of the sections was to be rephrased to make it more elaborative and comprehensive.

		1.3: Principle of underlying spoilage (5 L) Classification of foods by ease of spoilage, Factors affecting kinds, numbers and growth of microorganisms in food, Chemical changes caused by Microorganisms **1.4: Browning Reactions In Food (5 L)** Enzymatic browning, Non – Enzymatic browning, Maillard reaction, Caramelization reaction, Ascorbic acid oxidation	inhibitory substances, and biological structure. Enzymatic browning, Non – Enzymatic browning, Maillard reaction, Caramelization reaction, Ascorbic acid oxidation Classification of foods by ease of spoilage, Factors affecting kinds, numbers and growth of microorganisms in food, temperature, pressure Chemical changes caused by microorganisms	The number of lectures also changed due to the above alteration.
		MODULE 2: Principles of Food Preservation **2.1: Principles of Food preservation (15 L)** Preservation by high temperature – Factors affecting heat resistance (Thermal Death Time), Determination of heat resistance (Thermal Death Time), Heat treatments employed in food processing, Chemistry of Canning. Preservation by low temperature – Temperature employed in low-temperature storage.	**No changes**	N.A

		Principle of freezing, freezing curve, changes occurring during freezing, types of freezing i.e. slow freezing, quick freezing, Introduction to thawing, Mechanism of changes during thawing, and its effect on food. Preservation by drying – Methods of drying, Factors in the control of drying Preservation by radiation – kinds of ionizing radiations used in food irradiation, mechanism of action, use of radiation processing in the food industry, the concept of cold Sterilization.		
		MODULE 3: Sensory Evaluation, Food Quality, New Product Development **3.1: Sensory evaluation of food (7 L)** Objectives, type of food panels, characteristics of a panel member, the layout of sensory evaluation laboratory, sensitivity tests, threshold value, paired comparison test, duo trio test, triangle test, hedonic scale, the chemical dimension of basic tastes, Amoore's classification of odorous compounds. Sherman and Sczezniak classification of food texture.	**MODULE 3:** Food Quality, New Product Development **3.1: Food Quality (11 L)** Objectives, type of food panels, characteristics of a panel member, the layout of sensory evaluation laboratory, sensitivity tests, threshold value, paired comparison test, duo trio test, triangle test, hedonic scale, the chemical dimension of basic tastes, Amoore's classification of odorous compounds. Sherman and Sczezniak classification of food texture.	The title of the module was rephrased to be more precise. To make it more specific and comprehensive, Content from the existing section 3.1 and 3.2 were rearranged and combined together and titled in as section 3.1 Existing section 3.3 was shifted to as 3.2 and Title of existing section 3.3 had to be changed and content was rearranged and The number of lectures had to be thus changed due to the above alteration.

		Application of texture measurement in cereals, fruits, and vegetables, dairy, meat, and meat products. Dimensions of colour and attributes of colour; gloss etc. Perception of colour, Colour Measurement: Munsell colour system, CIE colour system, Hunter colour system, etc. **3.2: Food Quality (4 L)** Grading of Milk, MBRT, Resazurin Sensory attributes of cheese, cream, butter, ghee, juices, (Some more??) **3.3: New Product Development (4 L)** Definition, Importance, Need of product development, Steps of product development, Product development tools, Reasons for failure	Sensory attributes of cheese, cream, butter, ghee, juices. Application of texture measurement in cereals, fruits, and vegetables, dairy, meat, and meat products. Dimensions of colour and attributes of colour; gloss etc. Perception of colour, Colour Measurement: Munsell colour system, CIE colour system, Hunter colour system, etc. Grading of Milk, MBRT, Resazurin (include more tests for other foods) FSSAI and other Regulatory Bodies. **3.2: Product Development (4 L)** Importance, Need for product development, Steps of product development, Product development tools, Reasons for failure	
VI	Food Biochemistry BCH-VI.E-14 (PRACTICAL)	**Total of 11 experiments** 1) Preparation of food product by fermenting milk and sensory Evaluation **(3 P)** 2) Screening of food spoilage in fruits and vegetables **(2 P)** 3) TDT of an organism isolated from spoilt fruit (**1 P)** 4) Preservation of food item by canning **(1 P)** 5) Preservation of sugary and milk	**Total of 8 experiments** 1) Screening and evaluation of fresh and spoiled fruits and vegetables **(2 P)** 2) Texture evaluation of various processed food sample **(1 P)** 3) Processing and sensory evaluation of milk and milk products (milk, flavored milk, curd, cheese, condensed milk, khoya) **(5 P)** 4) TDT of an organism isolated from	Experiments were modified with more detailed content in context with the theory. Experiments were aligned and rearranged so that the No. of practicals was reduced. Thus the total number of experiments and the number of practical hours also had to be

		products. **(2 P)** 6) Study quality characteristics of foods preserved by drying/dehydration/ freezing. **(2 P)** 7) Sensory evaluation of milk and milk products **(2 P)** 8) Texture evaluation of various food samples- cookies/ biscuits/ snack foods **(1 P)** 9) Preparation of flavored milk **(1 P)** 10) Estimation of salt content in butter **(1 P)** 11) Visit to a food industry or food research institute and preparation of report **(3 P)**	spoilt fruit **(1 P)** **5)** Spoilage of bakery product (bread, biscuits) (**1 P)** 6) Estimation of salt content in butter **(1 P)** 7) Study quality characteristics of foods preserved by drying/ dehydration/ freezing. **(2 P)** 8) Visit to a food industry or food research institute and preparation of a report **(2 P)**	changed.
		REFERENCES for BCH-VI.E-14 **Mandatory Reading** • Frazier W. C., and Westhoff D. C., Food Microbiology, TMH Publication, New Delhi, 2004. **Supplementary Reading** • Ramaswamy H and Marcott M,Food Processing Principles and Applications CRC Press, 2006. • Ranganna S, Handbook of Analysis and Quality Control for Fruits and Vegetable Products, 2nd ed. TMH Education Pvt. Ltd, 1986. • Potter NH, Food Science, CBS Publication, New Delhi, 1998. • Fennema, Owen R, Food Chemistry, 3rd Ed., Marcell Dekker, New York, 1996	**REFERENCES for BCH-VI.E-14** **Mandatory Reading** • Frazier W. C. and Westhoff D. C., Food Microbiology, TMH Publication, New Delhi. **Supplementary Reading** • Ramaswamy, H. and Marcott, M. Food Processing Principles and Applications CRC Press. • Ranganna, S. Handbook of Analysis and Quality Control for Fruits and Vegetable Products, TMH Education Pvt. Ltd. • Potter, N.H. Food Science, CBS Publication, New Delhi. • Owen, F. R. Food Chemistry, Marcell Dekker, New York. • Gordon, F. W. New Product	The Year and the edition had to be removed for each of the references and instead, the tag ‘latest edition; had to be specified at the beginning.

		• Fuller, Gordon W, New Product Development From Concept to Marketplace, CRC Press,2004. • Desrosier, Norman W. and Desrosier.,James N.,The technology of food preservation, 4th Ed.,Westport, Conn. : AVI Pub. Co., 1977. • Pomeranz Y and Meloan CE (2002). Food Analysis – Theory and Practice, CBS Publishers and Distributors, New Delhi. **Web References:** https://www.youtube.com/watch?v=LUQxrnEFzB0 https://www.slideshare.net/natrajdurgannavar/sensory-evaluation-of-food http://ecoursesonline.iasri.res.in/mod/page/view.php?id=6091	Development From Concept to Marketplace, CRC Press. • Norman, D.W. and James, D. N. The technology of food preservation,Westport. • Pomeranz, Y. and Meloan, C.E. Food Analysis – Theory and Practice, CBS Publishers and Distributors, New Delhi. **Web References:** No changes	
VI	Environmental Chemistry BCH-VI.E-15 (THEORY)	**MODULE 1:** Basic Ecological concepts; Pollutants and Composting **1.1: Basic ecological concept (6 L)** **1.2: Pollutants (7 L)**	**MODULE 1:** Ecological Concepts and Pollutants **1.1: Basic ecological concept (9 L)** Biogeochemical cycles (C, N, O, P, S, Water), Food chain and food webs, Ecological pyramids; Productivity and eco-energetic (10% law) **1.2: Pollutants (6 L)** Pollutants of water, air and soil and their sources Eco-toxicology: concept of	Title of the module was changed in accordance with the content. Some examples were included in Section 1.1 to make it more specific. A statement was rephrased in section 1.2 to make it clearer. Section 1.3 was shifted to module 3 since it was more specific to module 3.

		1.3: Composting and Vermitechnology (2 L) Principle concept and method	permissible limits, ED50 & LD50; acute and chronic exposures. Significance of dissolved oxygen, BOD, COD.	The change in lecture hours were needed due to reshuffling and addition of content.
		MODULE 2: Impact of environmental pollution and its control and monitoring **2.1: Air Pollution (5 L)** **2.2: Water Pollution (5 L)** **2.3: Pollution monitoring (5 L)**	**MODULE 2:** Impact of environmental pollution and its control I **2.1: Pollution monitoring (5 L)** **2.2: Air Pollution (5 L)** **2.3: Water Pollution (5 L)**	Title of the module was rephrased in accordance with the content. Section 2.3 was shifted to as 2.1, section 2.1 shifted to as 2.2 and section 2.2 shifted to as 2.3 to maintain sequential continuity
		MODULE 3: Pollution Abatement **3.1: Bioremediation (10 L)** **3.2: Waste Management (5 L)**	**MODULE 3:** Impact of environmental pollution and its control II **3.1: Soil Pollution (1 L)** Hazardous and non-hazardous solid wastes **3.2: Bioremediation (10 L)** Bioremediation: Definition, Mechanism of microbial	Title of the module was rephrased in accordance with the content. A new topic was included as section 3.1 since it was relevant to the course thereby shifting existing section 3.1 to as 3.2. Section 1.3 was required to be

			bioremediation, Microbial desulphurization of coal (indirect mechanisms), Microbial processes – enzymatic transformations, co-metabolism, microbial adhesion, biofilms, production of extracellular polymers and emulsifiers. Phytoremediation Removal of metal pollutants through sedimentation, sorption, precipitation, speciation conversion. Biodegradation of xenobiotics: Aromatic hydrocarbons (benzene) and alkanes. Biosorption: Principle, Use of Fungi and Algae Genetically engineered microorganisms: Super Bug (Pseudomonas species) Concepts of Reuse, Recycle and Recovery. **3.3: Composting and Vermitechnology (3 L)** Principle concept and method **3.4: Hospital waste management (1 L)**	included in module 3 as 3.3. A small topic of section 3.2 was retitled as 3.4 and rest of the content of 3.2 was removed since it was not already mentioned in other sections. The change in lecture hours due to reshuffling and addition of topics.
VI	Environmental Chemistry BCH-VI.E-15 (PRACTICAL)	**Total 8 experiments**	**Total 8 experiments** **1)** Water quality by MPN method for sewage water **(2 P)** **2)** Routine analysis of potable water sample using Presumptive,	Title of the experiment 1, 2 were rephrased to be more specific.

			Confirmatory and Confirmed tests for coliform **(4 P)** **Experiments 3, 4, 5, 6, 7, and 8 were not changed.**	

REFERENCES				
Semester	Course	**Existing**	**Changes proposed**	Reason for the change
III	Metabolism of Biomolecules BCH-III.C-5	**REFERENCES for BCH-III.C-5** **Mandatory Reading** • Nelson, D. L. & Cox, M.M. (2017). Lehninger's Principles of Biochemistry (7th Edition). Worth Publishers, New York, USA. **Supplementary Reading** • Stryer, L; Berg, J; Tymoczko, J & Gatto, G. (2019). Biochemistry (9th Edition). W. H. Freeman and Co., New York, USA. • Murray, R. K, Granner, D. K., Mayes, P. A. & Rodwell, V. W. (2018). Harper's Illustrated Biochemistry (31st Edition). McGraw-Hill Companies. • Jain, J. L.; Jain S. & Jain N. (2016). Fundamentals of Biochemistry (7th Edition). S.Chand and Company, Ltd., New	**REFERENCES for BCH-III.C-5** **Mandatory Reading** • Nelson, D. L. and Cox, M.M. Lehninger's Principles of Biochemistry. Worth Publishers, New York, USA **Supplementary Reading** • Stryer, L., Berg, J., Tymoczko, J. and Gatto, G. Biochemistry. W. H. Freeman and Co., New York, USA. • Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. Harper's Illustrated Biochemistry. McGraw-Hill Companies. • Jain, J. L., Jain, S. and Jain, N. Fundamentals of Biochemistry. S. Chand and Company, Ltd., New Delhi. • Plummer, D. T. An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Company Limited,	According to the BoS members, Year of publication need not be mentioned. Students can refer to the latest edition. The Year and the edition had to be removed for each of the references. An additional supplementary reading had to be added

		Delhi. • Plummer, D. T. (2017). An Introduction to Practical Biochemistry, (3rd Edition). Tata McGraw-Hill Publishing Company Limited, New Delhi. • Harvey, R.A. & Ferrier, D.R. (2017). Lippincott's Illustrated Reviews, Biochemistry (7th Edition). Lippincott Williams and Wilkins. **Web References** •https://www.coursera.org/learn/energy-metabolism •https://online-learning.harvard.edu/course/principlesbiochemistry-1 •https://nptel.ac.in/courses/102/105/102105034/ •https://openstax.org/details/books/biology-2e	New Delhi. • Harvey, R.A. and Ferrier, D.R. Lippincott's Illustrated Reviews, Biochemistry. Lippincott Williams and Wilkins. • Voet, D. and Voet, J. G. Biochemistry John Wiley and Sons, Inc, USA. **Web References** No changes	
III	Tools and Techniques BCH-III.E-1	**REFERENCES Mandatory Reading:** • Wilson K and Walker J. 2005. Principles and Techniques of Practical Biochemistry, 6th Edition, Cambridge University Press. **Additional Reading:** • Upadhyay A, Upadhyay K and	**REFERENCES for BCH-III.E-1: Mandatory Reading:** • Wilson, K. and Walker, J. Principles and Techniques of Practical Biochemistry, Cambridge University Press. **Additional Reading:** • Upadhyay, A., Upadhyay, K. and	According to the BoS members, Year of publication need not be mentioned. Students can refer to the latest edition.

		Nath N. 2009. Biophysical Chemistry: Principles and Techniques, 3rd Edition, Himalaya Publishing, New Delhi. • Plummer D. 1988. An introduction to Practical Biochemistry, Tata McGraw Hill Publishing Company, New Delhi. • Jayraman J. 2011. Laboratory Manual in Biochemistry. New Age International Pvt Ltd Publishers, New Delhi. • Sadasivam S. and Manickam A. 2007. Biochemical Methods, 3rd edition, New Age International Publishers, New Delhi. **Web - links :** •https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-the-reproductive-system/a/hs-the-reproductive-system-review •https://www.khanacademy.org/science/high-school-biology/hs-cells/hs-introduction-to-cells/a/microscopy	Nath, N. Biophysical Chemistry: Principles and Techniques, Himalaya Publishing, New Delhi. • Plummer, D. An introduction to Practical Biochemistry, Tata McGraw Hill Publishing Company, New Delhi. • Jayraman, J. Laboratory Manual in Biochemistry. New Age International Pvt Ltd Publishers, New Delhi. • Sadasivam, S. and Manickam A. Biochemical Methods, New Age International Publishers, New Delhi. **Web - links :** No change	The Year and the edition had to be removed for each of the references.

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III	Enzymology BCH-III.E-2	**REFERENCES for BCH-III.E-2** **Mandatory Reading** • Nelson, D. L. & Cox, M. M. (2017). Lehninger's Principles of Biochemistry (7th Edition). Worth Publishers, New York, USA. **Supplementary Reading** • Stryer, L; Berg, J; Tymoczko, J & Gatto, G. (2019). Biochemistry (9th Edition). W. H. Freeman and Co., New York, USA. • Murray, R. K, Granner, D. K., Mayes, P. A. & Rodwell, V. W. (2018). Harper's Illustrated Biochemistry (31st Edition). McGraw-Hill Companies. • Jain, J. L.; Jain S. & Jain N. (2016). Fundamentals of Biochemistry (7th Edition).	**REFERENCES for BCH-III.E-2** **Mandatory Reading** • Malcolm, D. and Edwin C. Webb. Enzymes. Academic Press Inc., Publishers, New York **Supplementary Reading** •Nelson, D. L. and Cox, M. M. Lehninger's Principles of Biochemistry. Worth Publishers, New York, USA. • Stryer, L., Berg, J., Tymoczko, J. and Gatto, G. Biochemistry. W. H. Freeman and Co., New York, USA. • Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. Harper's Illustrated Biochemistry. McGraw-Hill Companies. • Jain, J. L., Jain, S. and Jain, N.	According to the BoS members, Year of publication need not be mentioned. Students can refer to the latest edition. The Year and the edition had to be removed for each of the references. An additional supplementary reading had to be added

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III	Fundamentals of Microbiology BCH-III.E-3	**REFERENCES for BCH-III.E-3** **Mandatory Reading** • Pelczar, M. J., Chan E, C.S., & Krieg, N.R. (latest edition). Microbiology (5th Edition). McGraw Hill Education. **Supplementary Reading** • Anantnaryan, R., & Paniker, C.K.J. (2017). Textbook of Microbiology, (10th edition). The Orient Blackswan. • Madigan, M. T., Martinko. J. M., & Parker J. (2007). Brock's Biology of Microorganisms, (8th Edition). Prentice Hall College Div. • Stanier, R.Y. (1993) General Microbiology, Cambridge University. • Willey, J. M., Sherwood, L., Woolverton, C. J. & Prescott, L. M. (2017). Prescott, Harley, and Klein's Microbiology, (10th Edition). McGraw-Hill Education, New York.	**REFERENCES for BCH-III.E-3** **Mandatory Reading** • Pelczar, M. J., Chan E, C.S., and Krieg, N.R. Microbiology. McGraw Hill Education. • Willey, J. M., Sherwood, L., Woolverton, C. J. and Prescott, L. M. Prescott, Harley, and Klein's microbiology. New York, McGraw-Hill Higher Education. **Supplementary Reading** • Atlas, R.M., Anantnaryan, R. and Paniker, C.K.J. Textbook of Microbiology, The Orient Blackswan. • Madigan, M. T., Martinko. J. M. and Parker J. Brock's Biology of Microorganisms, Prentice Hall College Div. • Stanier, R.Y. General Microbiology, Cambridge University. • Willey, J. M., Sherwood, L., Woolverton, C. J. and Prescott, L. M. Prescott, Harley, and Klein's Microbiology, McGraw-Hill	According to the BoS members, Year of publication need not be mentioned. Students can refer to the latest edition. The Year and the edition had to be removed for each of the references. An additional supplementary reading had to be added

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III	Plant Biochemistry BCH-III.E-4	**REFERENCES for BCH-III.E-4** **Mandatory Reading** • Taiz, L. and Zeiger, E. (2017). Plant Physiology (7th Edition). Sunderland Sinauer Associates Inc. **Supplementary Reading** • Nelson, D. L. & Cox, M.M. (2017). Lehninger's Principles of Biochemistry (7th Edition). Worth Publishers, New York, USA. • Chawla, H.S. (2002). Introduction to Plant Biotechnology, USA, Science Publishers Inc. • Singh, B. D. (2006) Plant Biotechnology, Kalyani Publishers. • Singh, B. D. (2011). Biotechnology Expanding Horizons (3rd Edition), Kalyani	**REFERENCES for BCH-III.E-4** **Mandatory Reading** • Taiz, L. and Zeiger, E. Plant Physiology. Sunderland Sinauer Associates Inc. **Supplementary Reading** • Nelson, D. L. and Cox, M.M. Lehninger's Principles of Biochemistry. Worth Publishers, New York, USA. • Chawla, H.S. Introduction to Plant Biotechnology, USA, Science Publishers Inc. • Singh, B. D. Plant Biotechnology, Kalyani Publishers. • Singh, B. D. Biotechnology Expanding Horizons (3rd Edition), Kalyani Publishers.,New Delhi. • Stumpf, G., Bruening and Doi, R.Y.	According to the BoS members, Year of publication need not be mentioned. Students can refer to the latest edition. The Year and the edition had to be removed for each of the references. An additional supplementary reading had to be added

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<tr><td>IV</td><td>Immunology
BCH-IV.C-6</td><td>**REFERENCES for BCH-IV.C-6**
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• Richard, A. G., Thomas, J. K. & Barbara A. O., (2018). Kuby Immunology, (7th Edition). W. H. Freeman & Company, New York.
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• Punt J., Stranford S., Jones P, Owen, J. A. (2018). Kuby Immunology, (8th Edition). W. H. Freeman & Company, New York.
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• Punt J., Stranford S., Jones P, Owen, J. A. Kuby Immunology. W. H. Freeman & Company, New York.
• Arora, M.P. Cell Biology, Immunology and Environmental Biology, Himalaya Publishing House.
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IV	Human Physiology BCH-IV.E-5	**REFERENCES for BCH-IV.E-5** **Mandatory Reading** **•** Sembulingam K. & Sembulingam P. (2012). Essentials of Medical Physiology, Sixth edition., Jaypee brothers medical publishers (P) Ltd, New Delhi**.** **Supplementary Reading** • Arora M.P. (2011). Animal physiology, Himalaya publishing house, New Delhi. • Verma S.K., Tyagi A.K. & Agarwal B.B.L. (2000). Animal	**REFERENCES for BCH-IV.E-5** **Mandatory Reading** **•** Sembulingam K. and Sembulingam P. Essentials of Medical Physiology, Jaypee brothers medical publishers (P) Ltd, New Delhi**.** **Supplementary Reading** • Arora, M.P. Animal physiology, Himalaya publishing house, New Delhi. • Verma, S.K., Tyagi, A.K. and Agarwal, B.B.L. Animal Physiology, S. Chand and Company.	According to the BoS members, Year of publication need not be mentioned. Students can refer to the latest edition. The Year and the edition had to be removed for each of the references. An additional supplementary

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IV	Nutritional Biochemistry BCH-IV.E-6	**REFERENCES for BCH-IV.E-6** **Mandatory Reading** • Gibson R. (2005). Principles of Nutritional Assessment. Oxford University Press**.** **Supplementary Reading** • Frazier W.C & Westhoff D.C. (2015). Food Microbiology. 5th edition. McGraw Hill Education (India) Private Limited: New Delhi • Tiwari R.P, Hoondal G.S. & Tewari R. (2009). Laboratory Techniques in Microbiology and	**REFERENCES for BCH-IV.E-6** **Mandatory Reading** • Gibson, R. Principles of Nutritional Assessment. Oxford University Press**.** **Supplementary Reading** • Frazier, W.C and Westhoff, D.C. Food Microbiology. McGraw Hill Education (India) Private Limited: New Delhi • Tiwari, R.P., Hoondal, G.S. and Tewari, R. Laboratory Techniques in Microbiology and Biotechnology, Abhishek Publications Chandigarh (India).	According to the BoS members, Year of publication need not be mentioned. Students can refer to the latest edition. The Year and the edition had to be removed for each of the references. An additional supplementary reading had to be added

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IV	Endocrinology BCH-IV.E-7	**REFERENCES for BCH-IV.E-7** **Mandatory Reading** • Jain, A. K., (2017). Textbook of Physiology (Volumes I and II) (7th Edition). Avichal Publishing Company. **Supplementary Reading** • Sembuligam K. and Sembulingam P. (2010). Essentials of Medical Physiology (5th Edition), Jaypee Brothers Medical Publishers, New Delhi, India. • Hadley M.C. and Levine. (2007). Endocrinology (6th Edition). J.E. Pearson Education, New Delhi. **Web References** •https://www.youtube.com/watch?v=YcPicFL5Jnw	**REFERENCES for BCH-IV.E-7** **Mandatory Reading** • Kovac's, W.J. and Ojeda, S.R. Textbook of Endocrine Physiology. Oxford University Press **Supplementary Reading** • Sembuligam K. and Sembulingam P. Essentials of Medical Physiology Jaypee Brothers Medical Publishers, New Delhi, India. • Hadley, M.C. and Levine. Endocrinology J.E. Pearson Education, New Delhi. **Web References** No changes	According to the BoS members, Year of publication need not be mentioned. Students can refer to the latest edition. The Year and the edition had to be removed for each of the references. An additional supplementary reading had to be added

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V	Molecular Biology BCH-V.C-7	**REFERENCES for BCH-IV.E-7** **Mandatory Reading** • Nelson, D. L. & Cox, M.M. (2017). Lehninger's Principles of Biochemistry (7th Edition). Worth Publishers, New York, USA. **Supplementary Reading** • Stryer, L; Berg, J; Tymoczko, J & Gatto, G. (2019). Biochemistry	**REFERENCES for BCH-V.C-7** **Mandatory Reading** • David, C., Nanette, P. and Michelle, M. Molecular Biology. Elsevier Academic Press. **Supplementary Reading** • Murray, R., Granner, D., Mayes, P. and Rodwell, V. Harper's Illustrated	According to the BoS members, Year of publication need not be mentioned. Students can refer to the latest edition. The Year and the edition had to

		(9th Edition). W. H. Freeman and Co., New York, USA. • Murray, R. K, Granner, D. K., Mayes, P. A. & Rodwell, V. W. (2018). Harper's Illustrated Biochemistry (31st Edition). McGraw-Hill Companies. • Jain, J. L.; Jain S. & Jain N. (2016). Fundamentals of Biochemistry (7th Edition). S.Chand and Company, Ltd., New Delhi. • Verma, P. S. and Agarwal, V. K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company Pvt. Ltd. • Harvey, R.A. & Ferrier, D.R. (2017). Lippincott's Illustrated Reviews, Biochemistry (7th Edition). Lippincott Williams and Wilkins. • Voet, D. & Voet, J. G. (2004). Biochemistry (4td Edition). John Wiley & Sons, Inc, USA. **Web References:** •https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics •https://vlab.amrita.edu/?	Biochemistry. Mc Graw Hill. • Watson, J. D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R.M. Molecular biology of the gene. Menlo Park, CA: Benjamin-Cummings. • Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. Molecular biology of the cell. New York: Garland Science. • Gardner, M. J., Simmons D.P. Snustad. Principles of Genetics. John Wiley & Sons. • Dubey, R.C. Advanced Biotechnology. S. Chand Publishing. **Web References:** No changes	be removed for each of the references. Mandatory and supplementary References had to be changed since they were not precisely in accordance with the course paper.

		sub=3&brch=73&sim=1 105&cnt=1. •http://textbookofbacteriology.net/ growth_3.html •https://openstax.org/details/books/ biology-2e •https://bio.libretexts.org/ Bookshelves/ Introductory_and_General_Biolog y/Book %3A_Concepts_in_Biology_(Ope nStax)/9%3A_Molecular_Biology		
V	Concepts in Genetics BCH-V.E-9	**REFERENCES for BCH-V.E-9** **Mandatory Reading** • Tamarin, R.H. (2017). Principles of Genetics (7th Edition). Tata McGraw-Hill Publishing Company Ltd. • Verma, P. S. and Agarwal, V. K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company Pvt. Ltd. **Supplementary Reading** • Stryer, L; Berg, J; Tymoczko, J & Gatto, G. (2019). Biochemistry (9th Edition). W. H. Freeman and Co., New York, USA. • Murray, R. K, Granner, D. K., Mayes, P. A. & Rodwell, V. W.	**REFERENCES for BCH-V.E-9** **Mandatory Reading** • Tamarin, R.H. Principles of Genetics. Tata McGraw-Hill Publishing Company Ltd. • Verma, P. S. and Agarwal, V. K. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company Pvt. Ltd. **Supplementary Reading** • Stryer, L., Berg, J., Tymoczko, J. and Gatto, G. Biochemistry. W. H. Freeman and Co., New York, USA. • Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. Harper’s Illustrated Biochemistry. McGraw-Hill Companies. • Jain, J. L., Jain S. and Jain N.	According to the BoS members, Year of publication need not be mentioned. Students can refer to the latest edition. The Year and the edition had to be removed for each of the references. An additional supplementary reading had to be added

		(2018). Harper's Illustrated Biochemistry (31st Edition). McGraw-Hill Companies. • Jain, J. L.; Jain S. & Jain N. (2016). Fundamentals of Biochemistry (7th Edition). S.Chand and Company, Ltd., New Delhi. • Verma, P. S. and Agarwal, V. K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company Pvt. Ltd. • Harvey, R.A. & Ferrier, D.R. (2017). Lippincott's Illustrated Reviews, Biochemistry (7th Edition). Lippincott Williams and Wilkins. • Voet, D. & Voet, J. G. (2004). Biochemistry (4td Edition). John Wiley & Sons, Inc, USA. **Web References:** •http:// www.biologydiscussion.com/ mendel/mendel-study-on-genetics- mendelian- inheritance/38754 •https://www.khanacademy.org/ science/high-school-biology/hs- classical-genetics/hs-	Fundamentals of Biochemistry. S. Chand and Company, Ltd., New Delhi. • Verma, P. S. and Agarwal, V. K. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company Pvt. Ltd. • Harvey, R.A. and Ferrier, D.R. Lippincott's Illustrated Reviews, Biochemistry. Lippincott Williams and Wilkins. • Voet, D. and Voet, J. G. Biochemistry. John Wiley & Sons, Inc, USA. • Lewin B., Krebs J. E., Goldstein E. S. and Kilpatrick S. T. Genes XI. Jones & Bartlett Publishers **Web References:** No change	

		pedigrees/v/pedigrees •https://study.com/academy/lesson/hardy-weinberg-equilibrium-i-overview.html •http://www.biologydiscussion.com/genetics/structural-change-in-the-structure-of-chromosomes/5261 •https://www.khanacademy.org/science/high-school-biology/hs-classical-genetics/hs-sex-linkage/a/x-inactivation •https://www.khanacademy.org/science/biology/classical-genetics/chromosomal-basis-of-genetics/a/discovery-of-the-chromosomal-basis-of-inheritance		
V	Regulation of gene expression BCH-V.E-10	**REFERENCES for BCH-V.E-10** **Mandatory Reading** • Nelson, D. L. & Cox, M.M. (2017). Lehninger's Principles of Biochemistry (7th Edition). Worth Publishers, New York, USA. **Supplementary Reading** • Stryer, L; Berg, J; Tymoczko, J & Gatto, G. (2019). Biochemistry (9th Edition). W. H. Freeman and Co., New York, USA. • Murray, R. K, Granner, D. K.,	**REFERENCES for BCH-V.E-10** **Mandatory Reading** • Nelson, D. L. and Cox, M.M. Lehninger's Principles of Biochemistry. Worth Publishers, New York, USA. **Supplementary Reading** • Stryer, L., Berg, J., Tymoczko, J. and Gatto, G. Biochemistry. W. H. Freeman and Co., New York, USA. • Murray, R. K., Granner, D., K.,	According to the BoS members, Year of publication need not be mentioned. Students can refer to the latest edition. The Year and the edition had to be removed for each of the references. An additional supplementary reading had to be added, along

		Mayes, P. A. & Rodwell, V. W. (2018). Harper's Illustrated Biochemistry (31st Edition). McGraw-Hill Companies. • Jain, J. L.; Jain S. & Jain N. (2016). Fundamentals of Biochemistry (7th Edition). S.Chand and Company, Ltd., New Delhi. • Verma, P. S. and Agarwal, V. K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company Pvt. Ltd. • Harvey, R.A. & Ferrier, D.R. (2017). Lippincott's Illustrated Reviews, Biochemistry (7th Edition). Lippincott Williams and Wilkins. • Voet, D. & Voet, J. G. (2004). Biochemistry (4td Edition). John Wiley & Sons, Inc, USA. **Web References:** •https:// courses.lumenlearning.com/suny-wmopen-biology1/chapter/ regulation-of-gene expression/ •https://www.khanacademy.org/ science/biology/gene-regulation •https://www.nature.com/scitable/	Mayes, P. A. and Rodwell, V. W. Harper's Illustrated Biochemistry. McGraw-Hill Companies. • Jain, J. L., Jain, S. and Jain, N. Fundamentals of Biochemistry. S. Chand and Company, Ltd., New Delhi. • Verma, P. S. and Agarwal, V. K. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company Pvt. Ltd. • Harvey, R.A. and Ferrier, D.R. Lippincott's Illustrated Reviews, Biochemistry. Lippincott Williams and Wilkins. • Voet, D. and Voet, J. G. Biochemistry. John Wiley & Sons, Inc, USA. **Web References:** No changes	with more molecular biology specific books - subject for review during subsequent BoS

		topic/gene-expression-and-regulation-15/ •https://bio.libretexts.org/Bookshelves/Genetics/Book%3A_Working_with_Molecular_Genetics_(Hardison)/Unit_IV%3A_Regulation_of_Gene_Expression •https://bio.libretexts.org/Bookshelves/Human_Biology/Book%3A_Human_Biology_(Wakim_and_Grewal)/06%3A_DNA_and_Protein_Synthesis/6.07%3A_Regulation_of_Gene_Expression		
V	Industrial Microbiology BCH-V.E-11	**REFERENCES for BCH-V.E-11** **Mandatory Reading** • Stanbury P. F, Whitaker A. and Hall. (1997). Principles of fermentation technology, 2nd Edition, Aditya Books Pvt. Ltd, New Delhi. • Casida L. E. (2009). Industrial Microbiology, New Age International (P) Ltd. New Delhi. **Supplementary Reading** • Okafor N. (2007). Modern Industrial Microbiology and	**REFERENCES for BCH-V.E-11** **Mandatory Reading** • Stanbury P. F, Whitaker A. and Hall. (Principles of fermentation technology, Aditya Books Pvt. Ltd, New Delhi. • Casida L. E. Industrial Microbiology, New Age International (P) Ltd. New Delhi. **Supplementary Reading** • Okafor N. Modern Industrial Microbiology and Biotechnology, Science Publishers Enfield, NH, USA. • Patel A. H. Industrial Microbiology,	According to the BoS members, Year of publication need not be mentioned. Students can refer to the latest edition. The Year and the edition had to be removed for each of the references.

		Biotechnology, Science Publishers Enfield, NH, USA. • Patel A. H. (2012). Industrial Microbiology, MacMillan Publishers India Ltd. • Prescott and Dunn. (1982). Industrial Microbiology, 4th edition, AVI Publishinhg Co. • Ratlege C. and Kristiansen B. (2001). Basic Biotechnology, 2nd edition. Cambridge university press. **Web References:** •http:// www.biologydiscussion.com/ fermentation/fermentation-technology-meaning methodology-types-and-procedure/ 17492 •https://study.com/academy/lesson/ bacterial-fermentation-process-products.html •https://study.com/academy/lesson/ alcohol-fermentation-definition-equation-process.html •http:// www.biologydiscussion.com/ biotechnology/bioprocess-technology/media-used-for the-growth-of-microorganisms/10096	MacMillan Publishers India Ltd. • Prescott and Dunn. Industrial Microbiology, AVI Publishinhg Co. • Ratlege C. and Kristiansen B. Basic Biotechnology. Cambridge university press/ **Web References:** No changes	

		•http:// www.biologydiscussion.com/ industrial-microbiology-2/ fermentation-industrial microbiology-2/production-of- ethanol-microbiology/66072		
VI	Clinical Biochemistry BCH-VI.C-8	**REFERENCES for BCH-VI.C-8** **Mandatory Reading** • Pattabiraman R. N. Text book of Biochemistry, All India Publisher distribution. **Supplementary Reading** • Chatterjee M. N., Shinde, R. Text book of Medical Biochemistry, Jaypee Publishers. • Vasudevan, D. M., Sreekumari S., Text book of Biochemistry for Medical Students, Jaypee Publishers. • Berg, Jeremy M., Tymoczko, John L., Stryer Lubert. Biochemistry, W.H. Freemann, N. York. • David, L. N., Michael, M. C., Lehninger, Albert, Biochemistry, Kalyani Publications, N. **Web References:** • George, F. Hoffmann., Johannes, Z., William, L. Nyhan. Inherited Metabolic Disorders: A clinical	**REFERENCES for BCH-VI.C-8** **Mandatory Reading** No changes **Supplementary Reading** Chatterjee M. N., Shinde, R. Text book of Medical Biochemistry, Jaypee Publishers. • Vasudevan, D. M. and Sreekumari S. Text book of Biochemistry for Medical Students, Jaypee Publishers. • Jeremy, B. M., Tymoczko, John L. and Lubert. S. Biochemistry, W.H. Freemann, N. York. • David, L. N., Michael, M. C., Lehninger, Albert, Biochemistry, Kalyani Publications, N. **Web References:** No change	According to the BoS members, Year of publication need not be mentioned. Students can refer to the latest edition. The Year and the edition had to be removed for each of the references.

		approach, Springer. • Fernandes, J., Saudubray, J.M., van Den Berghe, G. Inborn Metabolic Diseases. Springer.		
VI	Environmental Chemistry BCH-VI.E-16	**REFERENCES for BCH-VI.E-16** **Mandatory Reading** • Dara, S.S., A text book of Environmental Chemistry and Pollution Control. S.Chand Publishers **Supplementary Reading** • Khopkar, S. M., Environmental Pollution Analysis. John Wiley & Sons. • Mitchell, R. & Cu, J. D., Environmental MicrobiologyWiley-Blackwell Publication • Ramesh, K. V., Environmental Microbiology. MJP Publishers, India. • Maier, R., Pepper, I. & Gerba, C., Environmental Microbiology. Academic Press. • Moore J. W. & Moore, E. A., Environmental Chemistry. Elsevier. • Jadhav, H.V., Elements of Environmental Chemistry: For	**REFERENCES for BCH-VI.E-16** **Mandatory Reading** No changes **Supplementary Reading** • Khopkar, S. M. Environmental Pollution Analysis. John Wiley and Sons. • Mitchell, R. and Cu, J. D. Environmental Microbiology. Wiley-Blackwell Publication • Ramesh, K. V. Environmental Microbiology. MJP Publishers, India. • Maier, R., Pepper, I. and Gerba, C. Environmental Microbiology. Academic Press. • Moore J. W. and Moore, E. A., Environmental Chemistry. Elsevier. • Jadhav, H.V. Elements of Environmental Chemistry: For Undergraduate Science Students of Indian University. Himalaya Publishing House. • Satake, M., Sethi, S. and Eqbal, S.A. Environmental Chemistry. Discovery Publishing Pvt.Ltd,	According to the BoS members, Year of publication need not be mentioned. Students can refer to the latest edition. The Year and the edition had to be removed for each of the references. An additional supplementary reading had to be added

		Undergraduate Science Students of Indian University. Himalaya Publishing House. • Satake, M., Sethi, S. & Eqbal, S.A., Environmental Chemistry **Web References:** •https://openoregon.pressbooks.pub/envirobiology/	• Salle, A.J. Fundamental Principles of Bacteriology. McGraw Hill. • Frobisher, M. and Hinsdale, R.D. Fundamentals of Microbiology. Saunders. **Web References:** No changes	

SEMESTER III

CORE COURSE: METABOLISM OF BIOMOLECULES	
COURSE CODE:	**BCH-III.C-5**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, students will be able to: **CO1:** Explain the metabolic processes of the cell **CO2:** Discuss the interconnections of metabolic pathways. **CO3:** Isolate and estimate different biomolecules using various techniques **CO4:** Describe the causes and treatment of various metabolic disorders.

BCH-III.C-5: METABOLISM OF BIOMOLECULES (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Concepts of Metabolism; Carbohydrate metabolism	**1.1: Basic Concepts and Design of Metabolism** Metabolism: Catabolism and Anabolism, ATP as energy source, ATP cycle, ATP as energy currency, energy relationship between catabolic and anabolic pathways, other energy rich molecules **1.2:Carbohydrate Metabolism** Glycolysis, Fate of pyruvate, Fermentation, Tri-Carboxylic Acid cycle, Pentose-Phosphate pathway, Gluconeogenesis, Glycogen synthesis and breakdown, Glyoxylate pathway, Lactose intolerance, Wernicke-Korsakoff Syndrome	**04** **11**	**15**
MODULE 2: Oxidative Phosphorylation and Fatty acid metabolism	**2.1: Oxidative Phosphorylation** The respiratory chain in mitochondria, proton gradient powering ATP synthesis, inhibitors of oxidative phosphorylation: Cyanide, Carbon monoxide, Oligomycin. Transfer of cytosolic reducing equivalents to mitochondria: glycerol-3- phosphate and malate-aspartate shuttle **2.2: Fatty Acid Synthesis and Degradation** Digestion, mobilisation and transport of cholesterol and triacyl glycerols, β-oxidation of fatty acids, ketone bodies, ketoacidosis Biosynthesis of saturated and unsaturated fatty acids, and elongation of fatty acids	**05** **10**	**15**
MODULE 3: Amino acid and Nucleotide metabolism	**3.1: Amino acid Metabolism** Overview of biosynthesis and catabolism of amino acids, Phenylketonuria; regulation of amino acid biosynthesis, Urea cycle, urea cycle disorders **3.2: Nucleotide Metabolism** Biosynthesis - de novo and salvage pathways, degradation, ADA deficiency, Lesch-Nyhan syndrome, Gout	**07** **08**	**15**

BCH-III.C-5: METABOLISM OF BIOMOLECULES (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Lactic Acid fermentation	01
2.	Alcohol Fermentation by Yeast	02
3.	Estimation of blood glucose	01
4.	Separation of lipids by TLC	02
5.	Isolation of lecithin from egg yolk	03
6.	Isolation of cholesterol from egg yolk	03
7.	Estimation of protein and nucleic acid by direct spectroscopy	01
8.	Urea estimation	01
9.	Uric acid estimation	01
	Total	**15**

REFERENCES for BCH-III.C-5 (Latest Editions)

<u>Mandatory Reading</u>

10. Nelson, D. L. and Cox, M.M. Lehninger's Principles of Biochemistry. Worth Publishers, New York, USA

<u>Supplementary Reading</u>

11. Stryer, L., Berg, J., Tymoczko, J. and Gatto, G. Biochemistry. W. H. Freeman and Co., New York, USA.
12. Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. Harper's Illustrated Biochemistry. McGraw-Hill Companies.
13. Jain, J. L., Jain, S. and Jain, N. Fundamentals of Biochemistry. S. Chand and Company, Ltd., New Delhi.
14. Plummer, D. T. An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Company Limited, New Delhi.
15. Harvey, R.A. and Ferrier, D.R. Lippincott's Illustrated Reviews, Biochemistry. Lippincott Williams and Wilkins.
16. Voet, D. and Voet, J. G. Biochemistry John Wiley and Sons, Inc, USA.

Web References

1. https://www.coursera.org/learn/energy-metabolism
2. https://online-learning.harvard.edu/course/principles-biochemistry-1
3. https://nptel.ac.in/courses/102/105/102105034/
4. https://openstax.org/details/books/biology-2e

SEMESTER III

ELECTIVE COURSE: TOOLS AND TECHNIQUES IN BIOCHEMSITRY	
COURSE CODE:	**BCH-III.E-1**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, students will be able to: **CO1**: Comprehend the basic concepts of the principle, working, and applications of different types of chromatography. **CO2**: Compare, analyze and apply concepts of the principle and working of various types of centrifuges and electrophoretic techniques **CO3**: Compare, analyze and apply concepts of the principle and working of various types of spectroscopic and microscopic techniques. **CO4**: Acquire knowledge about different radioisotopes and their applications in biochemistry

BCH-III.E-1: TOOLS AND TECHNIQUES IN BIOCHEMISTRY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Chromatography and Centrifugation Techniques	**1.1: Chromatographic techniques** Basic principles of chromatography: Partition coefficient, concept of theoretical plates. Various modes of chromatography, Instrumentation and Applications – Plane chromatography (paper, TLC, 2D), Column chromatography - HPLC, Molecular Sieve Chromatography, Ion Exchange Chromatography, Affinity Chromatography, Gas Chromatography. **1.2: Centrifugation** Basic principle of sedimentation, sedimentation coefficient, various types of centrifuges, different types of rotors, Preparative centrifuge - differential centrifugation, density gradient centrifugation (Rate zonal and Isopycnic), Analytical centrifuge.	**09** **06**	**15**
MODULE 2: Electrophoretic and Spectroscopic Techniques	**2.1: Electrophoretic and Blotting techniques** Basic Principle of electrophoresis, Electrophoresis of protein and nucleic acids - Paper electrophoresis, Gel electrophoresis, discontinuous gel electrophoresis, PAGE, SDS-PAGE, Native gels, denaturing gels, agarose gel electrophoresis, Northern Blotting, Southern Blotting and Western blotting techniques – principle and applications **2.2: Spectroscopic techniques** Basic principle and working of – UV/VIS light spectroscopy, Fluorescence spectroscopy, NMR, IR spectroscopy, X-ray diffraction.	**08** **07**	**15**
MODULE 3: Microscopy and Radioisotopes	**3.1: Microscopic techniques** Basic components of the microscope. Working and representation and application of – compound microscope, electron microscope, Scanning electron microscope and confocal	**08**	

	microscope, Specimen preparation for electron microscope, scanning electron microscope and confocal microscope. **3.2: Radioisotopes** Concept of half-life, decay constant, detection methods - GM counter, solid and liquid scintillation counter, autoradiography; handling and safety of radioisotope, Applications of radioisotopes in biology.	**07**	**15**

BCH-III.E-1: TOOLS AND TECHNIQUES IN BIOCHEMISTRY (PRACTICAL)

SR.NO.	PRACTICAL	NO. OF PRACTICAL
1.	Estimation of proteins by Bradford's method	02
2.	Estimation of carbohydrate by DNSA method	02
3.	Separation and identification of amino acids by paper chromatography	02
4.	Isolation of cell organelle using density gradient centrifugation	02
5.	Demonstration of gel filtration chromatography	02
6.	SDS-PAGE analysis of proteins	03
7.	Lipid isolation by reverse phase chromatography	02
	Total	**15**

REFERENCES:

Mandatory Reading:

- Wilson K and Walker J. 2005. Principles and Techniques of Practical Biochemistry, 6th Edition, Cambridge University Press.

Additional Reading:

- Upadhyay A, Upadhyay K and Nath N. 2009. Biophysical Chemistry: Principles and Techniques, 3rd Edition, Himalaya Publishing, New Delhi.
- Plummer D. 1988. An introduction to Practical Biochemistry, Tata McGraw Hill Publishing Company, New Delhi.
- Jayraman J. 2011. Laboratory Manual in Biochemistry. New Age International Pvt Ltd Publishers, New Delhi.
- Sadasivam S. and Manickam A. 2007. Biochemical Methods, 3rd edition, New Age International Publishers, New Delhi.

Web-links:

1. https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-the-reproductive-system/a/hs-the-reproductive-system-review
2. https://www.khanacademy.org/science/high-school-biology/hs-cells/hs-introduction-to-cells/a/microscopy
3. https://www.khanacademy.org/test-prep/mcat/physical-processes/atomic-nucleus/a/decay-graphs-and-half-lives-article
4. https://www.khanacademy.org/science/organic-chemistry/spectroscopy-jay/uv-vis-spectroscopy/v/uv-vis-spectroscopy

SEMESTER III

ELECTIVE COURSE: ENZYMOLOGY	
COURSE CODE:	**BCH-III.E-2**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, students will be able to: **CO1:** Explain the structure of an enzyme and kinetics of enzyme catalysed reactions **CO2:** Differentiate between types of enzyme inhibitions **CO3:** Comprehend the wide applications of enzymes and future potential. **CO4:** Isolate and purify crude forms of enzyme extract and apply appropriate method for determination of activity of enzyme **CO5:** Discuss factors that affect enzymatic activity

BCH-III.E-2: ENZYMOLOGY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Introduction to enzymes and Features of enzyme catalysis	**1.1: Introduction to enzymes (8 L)** Nature of enzymes - protein and non-protein (ribozyme); co-enzymes, cofactor & prosthetic group; apoenzyme; holoenzyme; ribozymes & isoenzymes; multienzyme complex, specificity of enzymes; classification of enzymes. **1.2: Features of enzyme catalysis** Fischer's lock and key hypothesis; Koshland's induced fit hypothesis; factors affecting the rate of reactions (time, enzyme concentration, substrate concentration, pH and temperature)	**08** **07**	**15**
MODULE 2: Enzyme Kinetics and Inhibition	**2.1: Enzyme kinetics** Principles of reaction rates; order of reactions and equilibrium constants; derivation of Michaelis-Menten equation and Lineweaver- Burk plot; significance of K_m and V_{max}, K_{cat} and turnover number **2.2: Enzyme inhibition** Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and suicide, end product); mechanism-based inhibitors - antibiotics as inhibitors; types of irreversible inhibition; allosteric inhibition	**08** **07**	**15**
MODULE 3: Mechanism of enzymes, Purification & applications of enzymes	**3.1: Mechanisms of enzyme action and regulation** Mechanism of action of chymotrypsin; regulation of enzyme activity and its importance - aspartate transcarbamoylase **3.2: Enzyme purification** Purification of enzymes: salt precipitation; dialysis; molecular exclusion chromatography; PAGE; Molecular weight determination by SDS-PAGE **3.3: Applications of enzymes** Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases); enzyme	**04** **06** **05**	**15**

	immunoassay (HRPO); applications of enzymes in industry – detergents, leather, food		

BCH-III.E-2: ENZYMOLOGY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Preparation of buffers and solutions for the study of enzyme activity	01
2.	Effect of pH on enzyme activity	02
3.	Effect of temperature on enzyme activity	02
4.	Effect of substrate concentration and determination of K_m and V_{max}	02
5.	Partial purification of an enzyme from a suitable source, ammonium sulphate precipitation, dialysis	03
6.	Assay of enzyme activity and specific activity	01
7.	Native-PAGE	03
8.	Zymogram	01
	Total	**15**

REFERENCES for BCH-III.E-2 (Latest Editions)

Mandatory Reading

- Malcolm, D. and Edwin C. Webb. Enzymes. Academic Press Inc., Publishers, New York

Supplementary Reading

- Nelson, D. L. and Cox, M. M. Lehninger’s Principles of Biochemistry. Worth Publishers, New York, USA.
- Stryer, L., Berg, J., Tymoczko, J. and Gatto, G. Biochemistry. W. H. Freeman and Co., New York, USA.
- Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. Harper’s Illustrated Biochemistry. McGraw-Hill Companies.
- Jain, J. L., Jain, S. and Jain, N. Fundamentals of Biochemistry. S. Chand and Company, Ltd., New Delhi.
- Harvey, R.A. and Ferrier, D.R. Lippincott’s Illustrated Reviews, Biochemistry. Lippincott Williams and Wilkins.
- Voet, D. and Voet, J. G. Biochemistry. John Wiley & Sons, Inc, USA.

Web References

- https://www.khanacademy.org/test-prep/mcat/biomolecules/enzyme-structure-and-function/a/enzyme-structure-and-function
- https://www.khanacademy.org/test-prep/mcat/biomolecules/enzyme-kinetics/v/an-introduction-to-enzyme-kinetics
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5956270/
- http://web.sungshin.ac.kr/~spark/class/enzchem/EnzChem_ch02.pdf
- https://www.chem.wisc.edu/deptfiles/genchem/netorial/modules/biomolecules/modules/enzymes/enzyme3.htm
- https://www.creative-enzymes.com/resource/enzyme-definition-and-classification_18.html
- https://www.youtube.com/watch?v=OY1WsqlcUdo
- https://www.youtube.com/watch?v=Z2ZN_9nFl1E

SEMESTER III

ELECTIVE COURSE: FUNDAMENTALS OF MICROBIOLOGY	
COURSE CODE:	**BCH-III.E-3**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, students will be able to: **CO1:** Comprehend the scope and importance of Microbiology, classification schemes, cultivation, preservation, and maintenance of the microbial cultures. **CO2:** Discriminate between various groups of microorganisms using staining techniques. **CO3:** Compare, analyze and apply concepts of the principle and working of various types of microscopes. **CO4:** Adhere to strict laboratory safety measures to be followed in a microbiology laboratory. **CO5:** Acquire basic skills in aseptic techniques and acquaint with various sterilization techniques.

BCH-III.E-3: FUNDAMENTALS OF MICROBIOLOGY (THEORY)

<table>
<tr><th>MODULE</th><th>TOPICS</th><th>CONTACT HOURS</th><th>TOTAL HOURS</th></tr>
<tr><td rowspan="3">MODULE 1:
History & Development of Microbiology; Ultrastructure of a bacterial cell, growth curve – types, characteristics</td><td>1.1 : History and Scope of Microbiology
Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Paul Ehrlich, Elie Metchnikoff, Edward Jenner in the fields of microbiology and immunology.

Basics of Binomial Nomenclature; Classification systems of Whittaker (five Kingdom) and Carl Woese (three Domain). Tree of Life.</td><td>05</td><td rowspan="3">15</td></tr>
<tr><td>1.2: Basics of Microscopy
Principle, design and working of light microscope (Bright-field, Dark-field, Phase-contrast, Fluorescence). Preparation of samples.</td><td>03</td></tr>
<tr><td>1.3: Bacterial cell organization, reproduction and growth curve
Bacterial cell: Organization and ultrastructure; Gram characteristics.
Reproduction in bacteria - Binary fission
Bacterial growth curve- characteristics of growth phases; diauxic growth curve</td><td>07</td></tr>
<tr><td>MODULE 2:
Methods of cultivating and preserving bacteria</td><td>2.1: Cultivation of microorganisms
Sterilization: Principle and methods.

Types of culture media: Synthetic/defined, complex, solid, liquid, enrichment, selective, differential.

Cultivation of microorganisms: Aerobic and anaerobic, Broth cultures, agar plate, pour plate.

Determination of viable count: MPN, Serial dilution, spread plating, pour plating, determination of colony forming units (cfu) and calculation of viable count.</td><td>10</td><td>15</td></tr>
</table>

	Isolation of pure cultures: Streak plate; colony characteristics **2.2: Maintenance and preservation of microbial cultures** Slant and stab cultures, periodic transfer, storage in sterile soil, overlaying with mineral oil, glycerol stocks, preservation in liquid nitrogen, lyophilisation	**05**	
MODULE 3: Fungi and Viruses	**3.1: Fungi** General characteristics of fungi: habitat, nutritional requirements, cell ultra-structure, thallus organization, cell wall structure. Reproduction: sexual and asexual reproduction. Mycotoxins. **3.2: Viruses** Structure and classification: Bacterial, plant and animal viruses. Bacteriophage multiplication (lytic and lysogenic)	**08** **07**	**15**

BCH-III.E-3: FUNDAMENTALS OF MICROBIOLOGY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Introduction to microbiology laboratory equipments: Autoclave, millipore filters and assembly, incubators, hot air oven, Laminar air flow, Biosafety cabinet, microscope, pH meter.	01
2.	Preparation and sterilization of glasswares	01
3.	Preparation and sterilization of liquid and solid culture media.	01
4.	Preparation of media agar plates, butts and slants.	01
5.	Determination of viable count (soil and water sample): Serial dilution, spread plating, quantification of colony forming units	03

	(cfu) and calculation of viable count.	
6.	Isolation of pure cultures: Streak plate (T-streak, quadrant, radiant); colony characteristics	01
7.	Gram staining and cell morphology.	01
8.	Demonstration of coliphage in water sample.	02
9.	Isolation and staining of Fungi (Rhizopus, Mucor, Aspergillus, Penicillium) by lactophenol cotton blue.	02
10.	Decontamination and disposal of cultures	01
	Total	**15**

REFERENCES for BCH-III.E-3 (Latest Editions)

Mandatory Reading

- Pelczar, M. J., Chan E, C.S., and Krieg, N.R. Microbiology. McGraw Hill Education.
- Willey, J. M., Sherwood, L., Woolverton, C. J. and Prescott, L. M. Prescott, Harley, and Klein's microbiology. New York, McGraw-Hill Higher Education.

Supplementary Reading

- Atlas, R.M., Anantnaryan, R. and Paniker, C.K.J. Textbook of Microbiology, The Orient Blackswan.
- Madigan, M. T., Martinko. J. M. and Parker J. Brock’s Biology of Microorganisms, Prentice Hall College Div.
- Stanier, R.Y. General Microbiology, Cambridge University.

Web References

- https://openstax.org/details/books/microbiology
- https://vlab.amrita.edu/?sub=3&brch=73&sim=1105&cnt=1
- http://textbookofbacteriology.net/growth_3.html
- https://www.khanacademy.org/science/biology/bacteria-archaea/prokaryote-structure/v/bacteria

SEMESTER III

ELECTIVE COURSE: PLANT BIOCHEMISTRY	
COURSE CODE:	**BCH-III.E-4**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Describe the structural organization of plant cells. **CO2:** Illustrate the process of photosynthesis and explain its significance. **CO3:** Explain the effects of plant growth hormones, secondary metabolites and their applications. **CO4:** Identify and analyse plant pigments, enzymes and secondary metabolites using various laboratory techniques. **CO5:** Demonstrate the technique of plant tissue culture.

BCH-III.E-4: PLANT BIOCHEMISTRY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Plant Structure and Photosynthesis	**1.1: Introduction to Plant cell structure** Structural and functional organization of a plant cell	**05**	**15**
	1.2: Photosynthesis Structure of organelle involved in photosynthesis; Structure of PSI and PSII complexes – Oxygenic and non-oxygenic photosynthesis; Photosynthetic pigments: Chlorophylls, Beta carotene, bacteriochlorophyll and phycoerythrobilin, Proton gradient and electron transfer in plants, purple bacteria and green-sulphur bacteria. Light reactions (Cyclic and noncyclic photophosphorylation). Calvin cycle and its regulation; Photorespiration; C4 cycle and Crassulacean acid metabolism (CAM)	**10**	
MODULE 2: Nitrogen Metabolism and Secondary Metabolites	**2.1: Nitrogen Metabolism** Nitrogen Cycle, Biological Nitrogen fixation by free living and in symbiotic association, formation of nodules, nitrogenase enzyme. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants. Urea metabolism.	**06**	**15**
	2.2: Secondary Metabolites Introduction to secondary metabolites and their biological roles and economic importance. Representatives alkaloid group and their amino acid precursors, function of alkaloids. Examples of major phenolic groups; simple phenylpropanoids,coumarins, benzoic acid	**09**	

	derivatives, flavonoids, tannins and lignin, biological role of plant phenolics Classification of terpenoids and representative examples from each class, biological functions of terpenoids. Saponins		
MODULE 3: Plant Growth and Regulation	**3.1 Regulation of plant growth** Overview of Phytohormones. Auxins, Cytokinins, Gibberellins, Ethylene and Abscisic acid: physiological and developmental effects Commercial applications of plant growth hormones.	**07**	**15**
	3.2 Plant tissue culture General technique of plant tissue culture. Nutrient media and growth hormones. Types of Cultures: Callus culture, Suspension culture and Protoplast culture. Organogenesis and somatic embryogenesis Somaclonal variations and its advantages. Commercial applications of plant tissue culture.	**08**	

BCH-III.E-4: PLANT BIOCHEMISTRY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Extraction and separation of photosynthetic pigments by TLC	02
2.	Preparation and observation of leaf cross-section of C3 and C4 plants	01
3.	Extraction and Assay of urease	02
4.	Isolation of nodule forming bacteria from root nodules	02
5.	Extraction and estimation of β-carotene from carrot	02

6.	Estimation of phenolic compounds from mint and tulsi leaves	02
7.	Demonstration of Callus culture	02
8.	Effect of growth hormones on germination of seeds	02
	Total	**15**

REFERENCES for BCH-III.E-4 (Latest Editions)

Mandatory Reading

- Taiz, L. and Zeiger, E. Plant Physiology. Sunderland Sinauer Associates Inc.

Supplementary Reading

- Nelson, D. L. and Cox, M.M. Lehninger's Principles of Biochemistry. Worth Publishers, New York, USA.
- Chawla, H.S. Introduction to Plant Biotechnology, USA, Science Publishers Inc.
- Singh, B. D. Plant Biotechnology, Kalyani Publishers.
- Stumpf, G., Bruening and Doi, R.Y. Outlines of Biochemistry. E E Conn, P K. John Wiley and Sons, New York.

Web References

- http://ecoursesonline.iasri.res.in/course/view.php?id=140
- https://openstax.org/subjects/science
- https://nptel.ac.in/courses/102103016/

SEMESTER IV

CORE COURSE: IMMUNOLOGY	
COURSE CODE:	**BCH-IV.C-6**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, students will be able to: **CO1:** Comprehend the scope of the history of immunological studies **CO2:** Gain knowledge of the structure and function of the cells and organs of immune systems **CO3:** Describe the mechanisms of Ag-Ab reaction, hypersensitivity reactions and importance of the complement system **CO4:** Recognize the importance of Monoclonal Ab and various immunodeficiency diseases **CO5:** Describe the working principle of various techniques involved in Immunology

BCH-IV.C-6: IMMUNOLOGY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Introduction to the immune system and the cells and organs involved	**1.1: The immune system** Introduction to the immune system - historical perspective; types of immunity (innate and acquired); barriers of innate immunity – anatomic, physiologic, phagocytic, inflammatory; collaboration between innate and adaptive immunity; introduction to humoral and cell mediated immunity **1.2: Cells and Organs of the Immune system** Cells (myeloid and lymphoid lineage); immune-reactive cells (macrophages, granulocytes, NK Cells); primary lymphoid organs (bone marrow and thymus); secondary lymphoid organs; (spleen, lymph nodes, GALT and MALT).	**08** **07**	**15**
MODULE 2: B & T cells, Antigen-antibody interactions and the Complement system	**2.1: B and T cells** B-cells & T-cells – structure; function and significance; maturation, activation of B-cells and T-cells **2.2: Antigen-Antibody Interactions** Introduction to antigens and antibodies; structure, types, classes, properties and variants (e.g. immunogens, antigens, haptens, adjuvants); paratope and epitope; antigen – antibody interaction; forces involved in antigen-antibody reaction; concept of affinity, avidity, precipitation, agglutination reactions; immunoelectrophoresis, applications in diagnostics. RIA, ELISA. **2.3: The complement system** The complement system; functions, components and activation pathways (classical, alternate & lectin)	**04** **08** **03**	**15**
MODULE 3: MHC & Hypersensitivity,	**3.1: MHC and Autoimmunity** Major histocompatibility complex (MHC); introduction and discovery of human histocompatibility complex; structure of MHC I and II; presence of MHC I and II on different cells and their significance;	**05**	**15**

Vaccines & Monoclonal antibodies and Autoimmunity	Introduction to autoimmunity with examples; introduction to immunodeficiency types with examples **3.2: Hypersensitivity** Introduction and types of hypersensitivity **3.3: Vaccine and Monoclonal Antibodies** Introduction to vaccines and types of vaccines; Polyclonal & Monoclonal antibodies (hybridoma technology)	**05** **05**	

BCH-IV.C-6: IMMUNOLOGY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Study of lymphoid organs and cells of the Immune System	01
2.	Total count of WBC & RBCs using haemocytometer	02
3.	Differential count of WBC	01
4.	Blood grouping & Rh factor	01
5.	Preparation of serum	01
6.	Single Radial Immuno-diffusion	02
7.	Ouchterolony's double diffusion method and antibody titre calculation	02
8.	Immuno-electrophoresis	01
9.	ELISA (Demonstration)	02
10	Serological tests involving precipitations (Pregnancy &Widal)	02
	Total	**15**

REFERENCES for BCH-IV.C-6

Mandatory Reading

- Richard, A. G., Thomas, J. K. & Barbara A. O., (2018). Kuby Immunology, (7th Edition). W. H. Freeman & Company, New York.

Supplementary Reading

- Punt J., Stranford S., Jones P, Owen, J. A. (2018). Kuby Immunology, (8th Edition). W. H. Freeman & Company, New York.
- Arora, M.P. (2006). Cell Biology, Immunology and Environmental Biology, Himalaya Publishing House.
- Rao, C. V. (2011). Immunology (5th Edition), Narosa Publishing House Pvt. Ltd.
- Roitt, I., Brostoff, J. & Male, D.K. (2012). Immunology, (8th Edition). Elsevier Health, UK

Web References

- https://www.khanacademy.org/test-prep/nclex-rn/rn-immune-system
- https://www.youtube.com/watch?v=yDAGxVxY-L8
- https://www.frontiersin.org/articles/10.3389/fimmu.2017.00292/full
- https://www.ncbi.nlm.nih.gov/books/NBK459471/
- https://www.immunology.org/public-information/bitesized-immunology/immune-dysfunction/autoimmunity-introduction
- https://www.youtube.com/watch?v=2-57bqFSJ1E

SEMESTER IV

ELECTIVE COURSE: HUMAN PHYSIOLOGY	
COURSE CODE:	**BCH-IV.E-5**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, students will be able to: **CO1:** Describe the various chromosomal theories and Mendelian genetics. **CO2:** Understand and analyze the pedigree chart and inheritance pattern in a family **CO3:** Correlate various genetic disorders to chromosomal mutations **CO4:** Explain the various sex-determining mechanisms in animals

BCH-IV.E-5: HUMAN PHYSIOLOGY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: General Physiology and Body Fluids	**1.1: Introduction to General physiology** Overview of cell structure, composition, tissues, organs and systems, Transport through cell membrane – Passive and Active transport, Homeostasis **1.2: Body Fluids** Body fluids: intracellular, extracellular and interstitial fluid, Plasma, Blood, Lymph: RBCs, WBCs, clotting cascade mechanism, Blood related disorders: anemia, hemophilia, polycythemia, thalassemia, acidosis	**06** **09**	**15**
MODULE 2: Organ Systems I	**2.1: Skeletal and Muscular System (5 L)** Introduction to skeletal system, types of bones, composition, functions of bones. Introduction to muscular system, types of muscles, structure of muscle, Physiology of muscle contraction: proteins involved, neuromuscular junction, role of acetylcholine. Disorders of skeletal muscle: Duchenne muscular dystrophy, Myasthenia gravis, Osteoporosis, arthritis – physiological and immunological. **22.2: Digestive System** Introduction, parts of digestive system, gastrointestinal hormones, digestion and absorption, peristaltic system. Accessory organs of digestive system, Disorders of GI tract: GERD, Gastritis, Celiac disease and Liver cirrhosis. **2.3: Respiratory and Cardiovascular system** Introduction to respiratory system, functional anatomy of respiratory tract, lung volumes, Cardiovascular system: heart, blood	**05** **04** **06**	**15**

	vessels, divisions of circulation, Pacemaker, Cardiac cycle, ECG, Heart sounds, cardiovascular diseases: MI and Arrhythmia.		
MODULE 3: Organ Systems II	**3.1: Excretory System** Introduction, anatomy and functions of excretory system, Nephron, Renal circulation, Urine formation, Renal function tests, Renal disorders: Nephrosis, kidney stones. **3.2: Nervous system** Introduction, parts of brain, spinal cord, neuron and its associated functions, membrane potential, synapse, neurotransmitters, EEG, Disorders: Alzheimer's. Epilepsy and Meningitis. **3.3: Reproductive system** Functional anatomy of male and female reproductive system, menstrual cycle, spermatogenesis and oogenesis, PCOS, uterine fibroids, prostatitis and erectile dysfunction.	**05** **05** **05**	**15**

BCH-IV.E-5: HUMAN PHYSIOLOGY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Determination of clotting time	01
2.	Estimation of hemoglobin	01
3.	Observation of permanent slides – Transverse section of mammalian gonads, muscles, nerve cells	01
4.	Analysis of human blood pressure and pulse rate in man	01
5.	Determination of glucose and albumin in urine	02
6.	Determination of sugar in blood	01
7.	Determination of ESR and PCV	02

8.	Effect of different salt solutions on RBC’s	01
9.	Liver function test	01
10.	Kidney function tests	01
11.	Progesterone estimation (kit based)	01
12.	Analysis of ECG	01
13.	Case Study	01
	Total	**15**

REFERENCES for BCH-IV.E-5

Mandatory Reading

- Sembulingam K. and Sembulingam P. Essentials of Medical Physiology, Jaypee brothers medical publishers (P) Ltd, New Delhi.

Supplementary Reading

- Arora, M.P. Animal physiology, Himalaya publishing house, New Delhi.
- Verma, S.K., Tyagi, A.K. and Agarwal, B.B.L. Animal Physiology, S. Chand and Company.
- Guyton, A.C and Hall, J.E. Textbook of Medical Physiology, Reed Elseviers India Pvt. Ltd. New Delhi.
- Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. Harper’s Illustrated Biochemistry. McGraw-Hill Companies.
- Buja L. M. and Krueger G. R. F. Netter's Illustrated Human Pathology. Elsevier Inc., Philadelphia.
- Sadasivam, S. and Manickam A. Biochemical Methods, New Age International Publishers, New Delhi.

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- https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-body-structure-and-homeostasis/a/homeostasis
- https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-the-digestive-and-excretory-systems/a/hs-the-digestive-and-excretory-systems-review
- https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-the-circulatory-and-respiratory-systems/a/hs-the-respiratory-system-review
- https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-the-circulatory-and-respiratory-systems/a/hs-the-circulatory-system-review

- https://www.khanacademy.org/science/biology/human-biology/neuron-nervous-system/a/the-membrane-potential
- https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-the-reproductive-system/a/hs-the-reproductive-system-review
- https://openstax.org/details/books/biology-2e

SEMESTER IV

ELECTIVE COURSE: NUTRITIONAL BIOCHEMISTRY	
COURSE CODE:	**BCH-IV.E-6**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, students will be able to: **CO1**: Explain the various sources of food and RDA **CO2**: Apply theoretical and practical knowledge of antioxidants in various food samples. **CO3**: Correlate various nutritional disorders and the importance of diet **CO4:** Describe and design diet plans for different age groups.

BCH-IV.E-6: NUTRITIONAL BIOCHEMISTRY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Nutrition & Energy Metabolism, Dietary Carbohydrates and Dietary Lipids	**1.1: Nutrition and Energy Metabolism** Introduction, role of nutrients, unit of energy; Biological oxidation of foodstuff, calorific value of food, Physiological energy value of foods, antioxidants and their role, Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances (RDA) for different age groups, Basal Metabolic Index (BMI), Water metabolism, electrolyte imbalance; dehydration, Probiotics and prebiotics: sources and significance in the diet	**07**	**15**
	1.2: Dietary Carbohydrates Food sources, RDA, hormonal regulation of blood glucose, Diabetes: types and nutrition intake, Glycemic Index, Fiber; food sources, significance, Problems associated with carbohydrate intake.	**03**	
	1.3: Dietary Lipids Food sources, RDA, significance of: MUFA, PUFA, Saturated fatty acids, Omega fatty acids, TGs, Cholesterol, Lipoproteins, Phospholipids, deficiency and disorders related to dietary lipids.	**05**	
MODULE 2: Dietary Proteins, Vitamins and Mineral metabolism	**2.1: Dietary proteins** Essential and non-essential amino acids, Food source, Protein malnutrition, Nitrogen balance Supplements – risk of imbalance and toxicity of amino acids.	**04**	**15**
	2.2: Vitamins Fat soluble vitamins: Types and sources, physiological role, deficiency disorders, toxicity. Water soluble vitamins: Types and sources, physiological role, deficiency disorders,	**06**	

	toxicity. **2.3: Mineral Metabolism** Macronutrients – calcium, magnesium, sodium, potassium, phosphorus, sulphur and chlorine; physiological role, deficiency disorders and toxicity. Trace elements – essential and non-essential - physiological role, deficiency disorders and toxicity.	**05**	
MODULE 3: Food Allergens and Diet Plans	**3.1: Food allergens** Food allergens: gluten, milk and milk products, nuts, soy products, fish and shellfish. PEM – Marasmus and Kwashiorkar and Bulimia. **3.2: Diet Plans** Atkin's Diet, Keto Diet, Paleo Diet, Vegetarian and Veganism, Intermittent fasting and its effects on health. Diet plans for different age groups.	**05** **10**	**15**

BCH-IV.E-6: NUTRITIONAL BIOCHEMISTRY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Preparation of Probiotics, microscopy and sensory evaluation	02
2.	Assessment of Vitamin constituents in various foods: Lycopene, -β carotene	06
3.	Assessment of Nutritional Disorders: Anaemia, Hyperglycemia	02
4.	Formulating a Diet Plan: Diabetes, Sports Persons, Pregnancy	05
	Total	**15**

REFERENCES for BCH-IV.E-6

Mandatory Reading

- Gibson, R. Principles of Nutritional Assessment. Oxford University Press**.**

Supplementary Reading

- Frazier, W.C and Westhoff, D.C. Food Microbiology. McGraw Hill Education (India) Private Limited: New Delhi
- Tiwari, R.P., Hoondal, G.S. and Tewari, R. Laboratory Techniques in Microbiology and Biotechnology, Abhishek Publications Chandigarh (India).
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. Harper's Illustrated Biochemistry, Twenty-Sixth Edition Lange Medical Publications. New York
- Williams, M.H., Anderson, D.E. and Rawson, E.S. Nutrition for health, fitness and sport; McGraw Hill international edition.

Web References

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- https://www.khanacademy.org/science/high-school-biology/hs-biology-foundations/hs-biological-macromolecules/v/introduction-to-vitamins-and-minerals
- https://www.khanacademy.org/test-prep/mcat/biomolecules/enzyme-structure-and-function/v/cofactors-coenzymes-and-vitamins
- https://www.khanacademy.org/science/health-and-medicine/gastrointestinal-system-diseases/celiac-disease/v/what-is-gluten
- https://www.khanacademy.org/test-prep/mcat/biological-sciences-practice/biological-sciences-practice-tut/e/the-underlying-mechanism-of-milk-allergies-

SEMESTER IV

ELECTIVE COURSE: ENDOCRINOLOGY	
COURSE CODE:	**BCH-IV.E-7**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, students will be able to: **CO1:** Describe and differentiate the structure, receptors, and mechanism of actions of hormones. **CO2:** Comprehend and study the physiological actions of various hormones on the human body. **CO3:** Explain how disruptions in cellular signaling may lead to disease, and illustrate with selected examples. **CO4:** Analyze the correlation of hormones to human disorders and the consequences of under-and over-production of hormones. **CO5:** Perform pregnancy tests and examine the role of reproductive hormones in relation to pregnancy.

BCH-IV.E-7: ENDOCRINOLOGY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Introduction to endocrinology	**1.1 Introduction to endocrine system** Overview of organ system and their role in hormone production.	**01**	**15**
	1.2: Hormone, Receptor mechanism and Control system Chemical classification of hormones, Pathways of hormone action , Regulation of hormone secretion.	**04**	
	1.3: Hypothalamic and pituitary hormones Classification of hypothalamic and pituitary hormones. Overview on ADH, GH, MSH, ACTH, Ghrelin, Oxytocin, Prolactin. Feedback regulation. Pathophysiology - gigantism, dwarfism and diabetes insipidus	**10**	
MODULE 2: Thyroid and Parathyroid Hormone	**2.1: Thyroid Hormone** Physiology and biosynthesis of thyroid hormone and its regulation; TSH - physiological and biochemical action. Pathophysiology - Goiter, Grave's disease, cretinism	**07**	**15**
	2.2: Parathyroid Hormone Bone physiology. Chemistry, physiology and mechanism of role of PTH, Vitamin D and calcitonin in regulation of Ca^+ homeostatis.	**08**	

	Pathophysiology - rickets, osteomalacia, osteoporosis		
MODULE 3: Pancreatic, Adrenal and Reproductive Hormone	**3.1: Pancreatic and GI Hormones** Synthesis and regulation of release of insulin and glucagon, gastrin, secretin, CCK Pathophysiology - diabetes type I and type II. **3.2: Adrenal Hormones** Synthesis and mechanism of action of Epinephrine and norepinephrine. Fight or flight response. Pathophysiology – Addison's disease, Cushing syndrome **3.3: Reproductive Hormones** Synthesis and regulation of male and female sex hormones, Hormones during menstrual cycle, pregnancy, parturition.	**05** **05** **05**	**15**

BCH-IV.E-7: ENDOCRINOLOGY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Histology of endocrine structures	03
2.	hCG based pregnancy test	01
3.	Ovulation test	01
4.	Case studies	10

REFERENCES for BCH-IV.E-7

Mandatory Reading

- Kovac's, W.J. and Ojeda, S.R. Textbook of Endocrine Physiology. Oxford University Press

Supplementary Reading

- Sembuligam K. and Sembulingam P. Essentials of Medical Physiology Jaypee Brothers Medical Publishers, New Delhi, India.
- Hadley, M.C. and Levine. Endocrinology J.E. Pearson Education, New Delhi.
-

Web References

- https://www.youtube.com/watch?v=YcPicFL5Jnw
- https://www.youtube.com/watch?v=9o2dqeajWsI
- https://www.ncbi.nlm.nih.gov/books/NBK279388/
- http://www.vivo.colostate.edu/hbooks/pathphys/endocrine/thyroid/physio.html
- https://opentextbc.ca/biology/chapter/24-4-hormonal-control-of-human-reproduction/
- https://www.youtube.com/watch?v=HZhz-7Grux0
- https://www.khanacademy.org/science/health-and-medicine/advanced-endocrine-system/endocrine-system-introduction/v/hypothalamus-and-pituitary-gland
- https://www.youtube.com/watch?v=dX1QsJ7e7LI
- https://openstax.org/details/books/biology-2e

SEMESTER V

CORE COURSE: MOLECULAR BIOLOGY	
COURSE CODE:	**BCH-V.C-7**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Comprehend the scope and significance of molecular biology by imbibing the principles of hereditary genetic transmission and interactions of gene with the environment. **CO2:** Compare and contrast DNA, RNA and Proteins. **CO3:** Describe the process of DNA replication and transcription. **CO4:** Apply the practical and theoretical knowledge of various molecular techniques.

BCH-V.C-7: MOLECULAR BIOLOGY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Chemical Nature of Genetic Materials	**1.1: Nucleic Acids, bonds, types of DNAs, DNA packaging and model organisms** Structural components of nucleic acid: Sugar, Phosphate, Nucleosides and Nucleotides; Structure of DNA: Watson – Crick Model, Different forms of DNA (B, Z), Forces stabilizing the structure of DNA, Unusual structures of DNA (palindromic, mirror repeat, hairpin bent, cruciform); Structure of RNA, Different forms of RNA (mRNA, rRNA, tRNA); Differences between DNA and RNA Chargaff's experiments and Law **1.2: Chromosome** Fundamental functions of DNA. Chromosomal DNA and its packaging in the chromatin fibre. Chromatin structure, structural features (Telomere, Centromere and Repetitive sequences) of chromosomes and their functions, prokaryotic chromosomes, plasmids.	**10** **05**	**15**
MODULE 2: DNA/RNA a genetic material and DNA Replication	**2.1: DNA/RNA as genetic material** DNA as genetic material: Griffith's transforming principle, and Avery, Hershey and Chase Experiment proving DNA as genetic material RNA as the genetic material of some viruses **2.2: DNA Replication** Experimental evidence for semi-	**08** **07**	**15**

	conservative DNA replication in E.coli - Messelson and Stahl's experiment DNA template, Enzymes - DNA polymerases, ligase, DNA gyrase, Structure and function, Ancillary proteins associated with replication Mechanism of replication: Initiation, Elongation and Termination; Introduction to theta and rolling circle models DNA Proof reading.		
MODULE 3: DNA damage, repair and recombination	**3.1: DNA Damage and its Repair** Types of DNA damage (spontaneous and induced). AMES Test Mechanisms/pathways to repair DNA: Excision repair, mismatch repair, recombination repair in *E. coli* and SOS Repair. Role of *RecA* in DNA damage repair, Photoreactivation repair in *E.coli* involving photolyase. **3.2: Mechanisms of Genetic Recombination** General and site specific recombination. Heteroduplex DNA formation (Homologous recombination). Synaptonemal Complex, Bacterial *RecBCD* system and its stimulation of chi sequences. Role of *RecA* protein, homologous recombination, Holliday junctions.	**08** **07**	**15**

BCH-V.C-7: MOLECULAR BIOLOGY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Isolation of genomic DNA from prokaryotes and eukaryotes	05
2.	Isolation of RNA from prokaryotes	02
3.	Agarose gel electrophoresis of genomic DNA and its elution	05
4.	Mutagenesis in *E.coli* cells – UV	03
	Total	**15**

REFERENCES for BCH-V.C-7 (Latest Editions)

Mandatory Reading

- David, C., Nanette, P. and Michelle, M. Molecular Biology. Elsevier Academic Press.

Supplementary Reading

- Murray, R., Granner, D., Mayes, P. and Rodwell, V. Harper’s Illustrated Biochemistry. Mc Graw Hill.
- Watson, J. D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R.M. Molecular biology of the gene. Menlo Park, CA: Benjamin-Cummings.
- Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. Molecular biology of the cell. New York: Garland Science.
- Gardner, M. J., Simmons D.P. Snustad. Principles of Genetics. John Wiley & Sons.
- Dubey, R.C. Advanced Biotechnology. S. Chand Publishing.

Web References:

- https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics
- https://vlab.amrita.edu/?sub=3&brch=73&sim=1105&cnt=1
- http://textbookofbacteriology.net/growth_3.html
- https://openstax.org/details/books/biology-2e
- https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_Concepts_in_Biology_(OpenStax)/9%3A_Molecular_Biology

SEMESTER V

ELECTIVE COURSE: CONCEPTS IN GENETICS	
COURSE CODE:	**BCH-VE.-9**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1**: Describe the various chromosomal theories and Mendelian genetics. **CO2**: Comprehend and analyze the pedigree chart and inheritance pattern in family **CO3**: Correlate various genetic disorders to chromosomal mutations **CO4**: Explain the various sex-determining mechanisms in animals

BCH-V.E-9: CONCEPTS IN GENETICS (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Mendelian Genetics, Model Organisms and gene transfer mechanisms	**1.1: Mendelian Genetics** History of Mendelian Genetics, First Law of Inheritance, Second Law of Inheritance, Monohybrid and Dihybrid cross, Test cross and Back cross and their significance. Deviations in Mendel's Laws: Dominance, Co-dominance, Incomplete dominance; Multiple alleles: ABO blood group, Rh incompatibility Gene interaction - Epistasis: Dominant and Recessive epistasis with example; Non-epistatic gene interactions **1.2: Model Organisms used in used in study of genetics** Model organisms: *Escherichia coli*, *Saccharomyces cerevisiae*, *Neurospora crassa*, *Drosophila melanogaster*, *Caenorhabditis elegans*, *Arabidopsis thaliana* **1.3: Gene transfer mechanism in bacteria** Conjugation, Transformation and Transduction	**08** **03** **04**	**15**
MODULE 2: Chromosomal Linkage and Crossing-over and Human Genetics	**2.1: Chromosomal Linkage and Crossing-over** Sutton-Boveri chromosome theory of heredity Bateson and Punnet's coupling and repulsion hypothesis, Morgan's views on linkage, Theory of linkage; Kinds of linkage: Complete linkage, incomplete linkage; Significance of linkage Types of crossing over: Somatic or mitotic crossing over, Germinal or meiotic crossing over.	**09** **06**	**15**

	Mechanism of meiotic crossing over: Synapsis, Duplication of chromosomes, Crossing over by breakage and union, Terminalisation, Significance of crossing over. Transposable elements, Significance of crossing over. **2.2: Human Genetics** Importance of human genetics study, techniques involved: Karyotyping Amniocentesis, CVS, Pedigree analysis; Human traits Disorders due to mutant genes: PTC tasters, Huntington's chorea, Tongue rolling, hemophilia		
MODULE 3: Chromosomal aberrations, Determination of Sex and Sex differentiation and Population Genetics	**3.1: Chromosomal Mutations** Concept of gene doses, Barr bodies, Types of structural changes (Deletion, Duplication, Inversion, Translocation, Variation in chromosome morphology). Disorders – Down's syndrome, Kleinfelter's syndrome. Types of numerical changes with examples (Euploidy and Aneuploidy) - Monosomy and Trisomy of Sex and Autosomes Disorders – Turner's syndrome, Cri- du-chat syndrome. Disorders due to inborn errors of metabolism — Phenylketonuria (PKU), Alkaptonuria, Sickle-cell anaemia. **3.2: Genetically controlled sex determination and differentiation** Mechanisms: Heterogamesis; Types: Heterogametic males, Heterogametic females; Genic balance mechanism - Sex determination in *Drosophila melanogaster* and man; Male haploidy or haplodiploidy mechanism; Hormonally controlled sex	**06** **06** **03**	**15**

	determining mechanism - *Bonellia;* Environmentally controlled sex determining mechanism- *Ophryotrocha* **3.2: Population Genetics** Hardy-Weinberg law, Factors affecting Hardy Weinberg theory, Predicting allele and Genotype frequencies and exceptions to Hardy-Weinberg principle, Speciation: types and examples.		

REFERENCES for BCH-V.E-9

Mandatory Reading

- Tamarin, R.H. (2017). Principles of Genetics (7th Edition). Tata McGraw-Hill Publishing Company Ltd.
- Verma, P. S. and Agarwal, V. K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company Pvt. Ltd.

Supplementary Reading

- Stryer, L; Berg, J; Tymoczko, J & Gatto, G. (2019). Biochemistry (9th Edition). W. H. Freeman and Co., New York, USA.
- Murray, R. K, Granner, D. K., Mayes, P. A. & Rodwell, V. W. (2018). Harper’s Illustrated Biochemistry (31st Edition). McGraw-Hill Companies.
- Jain, J. L.; Jain S. & Jain N. (2016). Fundamentals of Biochemistry (7th Edition). S.Chand and Company, Ltd., New Delhi.
- Verma, P. S. and Agarwal, V. K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company Pvt. Ltd.
- Harvey, R.A. & Ferrier, D.R. (2017). Lippincott’s Illustrated Reviews, Biochemistry (7th Edition). Lippincott Williams and Wilkins.
- Voet, D. and Voet, J. G. Biochemistry. John Wiley & Sons, Inc, USA.
- Lewin B., Krebs J. E., Goldstein E. S. and Kilpatrick S. T. Genes XI. Jones & Bartlett Publishers

Web References:

- http://www.biologydiscussion.com/mendel/mendel-study-on-genetics-mendelian-

inheritance/38754

- https://www.khanacademy.org/science/high-school-biology/hs-classical-genetics/hs-pedigrees/v/pedigrees
- https://study.com/academy/lesson/hardy-weinberg-equilibrium-i-overview.html
- http://www.biologydiscussion.com/genetics/structural-change-in-the-structure-of-chromosomes/5261
- https://www.khanacademy.org/science/high-school-biology/hs-classical-genetics/hs-sex-linkage/a/x-inactivation
- https://www.khanacademy.org/science/biology/classical-genetics/chromosomal-basis-of-genetics/a/discovery-of-the-chromosomal-basis-of-inheritance

SEMESTER V

ELECTIVE COURSE: INDUSTRIAL MICROBIOLOGY	
COURSE CODE:	**BCH-VE.-11**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Handle the industrial-based equipment **CO2:** Isolate and maintain the microorganisms for biochemical production **CO3:** Handle the process for the production of various industrial biochemical products **CO4:** Lead and manage the processes of biochemical production of industrial importance.

BCH-V.E-11: INDUSTRIAL BIOCHEMISTRY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Introduction	**1.1: Introduction to Industrial Microbiology** Overview of industrial fermentation technology, scope and applications. **1.2: Industrial bioreactor** Fermenters: Structure of an Ideal fermentor, Parts of the fermentor and their uses – Impellers, Spargers, Baffles, Headspace, Controls and Sensors (temperature, pH, antifoam) Types of reactors (definition, description, diagram and uses) - Bubble columns, Airlift, Fluidized bed, Packed bed, Tray bioreactors, Photo-bioreactors. Sterilization of bioreactors **1.3: Fermentation Media** Characteristics of an ideal fermentation medium, types of media – crude and synthetic, composition of fermentation media. sterilization of media	**01** **08** **06**	**15**
MODULE 2: Fermentation, fermentors and Screening of microorganisms	**2.1: Types of fermentation and fermentors** Submerged, Surface/Solid state, Batch, Fed-batch, Continuous. Lab scale, Pilot Scale and industrial scale fermentors **2.2: Screening of microorganisms** Characteristics of microorganisms, strain	**07** **08**	**15**

	improvement, Screening procedures: Primary screening: Definition, Methods of primary screening – Crowded plate, Auxanography, Enrichment, Indicator dye Secondary screening: Definition and features, Example of secondary screening (giant colony method)		
MODULE 3: Fermentation Products	**3.1:** Fermentation products Physical and Chemical assays - Titration and gravimetric assay, Turbidity analysis and Cell determination, Spectrophotometric assay, chromatographic method Biological assays - Diffusion assays, Turbidometric and Growth assay	**05**	**15**
	3.2: Industrial production of economically important products Citric acid, Vinegar, Ethanol, SCP, Beer, Wine, Yogurt, Penicillin, Amylase, Steroids	**10**	

BCH-V.E-11: INDUSTRIAL BIOCHEMISTRY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Study and handling of a fermentor	02
2.	Media preparation for batch fermentation process	01
3.	A study on the phases of growth of microorganisms during fermentation	02
4.	Isolation of antibiotic producing bacteria – crowded plate technique and secondary screening using giant colony technique	03
5.	Production of wine (from fruit) using yeast	02
6.	Production of vinegar	02
7.	MIC of Penicillin for Gram positive bacteria (*S. aureus* or *Bacillus)*	01
8.	Production of amylase in solid state fermentation	02
	Total	**15**

REFERENCES for BCH-V.E-11

Mandatory Reading

- Stanbury P. F, Whitaker A. and Hall. (1997). Principles of fermentation technology, 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
- Casida L. E. (2009). Industrial Microbiology, New Age International (P) Ltd. New Delhi.

Supplementary Reading

- Okafor N. (2007). Modern Industrial Microbiology and Biotechnology, Science Publishers Enfield, NH, USA.
- Patel A. H. (2012). Industrial Microbiology, MacMillan Publishers India Ltd.
- Prescott and Dunn. (1982). Industrial Microbiology, 4th edition, AVI Publishinhg Co.
- Ratlege C. and Kristiansen B. (2001). Basic Biotechnology, 2nd edition. Cambridge university press.

Web References:

7. http://www.biologydiscussion.com/fermentation/fermentation-technology-meaning-methodology-types-and-procedure/17492
8. https://study.com/academy/lesson/bacterial-fermentation-process-products.html
9. https://study.com/academy/lesson/alcohol-fermentation-definition-equation-process.html
10. http://www.biologydiscussion.com/biotechnology/bioprocess-technology/media-used-for-the-growth-of-microorganisms/10096
11. http://www.biologydiscussion.com/industrial-microbiology-2/fermentation-industrial-microbiology-2/production-of-ethanol-microbiology/66072

THIRD YEAR
SYLLABI
(Semester VI)

SEMESTER VI

CORE COURSE: CLINICAL BIOCHEMISTRY	
COURSE CODE:	**BCH-VI.C-8**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1**: Comprehend the concepts of assessing the human physiology by analysing biological samples. Also, learn about culture, collection, handling and transport of clinical samples. **CO2**: Identify the metabolic factors and illustrate the mechanism of metabolic disorders at molecular level **CO3**: Determine various diagnostic tests associated with lipid and carbohydrate metabolism facilitating the employability in diagnostic and research institutes. **CO4:** Define complex genetic and metabolic traits and molecular and cellular therapies for the same. **CO5**: Critique the current screening programmes in various countries.

BCH-V.C-8: CLINICAL BIOCHEMISTRY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Laboratory Analysis of clinical samples	**1.1: Blood, Serum and Urine** Composition of Blood, Serum, Cerebrospinal Fluid and Urine. Collection, Preservation, Handling and Processing of clinical samples. Blood Bank	**02**	**15**
	1.2: Analysis of Blood, Serum, Urine and CSF **Blood**: Haemoglobin, Total cell and Differential cell (TC/DC) counts, Erythrocyte sedimentation Rate (ESR); Clotting time, Glucose tolerance test, Urea; Gases: Oxygen and Carbon dioxide levels; pH. **Serum**: Proteins, Albumin/Globulin Ratio; Bilirubin; Creatinine; Uric acid; Electrolytes. **Urine**: Colour, Odour, Sediment, Crystals, Glucose; Protein/Albumin **CSF**	**13**	
MODULE 2: Congenital and Metabolic disorders	**2.1: Congenital disorders** Disorders associated with carbohydrate metabolism- Glycogen storage diseases, Galactosemia. Protein metabolism – Phenylketonuria, Alkaptonuria. Lipid metabolism – Niemann – Pick disease, Tay- Sach's disease. Disorders due to chromosomal aberrations	**09**	**15**

	–Down syndrome Skin – Xeroderma pigmentosum Purine/pyramidine – Lesch-Nyhan Syndrome Porphyrins – acute intermittent porphyria **2.2 : Metabolic disorders** Carbohydrate – Diabetes mellitus Type I and Type II; Ketosis. Lipids – Dyslipidemia. Proteins – Albuminuria Blood – Anaemia: Haemolytic, Pernicious, Sickle cell anaemia; Iron deficiency. Heart – Hypertension, Arterosclerosis Liver – Kidney –Diabetes insipidus	**06**	
MODULE 3: Diagnostic Tests	**3.2: Diagnostic tests (rearrange)** Blood: Total and differential blood count, Blood groups and Rh factor incompatibility. Liver disorders and Liver function tests: Bilirubin metabolism, Types of jaundice and clinical assessment, Acute and chronic liver diseases, Cirrhosis, Viral, Metabolic and Drug induced/toxic liver diseases. Kidney disorders and Renal function tests: Glomerular filtration rate, Renal threshold and clearance values, Disorders of kidney, Renal failure and proteinuria, Renal tubular disorders and renal stones. Heart: Role of enzymes and other proteins in assessment of myocardial infarction.	**15**	**15**

BCH-VI.C-8: CLINICAL BIOCHEMISTRY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Identification of blood collection tubes and preparation of blood, plasma and serum	01
	Sample collection and processing – blood and urine	
2.	Blood staining	01
3.	Bleeding and Clotting time	01

4..	Erythrocyte Sedimentation Rate	01
5.	Glucose Tolerance Test	01
6.	PCV Test	01
7.	Physical & Chemical Examination of Urine	03
8.	Liver function test	03
9.	Renal function test	02
10.	Cholesterol test	01
	Visit to pathology lab and blood bank	
	Total	**15**

REFERENCES for BCH-V.C-8

Mandatory Reading

- Pattabiraman R. N. Text book of Biochemistry, All India Publisher distribution.

Supplementary Reading

- Chatterjee M. N., Shinde, R. Text book of Medical Biochemistry, Jaypee Publishers.
- Vasudevan, D. M., Sreekumari S., Text book of Biochemistry for Medical Students, Jaypee Publishers.
- Berg, Jeremy M., Tymoczko, John L., Stryer Lubert. Biochemistry, W.H. Freemann, N. York.
- David, L. N., Michael, M. C., Lehninger, Albert, Biochemistry, Kalyani Publications, N.

Web References:

5. George, F. Hoffmann., Johannes, Z., William, L. Nyhan. Inherited Metabolic Disorders: A clinical approach, Springer.
6. Fernandes, J., Saudubray, J.M., van Den Berghe, G. Inborn Metabolic Diseases. Springer.

SEMESTER VI

ELECTIVE COURSE: INTRODUCTION TO PHARMACOLOGY	
COURSE CODE:	**BCH-VI.E-13**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Comprehend the principles that govern pharmacology **CO2:** Describe pharmacodynamics and pharmacokinetics **CO3:** Recognize routes of administration for various drugs and their absorption **CO4:** Infer mechanism of action of drugs based on pathophysiology of the disease **CO5:** Apply the concept of drug action mechanism

BCH-VI.E-13: INTRODUCTION TO PHARMACOLOGY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Principles of pharmacology, Pharmacodynamics and Pharmacokinetics	**1.1: General Principles Of Pharmacology** Introduction to Pharmacology, Therapeutics; History – Traditional & Modern Medicine; Concepts of Pharmacology; Common terminologies used in pharmacology Nature of drugs; Sources of drugs, Scientific basis of use of drugs in humans Introduction to Pharmacopeia **1.2: Pharmacodynamics & Pharmacokinetics** Introduction; Pharmacodynamics: - Transport across biological membranes; Absorption of drugs, Bioavailability Pharmacokinetics: - Biotransformation, Excretion, Prolongation of drug action Mechanism of drug action, Placebo effect Receptors & Signal Transduction; Agonists,	**05** **10**	**15**

	Antagonism; Slow processes, Non-receptor mechanism Constant Rate infusion; Single bolus dose, Repeated (multiple) dosing		
MODULE 2: **Drug Absorption & Routes of Administration,** **Drug Development**	**2.1: Drug formulation and its administration** Bioavailability, Bioequivalence and generic vs. Proprietary prescribing, Prodrugs; routes of administration – Oral, Buccal & Sublingual, Rectal route, Skin, Lungs, Nose, Eye, Ear & Vagina, Intramuscular Injection, Subcutaneous injection, Intravenous injection, Intrathecal injection **2.2: Drug Development** Introduction to drug development, processes involved in drug development, Toxicity, Clinical trials	**10** **05**	**15**
MODULE 3: **Type of Drugs for different applications**	**3.1: Drugs for the Nervous and Musculoskeletal Systems** (Include brief pathophysiology of diseases wherever necessary) Sedatives, antipsychotic, antianxiety and antidepressants Anaesthetics & Muscle relaxants, Analgesics Anti-inflammatory drugs **3.2: Drugs for the Circulatory & Respiratory system** (Include brief pathophysiology of diseases wherever necessary) Antihypertensive drugs, drugs used in ischaemic heart disease, Anticoagulants & antiplatelet drugs, drugs for heart failure Drugs used to treat asthma, bronchitis, cough	**05** **05** **03**	**15**

	3.3: Drugs for the Gastro-intestine (Include brief pathophysiology of diseases wherever necessary) Drugs for peptic ulceration & Oesophageal disorders Diarrhoea, Irritable bowel syndrome, Liver diseases, Drugs that modify appetite **3.4: Antimicrobial drugs** Antibacterial, Antiviral, Antifungal drugs (any two examples of each)	**02**	

BCH-VI.E-13: INTRODUCTION TO PHARMACOLOGY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Study of efficiency of antibacterial and antifungal against standard organisms	04
2.	Comparative study of antimicrobial activity of natural extracts against standard drug	02
3.	Determining shelf life of a drug	02
4.	Estimation of active ingredient in a commercial vitamin	02
5.	Mode of action of commonly used drug and route of administration (case	04

	studies)	
6.	Study of dosage forms of drugs	01
	Total	**15**

REFERENCES for BCH-VI.E-13

Mandatory Reading

- Tripathi K. D. (2019). Essentials of Medical Pharmacology (8th Edition). Jaypee Brothers Medical Publishers (P) Ltd., London.

Supplementary Reading

- Ritter J. M., Lewis L. D., Mant T. GK., and Ferro A., (2008). A Textbook of Clinical Pharmacology and Therapeutics (5th Edition). Hachette Livre, U.K.
- Katzung B., (2017). Basic and Clinical Pharmacology (14th Edition). McGraw-Hill Education/Medical.
- Whalen K., (2018). Lippincott Illustrated Reviews: Pharmacology (Sangeeta Sharma & Thirumurthy Velpandian edition). Wolters Kluwer India Pvt. Ltd.

Web References:

- https://www.ncbi.nlm.nih.gov/books/NBK12815/
- https://www.youtube.com/watch?v=tobx537kFaI
- https://www.ncbi.nlm.nih.gov/books/NBK507791/
- https://www.youtube.com/watch?v=NKV5iaUVBUI

SEMESTER VI

ELECTIVE COURSE: FOOD BIOCHEMISTRY	
COURSE CODE:	**BCH-VI.E-14**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the student will be able to: **CO1:** Appreciate the importance of composition of food and its implications in food spoilage. **CO2:** Apply the knowledge to describe the changes occurring in food due to storage and handling. **CO3:** Comprehend and apply the concept of food preservation techniques. **CO4:** Evaluate and assess the quality of food.

BCH-VI.E-14: FOOD BIOCHEMISTRY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Introduction to Food Biochemistry and spoilage	**1.1: Introduction to Food biochemistry** Definition and composition of food. Food as a substrate for microorganisms **1.2: Spoilage of food** Intrinsic and Extrinsic factors - Hydrogen-ion concentration, moisture requirement, oxidation-reduction potential, nutrient content, inhibitory substances and biological structure. Enzymatic browning, Non – Enzymatic browning, Maillard reaction, Caramelization reaction, Ascorbic acid oxidation Classification of foods by ease of spoilage, Factors affecting kinds, numbers and growth of microorganisms in food, temperature, pressure Chemical changes caused by microorganisms	**02** **13**	**15**
MODULE 2: Principles of Food Preservation	**2.1: Principles of Food preservation** Preservation by high temperature – Factors affecting heat resistance (Thermal Death Time), Determination of heat resistance (Thermal Death Time), Heat treatments employed in food processing, Chemistry of canning	**15**	**15**

<table>
<tr><td></td><td>Preservation by low temperature – Temperature employed in low-temperature storage.

Principle of freezing, freezing curve, changes occurring during freezing, types of freezing i.e. slow freezing, quick freezing, Introduction to thawing, Mechanism of changes during thawing and its effect on food.

Preservation by drying – Methods of drying, Factors in the control of drying

Preservation by radiation – kinds of ionizing radiations used in food irradiation, mechanism of action, uses of radiation processing in food industry, concept of cold sterilization.</td><td></td><td></td></tr>
<tr><td rowspan="2">MODULE 3:
Food Quality, New Product Development</td><td>3.1 : Food Quality

Objectives, type of food panels, characteristics of panel members, layout of sensory evaluation laboratory, sensitivity tests, threshold value, paired comparison test, duotrio test, triangle test, hedonic scale, chemical dimension of basic tastes, Amoore’s classification of odorous compounds. Sherman and Sczezniak classification of food texture.

Sensory attributes of cheese, cream, butter, ghee, juices.

Application of texture measurement in cereals, fruits and vegetables, dairy, meat and meat products.

Dimensions of colour and attributes of colour; gloss etc. Perception of colour, Colour Measurement: Munsell colour system, CIE colour system, Hunter colour system, etc.

Grading of Milk, MBRT, Resazurin (include more tests for other foods)

FSSAI and other Regulatory Bodies</td><td>11</td><td rowspan="2">15</td></tr>
<tr><td>3.2: Product Development

Importance, Need of product

development, Steps of product development, Product development tools, Reasons for failure</td><td>04</td></tr>
</table>

BCH-VI.E-14: FOOD BIOCHEMISTRY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Screening and evaluation of fresh and spoiled fruits and vegetables	02
2.	Texture evaluation of various processed food sample	01
3.	Processing and sensory evaluation of milk and milk products (milk, flavoured milk, curd, cheese, condensed milk, khoya)	05
4.	TDT of an organism isolated from spoilt fruit	01
5.	Spoilage of bakery product (bread, biscuits)	01
6.	Estimation of salt content in butter	01
7.	Study quality characteristics of foods preserved by drying/ dehydration/ freezing.	02
8.	Visit to a food industry or food research institute and preparation of report	02
	Total	**15**

REFERENCES for BCH-VI.E-14

Mandatory Reading

- Frazier, W. C. and Westhoff, D. C., Food Microbiology. TMH Publication, New Delhi.

Supplementary Reading

- Ramaswamy, H. and Marcott, M. Food Processing Principles and Applications. CRC Press.
- Ranganna, S. Handbook of Analysis and Quality Control for Fruits and Vegetable Products, TMH Education Pvt. Ltd.
- Potter, N.H. Food Science, CBS Publication, New Delhi.
- Owen, F. R. Food Chemistry, Marcell Dekker, New York.
- Gordon, F. W. New Product Development From Concept to Marketplace, CRC Press.
- Norman, D.W. and James, D. N. The technology of food preservation,Westport.
- Pomeranz, Y. and Meloan, C.E. Food Analysis – Theory and Practice, CBS Publishers and Distributors, New Delhi.

Web References:

- https://www.youtube.com/watch?v=LUQxrnEFzB0
- https://www.slideshare.net/natrajdurgannavar/sensory-evaluation-of-food
- http://ecoursesonline.iasri.res.in/mod/page/view.php?id=6091

SEMESTER VI

ELECTIVE COURSE: GENETIC ENGINEERING AND BIOTECHNOLOGY	
COURSE CODE:	**BCH-VI.E-15**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Describe the concept of genetic engineering and its importance to biotechnology **CO2:** Summarize the various tools/requirements for carrying out genetic manipulations **CO3:** Explain the processes of transformation as well as principles governing DNA separation, amplification and sequencing techniques **CO4:** Illustrate the applications of genetic engineering in current use CO5: Carry out experiments such as transformation, DNA and RNA isolation

BCH-VI.E-15: GENETIC ENGINEERING AND BIOTECHNOLOGY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Introduction to	**1.1: Introduction to Genetic Engineering and Biotechnology**	**03**	**15**

Genetic Engineering	Concept of biotechnology, General features and mechanisms of genetic engineering, Applications and ethical issues of recombinant DNA technology, Gene cloning **1.2: DNA Modifying enzymes and Vectors for Gene Cloning** Nucleases - Endonucleases (Restriction enzymes – types and recognition sequences, Cleavage pattern), Exonucleases, Host control restriction and modification, DNA ligases, Reverse Transcriptases, Polynucleotide kinases, Alkaline phosphatases, Nucleotidyl transferases Vectors, Properties of ideal cloning vectors, Cloning vectors v/s Expression vectors - Types of cloning vectors; Plasmid vectors: Properties, Classification, pBR322, pUC 18 Bacteriophage vectors, Lambda phage, M13 Bacteriophage Hybrid vectors: Cosmids, Phagemids and Phasmids; Shuttle vectors; Plant vectors, Animal vectors	**12**	
MODULE 2: Transformation methods and Blotting techniques for DNA & RNA	**2.1: Transformation methods and identification of recombinants** DNA insertion into vectors: Ligation, Use of linkers and Adaptors, Homopolymer tailing Transformation; competence, Chemical induction, Microinjection, Lipofection, Electroporation, Macroinjection, Sonication, DNA co-precipitation, Ultrasonication, Laser induced Identification of Recombinants: Principle and importance of identification of recombinants: Antibiotic resistance (amp, tet resistance), lac Z selection, Colony hybridization **2.2: Blotting Techniques for DNA and RNA**	**10** **05**	**15**

	Isolation of Genomic DNA and RNA, Agarose gel electrophoresis, Southern blotting: Blotting of DNA from agarose gel by capillary action onto nitrocellulose membrane, Denaturing of DNA, Hybridisation with radiolabelled P 32 , Autoradiography Northern blotting: Blotting of RNA from agarose gel onto nitrocellulose membrane, Hybridisation with radiolabelled probe, Autoradiography		
MODULE 3: Applications of Genetic Engineering	**3.1: DNA Amplification and Sequencing** DNA amplification: Polymerase chain reaction (PCR) – Principle, Components, Method and Applications DNA sequencing: Significance and importance, Basic methods: Maxam Gilbert's method, Sanger's method. Advanced method: Shotgun method, Automatic DNA sequencer **3.2: Genomic and cDNA libraries** Preparation of genomic library, cDNA library, Screening of Libraries **3.3: Applications in agriculture** Flavr Savr tomato, Golden rice, Plant resistance to desiccation, cold, heat, pests, herbicides **3.4: Applications in pharmaceuticals** Recombinant insulin, Blood clotting factor VIII, Edible vaccines **3.5: Applications in environment** Bioremediation and Superbug	**08** **02** **05**	**15**

BCH-VI.E-15: GENETIC ENGINEERING AND BIOTECHNOLOGY (PRACTICAL)

SR. NO.	RACTICAL	NO. OF PRACTICALS
1.	Isolation of plasmid DNA by alkaline lysis and boiling prep method, and molecular weight determination by gel electrophoresis	04
2.	Restriction digestion of plasmid DNA and analysis by gel electrophoresis	02
3.	Preparation of competent cells of bacteria	02
4.	Transformation in bacteria using plasmid vector (pUC 18)	02
5.	Screening of transformants (4+5)	02
6.	Deciphering the DNA sequence from a sequencing gel photograph by Maxam and Gilbert's method and Sanger's method	02
7.	Blotting techniques (virtual laboratory)	01
	Total	**15**

REFERENCES for BCH-VI.E-15

Mandatory Reading

- Singh, B. D. (2008). Biotechnology: Expanding Horizons, Kalyani Publishers.

Supplementary Reading

- Primrose, S. B. and Twyman, R. M. (2009). Principles of Gene Manipulation and Genomics, Blackwell Publishing.
- Jogdand, S. N. (2008). Gene Biotechnology, 2nd edition, Himalaya Publishing House, Mumbai.
- Purohit, S. S. (2009). Biotechnology: Fundamentals and Applications, Student Edition.
- Watson, J. D., Tooze, J. and Kurtz, D. T. (1983). Recombinant DNA: A short Course, Scientific American Books (WH Freeman), New York.

Web References:

- https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics/hs-biotechnology/v/introduction-to-genetic-engineering
- https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Bruslind)/18%3A_Genetic_Engineering
- https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/7%3A_Microbial_Genetics/7.23%3A_Genetic_Engineering_Products/7.23B%3A__Applications_of_Genetic_Engineering
- https://www.slideshare.net/gnsk143/gene-transformation-methods
- https://www.brainkart.com/article/Identification-of-Recombinants---Recombinant-DNA-Technology_21278/

SEMESTER VI

ELECTIVE COURSE: ENVIRONMENTAL CHEMISTRY	
COURSE CODE:	**BCH-VI.E-16**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Explain about the biochemistry of environmental processes and ecology. **CO2:** Comprehend the basic knowledge of ecological concepts, various pollutants and its remediation. **CO3:** Apply the knowledge of principle and methodologies of composting and designing their own. **CO4:** Assess the quality of the air, water and soil.

BCH-VI.E-16: ENVIRONMENTAL CHEMISTRY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: Ecological Concepts and Pollutants	**1.1: Basic ecological concept** Biogeochemical cycles (C, N, O, P, S, Water), Food chain and food webs, Ecological pyramids; Productivity and eco-energetic (10% law)	**09** **06**	**15**

	1.2: Pollutants Pollutants of water, air and soil and their sources Eco-toxicology: concept of permissible limits, ED50 & LD50; acute and chronic exposures. Significance of dissolved oxygen, BOD, COD.		
MODULE 2: Impact of environmental pollution and its control I	**2.1: Pollution monitoring** Bioindicators: Concept and examples (indicators of water quality; air pollution indicators) Tests for assessing Genetic damage: AMES Test Concept and applications of biosensors in pollution detection **2.2: Air Pollution** Impacts of air pollution on human health, animals, plants and climate, Removal of gaseous contaminants: Bioscrubbers, Biotrickling filters and Biofilters/Biobeds **2.3: Water Pollution** Impacts of water pollution on human health, animals Wastewater treatment: Activated sludge process, Rotating biological discs, Oxidation ponds, Trickling filters	**05** **05** **05**	**15**
MODULE 3: Impact of environmental pollution and its control II	**3.1: Soil Pollution** Hazardous and non-hazardous solid wastes **3.2: Bioremediation** Bioremediation: Definition, Mechanism of microbial bioremediation, Microbial desulphurization of coal (indirect mechanisms). Microbial processes – enzymatic transformations, co-metabolism, microbial adhesion, biofilms, production of extracellular	**01** **10**	**15**

	polymers and emulsifiers. Phytoremediation Removal of metal pollutants through sedimentation, sorption, precipitation, speciation conversion Biodegradation of xenobiotics: Aromatic hydrocarbons (benzene) and alkanes Biosorption: Principle, Use of Fungi and Algae Genetically engineered microorganisms: Super Bug (Pseudomonas species) Concepts of Reuse, Recycle and Recovery. **3.3: Composting and Vermitechnology** Principle concept and method **3.4: Hospital waste management**	**03** **01**	

BCH-VI.E-16: ENVIRONMENTAL CHEMISTRY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Water quality by MPN method for sewage water	02

2.	Routine analysis of potable water sample using Presumptive, Confirmatory and Confirmed tests for coliform	04
3.	Determination of Dissolved Oxygen concentration of water sample by Winkler's method	01
4.	Determination of Biological Oxygen Demand (BOD) of the water sample	01
5.	Determination of Chemical Oxygen Demand (COD) of the water sample	01
6.	Determination of Total Solids (TS) of the given water sample	01
7.	Isolation of xenobiotic degrading bacteria by selective enrichment	03
8.	Visit to an effluent treatment plant (report)	02
	Total	**15**

REFERENCES for BCH-VI.E-16

Mandatory Reading

- Dara, S.S. A text book of Environmental Chemistry and Pollution Control. S. Chand Publishers

Supplementary Reading

- Khopkar, S. M. Environmental Pollution Analysis. John Wiley and Sons.
- Mitchell, R. and Cu, J. D. Environmental Microbiology. Wiley- Blackwell Publication
- Ramesh, K. V. Environmental Microbiology. MJP Publishers, India.
- Maier, R., Pepper, I. and Gerba, C. Environmental Microbiology. Academic Press.
- Moore J. W. and Moore, E. A., Environmental Chemistry. Elsevier.
- Jadhav, H.V. Elements of Environmental Chemistry: For Undergraduate Science Students of Indian University. Himalaya Publishing House.
- Satake, M., Sethi, S. and Eqbal, S.A. Environmental Chemistry. Discovery Publishing Pvt.Ltd,
- Salle, A.J. Fundamental Principles of Bacteriology. McGraw Hill.
- Frobisher, M. and Hinsdale, R.D. Fundamentals of Microbiology. Saunders.

Web References:

- https://openoregon.pressbooks.pub/envirobiology/

BIOTECHNOLOGY

Parvatibai Chowgule College of Arts and Science (Autonomous)

Margao, Goa

Syllabus for

Semester I and Semester II

for the undergraduate course

in

Biotechnology

(2015-2016)

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER I

PAPER TITLE: BASIC MICROBIOLOGY

PAPER CODE: BIO-I.C-1

NAME OF FACULTY: MS. LEE-ANNE D'COSTA

MARKS: 75 MARKS THEORY + 25 MARKS PRACTICAL

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVE: The main aim of this paper is to introduce the students to the vast world of Microbiology. This course covers a range of topics in Basic Microbiology from the historical perspective to the structure and composition of microorganisms, their interactions with the environment and their impact on humans.

LEARNING OUTCOME: On completion of this module, students will be able to understand the scope and importance of Microbiology, classification schemes, cultivation, preservation and maintenance of the microbial cultures. They will also be able to understand pathogenicity of microorganisms, precautions and measures to control the same.

BIO-I.C-1: BASIC MICROBIOLOGY

Theory (75 marks)

Sr.No	Topics	Sub Topics	No. of hours
1	History and Scope of Microbiology	- Historical Account from 16^{th} – 18^{th} century	2
2	Basics of Microscopy	- Principle of working of Light microscope (Bright-field, Dark-field, Phase-contrast, Fluorescence)	3
3	Bacterial Taxonomy	- Introduction to Archaea - Taxonomic ranks - Classification Systems (Phenetic, Numerical, Phylogenetic) - Bergey's Manual of Systematic/ Determinative Bacteriology and rDNA sequencing	8
4	Organization and Ultrastructure of a Bacterial cell	- Cell wall: structure and chemical composition in gram positive and gram negative bacteria. - Introduction to Cell membrane, pili, fimbriae and capsule - Flagella structure and function. - Nucleoid and plasmids: nature and function. - Endospore: structure, sporulation and germination. - Reserve materials	8
5	Reproduction in bacteria	- Binary fission - Definitions: cell growth, growth rate, generation time - Bacterial growth curve, characteristics of growth phases; diauxic growth curve, continuous,continuous and synchronous growth	4
6	Bacteria in Extreme Environments	- Thermophiles, barophiles, halophiles, acidophiles and Alkaliphiles	4
7	Viruses	- Basic Classification and Structure of Viruses (Prokaryotic and Eukaryotic) - Characteristic features of λphage - Viral replication (lytic and lysogenic)	7
8	Algae	- General Characteristic Features (cyanobacteria)	3
9	Fungi	- General Characteristic Features (yeast)	3
10	Protozoa	- General Characteristic Features *(Plasmodium)*	3
		Total	**45**

Practical (25 marks)

Introduction to microbiology laboratory: Concepts of sterilization	1
Introduction to Laminar Air Flow unit, autoclave, pH meter, incubator, microwave	2
Preparation and Sterilization of Glassware	1
Preparation of media and autoclaving	1

Pour Plate Technique and Open Air Cultures	1
Bacterial Isolation Techniques: Streaking Methods - Simple continuous, T-streak, Quadrant, Radiant	1
A) Introduction to Microscope B) Preparation and Staining of specimen	2
Isolation and Staining of Fungi by Lactophenol cotton blue	1
A) Study of Algal specimens B) Study of Protozoans in pond water	1
Preparation for Biochemical tests for Bacterial Identification	1
Use of biochemical tests for bacterial identification: IMViC test, carbohydrate test	2
Cleaning and Decontamination	1
Total	**15**

REFERENCES:

1. ANANTNARYAN, R. & PANIKER, C.K.J. (2005). *Text book of Microbiology, 7th edition*, Orient Blackswan.
2. ANEJA, K. R. (2007). *Experiments in Microbiology, Plant Pathology and Plant Tissue Culture,* New Age International.
3. DUBEY, R.C & MAHESHWARI, D.K. (2002). *Practical Microbiology*, S. Chand & Company Ltd., New Delhi.
4. DUBEY, R.C. & MAHESHWARI, D.K. (2008). *A Textbook of Microbiology,* S. Chand and Company Ltd., New Delhi.
5. GUNASEKARAN, P. (1995). *Laboratory Manual in Microbiology,* New Age International.
6. MADIGAN, M. T., MARTINKO. J. M. & PARKER J. (2007). *Brock's Biology of Microorganisms,* Pearson Prentice Hall.
7. MCKANE, L. & KANDEL, J. *Microbiology essentials and applications*
8. PELCZAR, M.J., CHAN E, C.S. & KRIEG, N.R. (1993). *Microbiology,* Fong and Sons Printers Pvt. Ltd.
9. POWAR, C.B & DAGINAWALA, H.F. (1982). *General Microbiology – Volume II*, Himalaya Publishing house: Mumbai.
10. STANIER, R.Y. (1993) *General Microbiology*, Cambridge University.
11. TAURO, P., KAPOOR, K.K & YADAV, K.S. (). *Introduction to Microbiology,*
12. WILLEY, J. M., SHERWOOD, L., WOOLVERTON, C. J. & PRESCOTT, L. M. (2008). *Prescott, Harley, and Klein's Microbiology*, New York, McGraw-Hill Higher Education.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER I

PAPER TITLE: FUNDAMENTALS OF BIOCHEMISTRY

PAPER CODE: BIO-I.C-2

NAME OF FACULTY: MS. LIESL DE SILVA, MS. LEE-ANNE D'COSTA AND MS. MADHAVI M. MOTANKAR

MARKS: 75 MARKS THEORY + 25 MARKS PRACTICAL

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVE: The aim of this paper is to apply chemistry to the study of living organisms and the atoms and molecules which comprises of them. For example, biomolecules like nucleic acids, proteins and components of cells are composed of various elements and interact using different types of bonds. Biochemistry analyzes and demonstrates the complexity of these contents and the pathways of various reactions in cells.

LEARNING OUTCOME: On completion of this module, students will be able to understand the chemical nature of different biomolecules, their structures and their importance in metabolic pathways. They will be equipped with the knowledge, skills and understanding of spectrophotometric estimation of these biomolecules and the effect of various factors on the functioning of enzymes.

BIO-I.C-2: FUNDAMENTALS OF BIOCHEMISTRY

Theory (75 marks)

Sr. No	Topic	Sub –Topics	No. of hours
1	Introduction and Scope of Biochemistry	- Landmarks in the history of Biochemistry (contributions particularly by Louis Pasteur, Carl Neuberg, Wilhelm Kuhne, Eduard Buchner)	2
2	Urey -Miller's experiment Molecular interactions Water	-Urey -Miller's experiment -Covalent, hydrogen, ionic, hydrophobic and Vander waal's interactions. -Structure and unique properties	3
3	Bio-molecules	Definition , structure ,function, Biological Significance, Classification; **Carbohydrate** • Monosaccharide • Disaccharide (Lactose, Sucrose and Maltose) • Reducing and non reducing sugars • Polysaccharides: (Structural and storage)	5
		Lipids • Fatty acids (saturated & unsaturated) • Simple Lipids : Fats, oils, waxes • Compound Lipids : Phospholipids & Glycolipids • Derived Lipids : Steroids	4
		Amino Acids • Structure and nomenclature, General properties, Zwitter ions **Proteins** • Structural Levels of protein • Peptide bond formation • Ramchandran plot	5
		Nucleic acids • Structural components of nucleic acid, Nucleotides & Nucleosides. • Structure of DNA & Types of DNA (A, B, C, D, E, Z) ; RNA and its types, • Differences between DNA and RNA, • Forces stabilizing the structure of DNA.	4
		Vitamins • Deficiencies symptoms. • Co-enzymes(Thiamine, riboflavin, niacin, PLP, Lipoic acid, Pantothenate, Folic acid, Cyanocobalamine.) **Hormones** • Classification and functions	3

4	**Enzymology**	**Basic concepts** • Classification of enzymes • Mechanism of enzyme action ,Lock & key theory & Induced fit theory • Factors affecting enzymes activity (time, enzyme conc., substrate concentration, pH, temperature) • Enzyme Inhibition and its types • MM equation, Lineweaver-Burk plot. • Ribozymes & Isoenzymes	8
5	**Metabolism**	(Outlines of pathway and structures of intermediates, name of the enzymes and their regulatory aspects) • Definition of metabolism; energy relationship between catabolic and anabolic pathways. • ATP as the energy currency of the cell. Generalized concept of ; • Carbohydrate metabolism : Glycolysis, Tri-Carboxylic Acid cycle, Pentose-phosphate pathway, Gluconeogenesis, glycogen synthesis and breakdown. • Oxidative degradation of proteins : Urea cycle. • Lipid metabolism : Synthesis and degradation of fatty acids • Nucleic-acid metabolism : *De novo* and salvage pathways.	11
		Total	**45**

Practical (25 marks)

Fundamentals of Biochemistry	
Preparation of 1 N/M solutions / buffers (Any 2)	1
Principle and working of a colorimeter and spectrophotometer, Concept of complementary colors.	1
Determination of λ_{max} and Molar extinction coefficient of a given compound	2
Preparation of solutions for estimation of reducing sugar and proteins	1
Estimation of reducing sugar - DNSA method.	1
Estimation of protein – Folin Lowry's method.	1
Estimation of protein – Biuret / Bradford method	1
Preparation of solutions for estimation of DNA	1
Estimation of DNA by Diphenylamine method	1
Determination of peroxide value of oil.	1
Effect of pH and temperature on amylase activity.	2
Titration curve of any 2 amino acids	2
Total	**15**

REFERENCES :

1. GUPTA, P.K. (1999). *A Text-book of Cell and Molecular Biology*, Rastogi Publcations, Meerut, India.
2. JAIN, J.L (1999). *Fundamentals of Biochemistry*, S.Chand and Company, Ltd., New Delhi.
3. MURRAY, R.K., GRANNER, D.K., MAYES, P.A. & RODWELL, V.W. (2003), *Harper's Illustrated Biochemistry*, McGraw-Hill Companies.
4. NELSON, D. L. & COX, M.M. (2000). *Lehninger's Principles of Biochemistry (3rd Edition),* Worth Publishers, New York, USA.
5. STRYER, L. (1995). *Biochemistry*, W.H. Freeman and Co., New York, USA.
6. ZUBAY, G. (1993). *Biochemistry (3rd Edition)*, WCB Publishers, Iowa, USA.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER II

PAPER TITLE: FUNDAMENTAL GENETICS

PAPER CODE: BIO-II.C-3

NAME OF FACULTY: MS. LIESL DE SILVA

MARKS: 75 MARKS THEORY + 25 MARKS PRACTICAL

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVE: Genetics allows for the understanding of the structure and function of genes and chromosomes as well as the harmful effects of mutations which can cause various genetic disorders. Overall, this paper provides a platform for delving further into studies of Molecular Biology and Genetics.

LEARNING OUTCOME: On completion of this module, students will be able to demonstrate an understanding of inheritance patterns and the basic principles of genetics. They will learn about the different mutations, its effects on cells and the application of the same to research.

BIO-II.C-3: FUNDAMENTAL GENETICS

Theory (75 marks)

Sr.No	Topics	Sub Topics	No. of hours
1	Introduction to Genetics	-Scope and Importance of Genetics -Genetical Terminology	2
2	Mendelian Genetics	-Mendel's Experiments -Principle of Segregation -Monohybrid crosses (Dominance, Recessiveness, Codominance, incomplete dominance) -Principle of Independent Assortment -Multiple Alleles – ABO blood type and Rh factor alleles in humans -Genotypic interaction – Epistasis, Pleiotropy and extra-nuclear inheritance -Probability in Mendelian Inheritance	8
3	Chromosomes	-Chromosome number -Morphology -Chromosome material and Chemical Composition -Giant chromosomes	3
4	Cell Cycle, Division and Apoptosis	-Cell cycle - The G1, S and G2 phase -Mitosis and Meiosis -Apoptosis	5
5	Introduction to the Concepts of:	-Inbreeding -Outbreeding -Hybrid Vigour	2
6	Linkage and Crossing Over	-Concept of Linkage and Crossing over -Sutton-Boveri Chromosome theory of inheritance	4

		-Coupling and repulsion hypothesis -Types of Linkage (complete and incomplete) -Types of Crossing over -Mechanism of Meiotic crossing over & significance	
7	Sex Determination, Sex Linkage and Pedigree Analysis	-Sex determination (pattern and sex chromosomes) -Sex determination in human beings and flowering plants -Dosage compensation -Sex-linked inheritance – Haemophilia, Duchenne Muscular Dystrophy, Fragile X Syndrome, Colour blindness -Pedigree Analysis – Penetrance and Expressivity, Family tree, Dominant inheritance, Recessive inheritance	8
8	Structural and Numerical Chromosomal Mutations	-Types of structural changes (deletion, duplication, inversion, translocation, variation in chromosome morphology) -Types of numerical changes (Euploidy and Aneuploidy)	4
9	Human Genetics	-Gene action and related diseases (Alkaptonuria, Phenylketonuria, Sickle Cell Anaemia) -Autosomal and sex chromosomal anomalies involving numerical and structural aberrations. (Down’s, Cri-du-chat, Klinefelter’s and Turner’s syndromes)	4
10	Population Genetics	-Gene pool, Theory of Allele Frequencies (Gene and genotypic frequencies) -The Hardy-Weinberg principle and its application -Exceptions to the Hardy-Weinberg principle - Natural selection, Random genetic drift -Problems on Hardy-Weinberg principle -Speciation-Definition of species and mode of	5

		speciation (allopatric, sympatric)	
		Total	**45**

Practical (25 marks)

Fundamental Genetics	
Study of a Dissection Microscope	1
Study of Polytene Chromosomes	2
Study of cell division: Mitosis and Meiosis	2
Study of Barr bodies in Sex Determination	1
Pedigree analysis and problem solving	2
Problem solving on Mendel's Laws & Hardy-Weinberg's Law	2
Study of Mendelian traits in Human Population	2
Karyotype analysis of Chromosomal abnormalities	2
Introduction to the Concept of Genetic Counselling	1
Total	**15**

REFERENCES:

1. GARDNER, E. J., SIMMONS, M. J. & SNUSTAD, D. P. (2013). *Principles of Genetics, 8th Edition*, John Wiley and Sons.
2. HOTTER, P. (2007. *Dictionary of Genetics,* IVY Publishing House, Delhi
3. JAYARAMAN, K. & JAYARAMAN, R. (1979). *Laboratory manual in Molecular Genetics,* John Wiley and Sons.
4. KREBS, J.E., GOLDSTEIN, E.S. & KILPATRICK, S.T. (2014). *Lewin's Genes XI*, Jones and Bartlett India Pvt. Ltd.
5. TAMARIN, R.H. (2002). *Principles of Genetics, 7th Edition*, Tata McGraw-Hill Publishing Company Ltd.
6. VERMA, P.S. & AGARWAL, V.K. (2013). *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology,* S. Chand & Company Pvt. Ltd.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER II

PAPER TITLE: CELL AND MOLECULAR BIOLOGY

PAPER CODE: BIO-II.C-4

NAME OF FACULTY: MS. MADHAVI M. MOTANKAR

MARKS: 75 MARKS (THEORY) + 25 MARKS (PRACTICAL)

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVE: This paper aims at introducing the importance of the basic concepts of the cell biology and molecular interactions between cells and the flow of genetic information that results in production of protein molecules and its importance in the field of biotechnology.

LEARNING OUTCOME: On completion of this paper the students will be able to understand the structure and functions of various cell organelles and describe the basic biological concepts, its principles, critically evaluate biological data and design experiments to address an interesting and novel problem.

BIO-II.C-4: CELL AND MOLECULAR BIOLOGY

Theory (75 marks)

Sr.No	Topics	Sub Topics	No. of hours
1	Introduction to Cell Biology	- Definition and History of Cell Biology - Cell Theory	1
2	Ultrastructure of the Cell	- Prokaryotic - Eukaryotic	2
3	Cell Wall & Plasma Membrane	- Chemical Composition, structure and functions of the cell wall and plasma membrane - Fluid Mosaic Model	3
4	Ultrastructure and Function of Organelles	- Endoplasmic Reticulum - Golgi Apparatus - Lysosomes - Microbodies - Mitochondria - Chloroplast - Ribosomes - Cytoskeleton - Centrioles and Basal Bodies - Cilia and Flagella - Nucleus	12
5	Cellular Communication and Signal Transduction	- Intercellular junctions (Microvilli, Tight junctions, Desmosomes,Gap junctions and cell to cell surface adhesion) - Role of Membrane Receptors (Ca^{2+} ions, G proteins)	2
6	DNA Replication and Regulation in Prokaryotic and Eukaryotic systems	- Watson & Crick's model of DNA - Experimental evidences for Semi-conservative replication of DNA in E.coli. - Mechanism of DNA replication in Prokaryotes	6

		Initiation, Elongation and Termination of replication. Replication of circular DNA (rolling circle model) - Mechanism of DNA replication in Eukaryotes - Regulation of DNA Replication	
7	Transcription in Prokaryotic and Eukaryotic Systems	- Mechanism of Transcription in prokaryotes. Initiation, Elongation and Termination. - Mechanism of Transcription in eukaryotes. Initiation, Elongation and Termination. - Post-transcriptional modifications. mRNA Capping, Splicing & Poly A-tail	4
8	Translation in Prokaryotic and Eukaryotic Systems	- Introduction to translation – protein synthesis and genetic code - Mechanism of Protein synthesis in Prokaryotes Activation of amino acids, Initiation, Elongation and Chain Termination - Mechanism of protein synthesis in Eukaryotes Activation of amino acids, Initiation, Elongation and Termination - Post-translational modifications. Phosphorylation, Acylation, Glycosylation & Disulphide linkage.	5
9	Regulation of Gene Expression	- Lactose operon : Structure, role of Lac repressor and inducer. - Tryptophan operon	3
10	DNA Mutation and Repair Systems	- Mechanism of DNA Damage - Molecular basis of Mutations - agents causing damage. - Types of mutations Nonsense, Missense, Silent, Frameshift, Reversion, Spontaneous - Mechanism of DNA Repair Photoreactivation, Excision Repair, Recombinational repair, SOS Repair	4
11	Mechanism of Gene transfer	- Conjugation, - Transformation	3

		- Transduction	
		Total	**45**

Practical (25 marks)

Cell and Molecular Biology	
Cell structure-prokaryotes & eukaryotes (Yeast, animal, Plant)	1
Cell Enumeration using Haemocytometer	1
Cell harvesting & lysis using osmotic (salt) and Chemical (detergent) methods	2
Sub cellular fractionation of Mitochondria and Chloroplast	2
Isolation of genomic DNA from plant cell.	2
Isolation of genomic DNA from animal cell.	2
Isolation of genomic DNA from bacterial cell.	2
Agarose gel electrophoresis.	1
Determination of molecular size of DNA by Agarose Gel Electrophoresis.	1
Mutagenesis in E.coli cells – UV survival or Chemical mutagens	1
TOTAL	**15**

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1. KREBS, J.E., GOLDSTEIN, E.S. & KILPATRICK, S.T. (2014). *Lewin's Genes XI*, Jones and Bartlett India Pvt. Ltd.
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4. ROBERTIS, E.D.P. & ROBERTIS, E.M.F. (1998). *Cell Biology and Molecular Biology, 8th edition*, Sauder College.
5. WATSON, J.D., HOPKINS, N.H. *et al*. (2008). *Molecular Biology of the Gene*, Garland Publishing (Taylor & Francis Group), New York & London.
6. MONROE, S.W. (1985). *Genetics. 3rd Edition*, University of Missouri, St. Louis.

7. TURNER, P.C.,.MCLENNAN, A.G, BATES, A.D. & WHITE, M.R.H. (1998). *Instant notes in Molecular Biology*, *1st Indian Edition*, Bios Scientific Publication.
8. RASTOGI, S.C. (2003). *Cell and Molecular Biology, 2nd Edition*, New Age International Ltd.
9. VERMA, P.S. & AGARWAL, V.K. (2013). *Cell Biology, Genetics, Molecular Biology*, *Evolution and Ecology,* S. Chand & Company Pvt. Ltd.
10. VERMA, A.S., DAS, S. & SINGH, A. (2014). *Laboratory Manual for Biotechnology, 1st Edition,* S. Chand & Company Pvt. Ltd.

Annexure I

List of Core and Elective Courses for the undergraduate programme in Biotechnology

Core Papers for Major in Biotechnology (CC)

Sr. No.	Semester	Title of the Paper	Code
1	I	Basic Microbiology	BIO-I.C-1
2	I	Fundamentals of Biochemistry	BIO-I.C-2
3	II	Fundamental Genetics	BIO-II.C-3
4	II	Cell and Molecular Biology	BIO-II.C-4
5	III	Immunology	BIO-III.C-5
6	IV	Concepts in Genetic Engineering	BIO-IV.C-6
7	V	Industrial Biotechnology - Basic	BIO-V.C-7
8	VI	Bioethics and Biosafety	BIO-VI.C-8

Elective Papers for Major in Biotechnology (CE)

Sr. No.	Semester	Title of the Paper	Code
1	III	Basics of Plant and Animal Sciences	BIO-III.E-1
2	III	Molecular Genetics	BIO-III.E-2
3	III	Biostatistics	BIO-III.E-3
4	III	Evolution and Anthropology	BIO-III.E-4
5	IV	Plant and Animal Physiology	BIO-IV.E-5
6	IV	Applied Biophysics	BIO-IV.E-6
7	IV	Ecology and Biodiversity	BIO-IV.E-7
8	IV	Advanced Biochemistry	BIO-IV.E-8

Sr. No.	Semester	Title of the Paper	Code
9	V	Molecular Medicine	BIO-V.E-9
10	V	Environmental Biotechnology	BIO-V.E-10
11	V	Introduction to Drug Development	BIO-V.E-11
12	V	Bioinformatics	BIO-V.E-12
13	VI	Advanced Microbiology	BIO-VI.E-13
14	VI	Industrial Biotechnology – Advanced	BIO-VI.E-14
15	VI	Plant Biotechnology	BIO-VI.E-15
16	VI	Animal Cell Culture	BIO-VI.E-16

Annexure II

Parvatibai Chowgule College of Arts and Science (Autonomous)

Margao, Goa

Syllabus for

Semester III and Semester IV

for the undergraduate course

in

Biotechnology

(2016-2017)

Core and Elective Courses for students of Single Major in Biotechnology

Semester III:

1. Immunology
2. Basics of Plant and Animal Sciences
3. Molecular Genetics
4. Biostatistics
5. Evolution and Anthropology

Semester IV:

1. Concepts in Genetic Engineering
2. Plant and Animal Physiology
3. Applied Biophysics
4. Ecology and Biodiversity
5. Advanced Biochemistry

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER III

PAPER TITLE: IMMUNOLOGY

PAPER CODE: BIO-III.C-5

NAME OF FACULTY: MS. LEE-ANNE D'COSTA, MS. MADHAVI M. MOTANKAR & MS. LIESL DE SILVA

MARKS: 75 MARKS THEORY + 25 MARKS PRACTICAL

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVES:

This paper aims at introducing the basic concepts of the immune system and its defense mechanisms. This will help them understand and reason out concepts related to diseases. A section on vaccination, monoclonal and polyclonal antibodies stresses on the importance of these for treatment of lethal diseases.

LEARNING OUTCOME:

On completion of this module, the student will be able to understand all about the immune system and various antigen-antibody interactions involved in certain immune reactions.

BIO-III.C-5: IMMUNOLOGY
Theory (75 marks)

Sr. No	**Topic**	**Sub –Topics**	**No. of hours**
1	Immune system and Autoimmunity	- Introduction to the immune system - Historical perspective - Types of Immunity (Innate and Acquired) - Barriers of Innate Immunity – anatomic, physiologic, phagocytic, inflammatory - Collaboration between innate and adaptive immunity - Introduction to Humoral and Cell mediated immunity - Autoimmunity - Introduction to Autoimmunity (any one example) - B-cells & T-cells - Maturation, Activation of B-cells and T-cells	9
2	Cells and Organs of the Immune system	- Cells (myeloid and lymphoid lineage) - Immunoreactive Cells (Macrophages, Granulocytes, NK Cells) - Primary lymphoid organs (bone marrow and thymus) - Secondary lymphoid organs (spleen, lymph nodes, GALT and MALT)	7
3	Antigens-Antibodies and their interactions	- Introduction to Antigens and Antibodies - Structure, types, classes, properties and variants (e.g. Immunogens, Antigens, Haptens, adjuvants) - Paratope and Epitope - Antigen – Antibody Interaction - Forces involved in antigen-antibody reaction - Concept of affinity, avidity, precipitation, agglutination reactions - Applications in diagnostics	6
4	MHC and Hypersensitivity	- Major Histocompatibility Complex (MHC) - Introduction and discovery of Human Histocompatibility complex - Structure of MHC I and II	5

		- Presence of MHC I and II on different cells and their significance - Hypersensitivity - Introduction - Hypersensitive reactions (Type I and Type II, III, IV)	
5	Complement system	- The complement system - Functions, components and activation pathways (Classical, Alternate & Lectin)	4
6	Immune response, Monoclonal antibodies	- Immune response to bacterial infection - Immune response to viral infection - Polyclonal & Monoclonal antibodies (Hybridoma technology) - Vaccination - Introduction to vaccines and types of vaccines	8
7	Introduction to Cancer	- Cancer and the Immune System - Introduction to Oncogenes and Tumour-Supressor genes	3
8	Immunodeficiency	- Immunodeficiency types with examples	3
		TOTAL	**45**

Practical (25 marks)

IMMUNOLOGY	
Study of lymphoid organs and cells of the Immune System	2
Total count of WBC & RBCs using haemocytometer	2
Differential count of WBC	1
Blood grouping & Rh factor	1
Preparation of serum	1
Single Radial Immunodiffusion	1
Ouchterolony's double diffusion method	2
Immunoelectrophoresis	1
ELISA (Demonstration) / ESR	1
Serological tests involving precipitations (Pregnancy & Widal)	2
Estimation of Haemoglobin by Sahali's method	1
TOTAL	**15**

REFERENCES:

1. ARORA, M.P. (2006). *Cell Biology, Immunology and Environmental Biology,* Himalaya Publishing House.
2. KUBY, J. (2000). *Immunology,* W.H. Freeman.
3. RAO, C.V. (2011). *Immunology,* Narosa Book Distributors Pvt. Ltd.
4. ROITT, I.M., BROSTOFF, J. & MALE, D.K. (1993). *Immunology,* Mosby-Year book Europe Limited.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER III

PAPER TITLE: BASICS OF PLANT AND ANIMAL SCIENCES

PAPER CODE: BIO-III.E-1

NAME OF FACULTY: MS. LIESL DE SILVA

MARKS: 75 MARKS THEORY + 25 MARKS PRACTICAL

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVE: This paper will provide students with an insight into the Plant and Animal Kingdoms and their classification into different phyla. They will understand the variety of habitats that support the growth and reproduction of different plants and animals and will also look into the general characteristics and adaptations exhibited by these organisms.

LEARNING OUTCOME: On completion of this module, students will be able to distinguish between various phyla of the plant and animal kingdom and will also delve into the characteristics of these phyla. They will understand the differences in morphology and anatomy in Angiosperms and specific features present in non-chordates and chordates.

BIO-III.E-1: BASICS OF PLANT AND ANIMAL SCIENCES

Theory (75 marks)

Sr. No	**Topic**	**Sub –Topics**	**No. of hours**
1	Introduction	- Introduction to the Plant and Animal Kingdom - Introduction to Classification Systems	2
2	Plant Kingdom	Study of the General Characteristics of: - Algae (uni and multicellular) - Fungi - Lichens - Bryophytes - Pteridophytes - Gymnosperms	8
3	Morphology and Anatomy in Angiosperms	- Vegetative Morphology • Roots, stem and leaf - Reproductive Morphology • Flower, Inflorescence, Fruits - Comparative Anatomy of roots, stem and leaves in monocots and dicots - Secondary growth in Angiosperms	10
4	Economic importance	Economic importance of the each phylum of the Plant Kingdom	2
5	Animal Kingdom – Non chordates	Study of Habitat and General characteristics of: - Protozoa - Porifera - Cnidaria - Platyhelminthes - Aschelminthes - Annelida - Arthropoda - Mollusca - Echinodermata	7

6	Animal Kingdom – Chordates	Study of Habitat and General characteristics of: - Superclass Pisces - Class Amphibia - Class Reptilia - Class Aves - Class Mammalia	4
7	Salient features of non-chordates	Study of salient features of non-chordates: - Disease-causing Protozoa, Platyhelminthes and nematodes (Aschelminthes) - Circulation in Porifera and Echinodermata - Excretion in Aschelminthes and Annelida - Metamorphosis in insects and economic importance (Arthropoda) - Corals and coral reefs (Cnidaria)	8
8	Salient features of Chordates	Study of salient features of chordates: - Economic importance of fishes - Parental care in amphibians - Venomous and non venomous reptiles - Migration in birds - Dentition in mammals	4
		TOTAL	**45**

Practical (25 marks)

BASICS OF PLANT AND ANIMAL SCIENCES	
Study of algal types through temporary mounting and staining *Chlorella* and *Anabaena*	1
Microscopy study of thallus structures in *Riccia* and *Cycas*	1
Preparation of mycorrhizal slides by trypan blue method	1
T.S of monocot and dicot root	1
T.S of monocot and dicot stem	1
T.S of monocot and dicot leaf	1
Observation of permanent slides: Anther, ovules, embryo sac, embryo	1

Study of specimens with reference to Habit, Habitat, Characteristic Features: Two examples from each Invertebrate major phyla.	3
Study of specimens with reference to Habit, Habitat, Characteristic Features: Two examples from each class of phylum Chordata.	2
Identification of local edible fishes	1
Identification of fresh water mollusks	1
Preparation of checklist of butterflies and birds of college campus	1
TOTAL	**15**

REFERENCES:

1. BARNES, R.D. (2000). *Invertebrate Zoology,* Hall Saunders International Editions.
2. JORDAN, E.L. & VERMA, P.S. (2000). *Invertebrate Zoology*, S. Chand & Co. Pvt. Ltd. New Delhi.
3. JORDAN, E.L. & VERMA, P.S. (2006). *Chordate Zoology, New Edition,* S. Chand & Co. Pvt. Ltd. New Delhi.
4. PANDEY, S.N. & CHADHA, A. (1993). *A Textbook of Botany, Plant Anatomy and Economic Botany, Volume III,* Vikas Publishing House Pvt. Ltd.
5. VERMA, V. (2010). *Botany,* Ane Books, Pvt. Ltd.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER III

PAPER TITLE: MOLECULAR GENETICS

PAPER CODE: BIO-III.E-2

NAME OF FACULTY: MS. LIESL DE SILVA

MARKS: 75 MARKS THEORY + 25 MARKS PRACTICAL

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

PREREQUISITES: Completion of BIO-II.C-3 and BIO-II.C-4

COURSE OBJECTIVE: Having completed the two prerequisite courses - Fundamental Genetics and Cell and Molecular Biology, students will be able to apply their knowledge and skills to this paper. It focuses on various aspects of human genetics and explores the techniques and tools at the molecular level that can be used to identify them.

LEARNING OUTCOME: On completion of this course, students will understand the molecular aspects of genetics including DNA variation and mutations. They will also be able to apply their knowledge of various molecular techniques in order to diagnose specific genetic disorders and to calculate risk factors in genetic counseling for individuals with a family history of these disorders.

BIO-III.E-2: MOLECULAR GENETICS

Theory (75 marks)

Sr. No	**Topic**	**Sub –Topics**	**No. of hours**
1	Introduction	- Introduction to Molecular Genetics – organization of a eukaryotic genome (human genome)	2
2	Chromosomes and Cell Division	- Classification and nomenclature of chromosomes - Methods of chromosome analysis (chromosome banding techniques – G, R, Q, C and High resolution banding) - Brief account of cell cycle, mitosis and meiosis - Mechanisms of Aneuploidy – non-disjunction, non-conjugation, anaphase lag, premature division of centromere - Syndromes caused by aneuploidy – prevalence, causes and clinical features of Down's syndrome, Edward's syndrome and Patau syndrome - Causes of Polyploidy - Structural abnormalities – reciprocal and Robertsonian translocations - Brief account of mosaicism and Chimerism	9
3	Review of central dogma of molecular biology	- Brief review of structure of DNA and replication, transcription and translation processes	1
4	DNA Variation	Variation in DNA: - Genetic Polymorphism - Restriction Fragment Length Polymorphism (RFLP) - Short Tandem Repeat Polymorphism (STR) - Variable Number Tandem Repeat (VNTR)	3
5	Techniques and Tools in Molecular Biology	Techniques and Tools in Molecular Biology used in Genetic Diagnoses: - Genetic Material studied for diagnoses– DNA, RNA and cDNA - DNA fragmentation and separation by electrophoresis and	8

		membrane transfer - Selective amplification of a nucleotide sequence using PCR - Molecular hybridization techniques and applications: • Labeled probes • Fluorescence in situ hybridization (FISH) • Southern blot hybridization • Dot blot and reverse dot blot • ARMS and OLA techniques • DNA microarrays	
6	The Diagnosis of Inherited Diseases	Clinical description, molecular basis and genotype-phenotype correlation of: - Cystic fibrosis - α-thalassemia and β-thalassemia - Duchenne Muscular dystrophy - Huntington's disease	6
7	Genetic Counselling	- Screening (pre and post natal) for genetic abnormalities - Establishing the diagnosis (family history and pedigree chart) - Calculation, presentation and quantification of risk (Bayesian Determination of Recurrent risks for genetic disorders within families) - Placing risks in context and discussion of options - Patient support groups - Directive and non-directive genetic counseling - Special problems in genetic counselling	7
8	Gene Therapy	An Overview of Gene Therapy and its applications in treating genetic disorders e.g. SCID	3
9	Forensic Genetics	- Brief History - Biological evidence – sources, collection, identification, characterization - DNA fingerprinting using PCR-based and non-PCR-based techniques	6
		TOTAL	**45**

Practical (25 marks)

MOLECULAR GENETICS	
Extraction of DNA from human blood and saliva	2
Visualization of extracted DNA on agarose gels	1
Preparation of a Southern blot	1
Study of diagnostic tools based on DNA polymorphisms	1
Preparation of human metaphase chromosomes	1
Steps in molecular diagnosis of and further genetic counseling for: 1) Cystic fibrosis 2) α-thalassemia and β-thalassemia 3) Duchenne Muscular dystrophy 4) Huntington's disease	4
Risk calculation: using Bayes method for any two clinical case studies	2
Clinical features of Down's syndrome, Edward's syndrome and Patau syndrome and mechanisms leading to aneuploidy	2
Research: Current status of gene therapy for any two genetic disorders	1
TOTAL	**15**

REFERENCES:

6. GOODWIN, W., LINACRE, A. & HADI, S. (2007). *An Introduction to Forensic Genetics,* John Wiley & Sons, Ltd.
7. PASTERNAK, J.J. (2005). *An Introduction to Human Molecular Genetics, Mechanisms of Inherited Diseases, Second Edition,* John Wiley % Sons, Inc.
8. SERRE, J.L. (2006). *Diagnostic Techniques in Genetics,* John Wiley & Sons, Ltd.
9. TURNPENNY, P.D. & ELLARD, S. (2007). *Emery's Elements of Medical Genetics, 13th Edition,* Churchill Livingstone Elsevier.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER III

PAPER TITLE: BIOSTATISTICS

PAPER CODE: BIO-III.E-3

NAME OF FACULTY: MS. LEE-ANNE D'COSTA

MARKS: 75 MARKS THEORY + 25 MARKS PRACTICAL

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVES: The main aim of this paper is to introduce the students to the concept of Biostatistics. This paper covers a range of topics which will introduce the theory behind each topic and the concept in each case through problem solving.

LEARNING OUTCOME:

On completion of this module, students will be able to understand the importance of Biostatistics and the application of the same to the field of Biotechnology. They paper is so designed so as to understand the concepts that can be applied to relevant research work and to evaluate different parameters that are studied in quantitative research.

BIO-III.E-3: BIOSTATISTICS

Theory (75 marks)

Sr.No	Topics	Sub Topics	No. of hours
1	Review of statistical principles applied to biological data	- Recap of mean, median, mode, standard deviation & variance (formulae and steps in the calculation) - Concept of Pythagorean means and its calculation (Arithmetic, Harmonic & Geometric mean & the relationship between them) - Concept and importance of correlation & regression (recap of formulae and steps in the calculation) - Null and alternate hypothesis with examples - Understanding decision errors, decision rules - One tailed and two tailed tests - Concept of parametric and non-parametric tests. - Z test, T test, F test - Introduction to Chi-square test - Importance of Chi-square test - Procedure for calculation of chi square and problem solving with examples	12
2	Scope & importance of Biostatistics	- Definition of statistics and biostatistics - Understanding importance of biostatistics - Applications of Biostatistics	2

		- Types of Biological Data	
3	Software used in Biostatistics computation	- Introduction to statistical software - Introduction, Importance and applications of statistical software – MS Excel, SPSS, PSPP - Examples and uses of the free statistical software - Introduction to open source software in Biostatics	6
4	Graphical & Diagrammatic representation of data	- Importance of graphical and diagrammatic representation of data and its uses. - Construction of graphs using MS Excel.	3
5	Introduction to Sampling Design	- Concepts of: statistical population, sample. - Advantages and disadvantages of sampling - Types of Sampling Designs – simple random sampling, stratified random sampling, systematic sampling, cluster sampling	3
6	Introduction to multivariate analysis	- Introduction to multivariate data, matrices - Concept of correlation matrix, multiple and partial correlations, multiple regression - Introduction to principle component analysis (PCA), Cluster analysis	7
7	Design of experiments	- Introduction to ANOVA - One way ANOVA – examples and problem solving - Introduction to two way ANOVA (only importance & difference from one way	7

		ANOVA) - Introduction to designs – completely randomized design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD)	
8	Case studies	- Application of statistical analysis in Biotechnology	5
		TOTAL	**45**

Practical (25 marks)

BIOSTATISTICS	
Problem solving on arithmetic mean, median, mode (measures of central tendency) with reference to biological data.	2
Problem solving on measures of central tendency with reference to biological data using MS Excel and PSPP.	3
Problem solving on measures of dispersion with reference to biological data.	2
Graphical presentation of data – Construction of various types of graphs and charts based on the given data (Manually and using MS Excel)	2
Problem solving on ANOVA and Chi square test	3
Application of biostatistics to Biotechnology (case studies)	3
TOTAL	**15**

REFERENCES:

1. BANERJEE, P.K. (2011). *Introduction to Biostatistics, A textbook of biometry*, New Delhi, India: S. Chand & Company Ltd.
2. JOHNSON, R.A. & WICHERN, D.W. (2007). *Applied Multivariate Statistical Analysis, 6th Edition,* Pearson Education, Inc.
3. KHAN & KHANUM (2004). *Fundamentals of Biostatistics*, Delhi: Ukaaz publications.
4. KOTHARI, C.R. (1995). *Research Methodology, Methods and Techniques,* V.S. Johri for Vishwa Prakashan.
5. MONTGOMERY, D.C. (2007). *Design and Analysis of Experiments, 5th Edition*, John Wiley & Sons.
6. RAJAN, K. (2007). *Biostatistics Theory and Problems,* New Delhi: India, Himalaya Publishing House.
7. RASTOGI, V.B. (2011). *Fundamentals of Statistics*, Ane Books Pvt. Ltd.
8. ROSS, S. M. (2010). *Introductory Statistics. Third edition,* Academic press.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER III

PAPER TITLE: EVOLUTION AND ANTHROPOLOGY

PAPER CODE: BIO-III.E-4

NAME OF FACULTY: MS. MADHAVI M. MOTANKAR

MARKS: 75 MARKS (THEORY) + 25 MARKS (PRACTICAL)

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVE: This paper aims at introducing the importance of the basic concepts of Evolution and anthropology and its importance in the field of biotechnology which will increase the awareness of the principles of human evolution and the biological adaptations that humans have made through time to various biotic and abiotic factors. .

LEARNING OUTCOME: On completion of this paper the students will be able to understand the evolutionary history, describe the historical development of anthropology and be able to characterize how each subfield contributes to the unified discipline, compare past and present cultures, including ecological adaptations with a scientific approach. The students would be able to explain quantitative and qualitative methods in the analysis of anthropological data and critically evaluate the logic of anthropological research and apply anthropological research to contemporary environmental, social, or health issues worldwide.

BIO-III.E-4: EVOLUTION AND ANTHROPOLOGY

Theory (75 marks)

Sr.No.	Topics	Sub Topics	No. of hours
1	Evolution of Life	- Organic evolution, Evidences, Mechanism & theories. - Chemical evolution Biological evolution - Types of Organic evolution	5
2	Evolution of Species	- Lamarkism - Darwinism - Modern synthetic theory - Mutational theory - Introduction to Molecular clock	5
3	Evolution above species level	- Adaptive radiations with examples macroevolutions - Microevolution - Simpson's adaptive grid - Macroevolution	5
4	Speciation	- Nature of Speciation - Modes of speciation (instantaneous and gradual) - Types of barriers and isolation	4
5	Selection	- Types – selection, natural selection (directional, disruptive, stabilizing) and artificial,	4
6	Geographical and Geological Time Scale	- An overview of the geographical and geological time scale	3
7	Fossils	- Formation, conditions, nature and types of fossils - Determination of age of rocks and fossils (carbon dating) - Evidences of evolution from fossils	6

8	Introduction to Anthropology	- Definition, areas and applications - Relationship of biological anthropology with other sciences	2
9	Evolution of Man	Phylogenetic status, characteristics and geographical distribution of the following: - Homo erectus - Neanderthal Man - Rhodesian man - Homo sapiens	6
10	The Role of Biotechnology in Anthropology	- Phylogenetic trees - Mitochondrial DNA - Y chromosome analysis	5
		TOTAL	**45**

Practical (25 marks)

EVOLUTION AND ANTHROPOLOGY	
Study of the various theories of evolution.	1
Evidences for Evolution - Study of Darwin's theory of evolution with examples	1
Evidences for Evolution - Study of L.S.B. Leakey's work in establishing human evolutionary development in Africa	1
Problems based on Selection	3
Study of genetic evolution across species	2
Construction of phylogenetic trees	1
Study of types of fossils	2
Study of dentition of different types of mammals – (Herbivores, Carnivores and Omnivores)	1
Visit to museum in Old Goa for anthropological studies	1
Comparative studies of prehominids and hominids	1
Comparative studies of haemoglobins	1
TOTAL	**15**

REFERENCES:

1. BHASIN M.K. & CHAHAL, S.M.S.(1996), *Manual of Human Blood Analysis*, Kamla Raj, Delhi.

2. HAVILAND. (2008). *Introduction to Anthropology*, Paperback.

3. ROUTLEGE & PAUL, K. (1971), *Notes and Queries in Anthropology*, London.

4. SRIVASTAVA, V.K. (2004), *Methodology and Fieldwork*, Oxford.

5. STANFORD, C., ALLEN, J.S. & ANTON, S.C. (2009), *Exploring Biological Anthropology: The Essentials*, Prentice Hall.

6. VERMA, P.S. AND AGARWAL, V.K. (2013). *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology,* S. Chand & Company Private limited, New Delhi.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER IV

PAPER TITLE: CONCEPTS IN GENETIC ENGINEERING

PAPER CODE: BIO-IV.C-6

NAME OF FACULTY: MS. LEE-ANNE D'COSTA

MARKS: 75 MARKS THEORY + 25 MARKS PRACTICAL

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVES: The paper aims to introduce the students to the principles and techniques involved in Genetic Engineering. This paper will define the meaning of Genetic engineering and the methods used in Genetic engineering of genes through the use of genetic material and vehicles for suitable manipulation of genes.

LEARNING OUTCOME:

On completion of this module, students will be able to understand how genes are genetically engineered and the need for the same. They will also be able to critically analyze different concepts studied in this paper. The practical component will train them towards performing with understanding genetic manipulations of genes.

BIO-IV.C-6: CONCEPTS IN GENETIC ENGINEERING

Theory (75 marks)

Sr.No	Topics	Sub Topics	No. of hours
1	Introduction to genetic engineering	- Aims, principles, applications, ethical issues involving recombinant DNA technology and Genetic engineering	2
2	DNA modifying enzymes	- Nucleases- Endonucleases (Restriction enzymes recognition sequences, cleavage pattern), Exonucleases - DNA ligases - Reverse Transcriptases - Polynucleotide kinases - Alkaline phosphatases - Nucleotidyl transferases	3
3	Vehicles for Gene cloning	- Vectors - properties of ideal cloning vectors - Plasmids - Properties, Classification - Vector for Prokaryotes - pBR322, pUC 18 - Bacteriophages as cloning vectors - Lambda Bacteriophages Features- Insertional vectors and Replacement vectors & M13 Bacteriophage - Cosmids, Phagemids and Phasmids-	10

		Definition, features with examples - List of vectors for cloning in *Saccharomyces cerevesiae*. (Examples and features) - Shuttle vectors - any one example - Vectors for plant – Ti plasmid	
4	DNA Insertion into Vector	- Ligation (Definition and concept) - Use of linkers and Adaptors - Homopolymer tailing	3
5	Transformation methods	- Methods, Advantages and Disadvantages: Competence (transformation in bacteria), Microinjection, Lipofection, Electroporation, Macroinjection, Sonication, Silicon carbide fibre vortex, DNA co-precipitation, Ultrasonication, Laser induced, *Agrobacterium* mediated transfers	8
6	Identification of Recombinants	- Principle and importance of identification of recombinants. - Antibiotic resistance (amp, tet resistance) - lac Z selection - Colony hybridization - *cI* selection	4
7	DNA isolation methods and analysis	- Isolation of Genomic DNA & plasmid DNA	5

		- Principle of Plasmid Isolation. - Spectrophotometric analysis of DNA - Agarose gel electrophoresis. - Purification of DNA	
8	Amplification of nucleotide sequences	- Polymerase chain reaction (Principles, components & method of PCR)	3
9	DNA sequencing	- Significance and importance of DNA sequencing - Maxam Gilbert's method - Sanger's method - Automatic DNA sequencer	5
10	Genomic / cDNA libraries	- Preparation of genomic library, cDNA library. - Screening of Libraries.	2
		TOTAL	**45**

Practical (25 marks)

CONCEPTS IN GENETIC ENGINEERING	
Plasmid DNA isolation by alkaline lysis method.	1
Plasmid DNA isolation by boiling method.	1
Restriction digestion of plasmid DNA and confirmation by gel electrophoresis	2
Ligation of restricted fragments and conformation by gel electrophoresis	2

Plasmid DNA separation on agarose gel.	1
Molecular size determination of restricted products	1
Preparation of competent cells in bacteria.	2
Transformation in bacteria using suitable plasmid (pUC 18)	1
Selection of transformed colonies	1
Elution of DNA from agarose electrophoresis.	1
Deciphering the DNA sequence from a sequencing gel photograph by Maxam and Gilbert's method and Sanger's method.	1
Concept of PCR – principle, preparation of reaction mixtures & analysis of the PCR method (Demonstration)	1
TOTAL	**15**

REFERENCES:

1. JOGDAND, S.N. (2008). *Gene Biotechnology, 2nd edition*, Himalaya Publishing House, Mumbai.
2. PRIMROSE, S.B. & TWYMAN, R.M. (2009). *Principles of Gene Manipulation and Genomics,* Blackwell Publishing.
3. PUROHIT, S.S. (2009). *Biotechnology: Fundamentals and Applications*, Student Edition.
4. SINGH, B.D. (2008). *Biotechnology: Expanding Horizons*, Kalyani publishers.
5. WATSON, J.D., TOOZE, J. & KURTZ, D.T. (1983). *Recombinant DNA: A short Course,* Scientific American Books (WH Freeman), New York.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER IV

PAPER TITLE: PLANT AND ANIMAL PHYSIOLOGY

PAPER CODE: BIO-IV.E-5

NAME OF FACULTY: MS. LEE-ANNE D'COSTA

MARKS: 75 MARKS THEORY + 25 MARKS PRACTICAL

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVES: The main aim of this paper is to introduce the students to the physiology of plant and animal systems with special emphasis on humans, thereby allowing them to understand how plant and animal systems function.

LEARNING OUTCOME:

On completion of this module, students will be able to understand plant and animal physiology. The organs and processes involved in each case. They will also be able to comprehend and distinguish organs and organs systems while understanding the biological functions associated with every system.

BIO-IV.E-5: PLANT AND ANIMAL PHYSIOLOGY

Theory (75 marks)

Sr.No	Topics	Sub Topics	No. of hours
		Plant physiology	
1	Plant – Water Relations	- Absorption (passive and active) - Ascent of sap and transpiration	2
2	Photosynthesis & photorespiration	- Chloroplast pigments, photosystem I and II - Electron flow through cyclic and non cyclic photophosphorylation - CO_2 fixation in C3 and C4 plants - CAM and glycolate pathways	8
3	Physiology of flowering in angiosperms	- Photoperiodism, vernalization and dormancy - Molecular models of flowering: ABC model	3
4	Plant hormones and regulation of plant growth	- Hormonal (Auxin,cytokinin, Gibberllins, Ethylene and Abscissic acid) - Regulation of plant growth and development	4
5	Secondary metabolites in plant	- Classification of secondary metabolites and sources of: - Phenolics - Porphyrins - Terpenoids - Alkaloids	4

Animal physiology			
6	Digestion	- The digestive system and associated glands in mammals.	3
7	Muscular System	- Introduction to the muscular system - Types of Muscles - Muscle movement	2
8	Respiration and Circulation	- The respiratory system – organs and their function - The circulatory system – components and their function	5
9	Excretory system	- The excretory system and associated functions.	3
10	Nervous system	- The nervous system and associated functions.	5
11	Gametogenesis and reproductive physiology	- Spermatogenesis and oogenesis - Mammalian reproductive physiology – male and female reproductive system - An overview of developmental biology and regulatory mechanisms	6
		TOTAL	**45**

Practical (25 marks)

PLANT AND ANIMAL PHYSIOLOGY	
Study of physiology of plants using charts.	1
Study of rate of photorespiration in plants	1

Study of osmosis: endosmosis and exosmosis in plants	1
Action of plant growth hormones (IAA, GA, kinetin) on germinating seeds	2
Isolation of *Rhizobium* from root nodules and Gram's staining.	1
Estimation of chlorophyll from plant source	1
Qualitative phytochemical analysis in medicinal plants	1
Analysis of the animal physiology systems in man using charts – the reproductive, digestive, respiratory, circulatory, excretory, nervous and muscular systems.	2
Observation of permanent slides – Transverse section of mammalian gonads; Developmental stages (cleavage, blastula, gastrula) in Frog; Developmental stages (18 hrs., 24 hrs., 36 hrs., 48 hrs., 72 hrs., 96 hrs.) in Chick embryo Study of extra embryonic membranes in chicks	1
Analysis of components of blood – WBC's and RBC's & establishing Total count of each.	2
Analysis of human blood pressure and pulse rate in man	1
Osmolarity of RBC's (Effect of different salt solutions of RBC's)	1
TOTAL	**15**

REFERENCES:

Plant physiology:

6. GALSTON, A.W. (1989). *Life Processes in Plants,* Scientific American Library, Springer-Verlag., New York, USA.
7. HOPKINS, W.G. (1995). *Introduction to Plant Physiology*, John Wiley & Sons, Inc., New York, USA.

8. MOORE, T.C. (1989). *Biochemistry and Physiology of Plant Hormones (Second edition),* Springer-Verlag., New York.
9. PANDEY, S.N., MISHRA, S.P. & TRIVEDI, P.S. (1982)*, College Botany*, Tata McGraw-Hill, New Delhi.

Animal Physiology:

10. ARORA, M.P. (2011). *Animal physiology*, Himalaya publishing house.
11. SEMBULINGAM, K. & SEMBULINGAM, P. (2012). *Essentials of Medical Physiology, Sixth edition*., Jaypee brothers medical publishers (P) Ltd, New Delhi
12. VERMA, S.K., TYAGI, A.K. & AGARWAL, B.B.L. (2000). *Animal Physiology,* S. Chand and Company

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER IV

PAPER TITLE: APPLIED BIOPHYSICS

PAPER CODE: BIO-IV.E-6

NAME OF FACULTY: MS. MADHAVI M. MOTANKAR

MARKS: 75 MARKS (THEORY) + 25 MARKS (PRACTICAL)

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVE: This paper aims at introducing the importance of the basic concepts of biophysics and their applications and its importance in the field of biotechnology.

LEARNING OUTCOME: On completion of this paper the students will be able to understand the scope of applied biophysics, as they would be studying about the various molecular interactions between biological systems, principles and applications of separation & spectroscopic techniques along with the uses of radioactivity and various physical methods of imaging of the biological structures which have wide applications in biomedical research which could address an interesting and novel problem.

BIO-IV.E-6: APPLIED BIOPHYSICS

Theory (75 marks)

Sr.No.	Topics	Sub Topics	No. of hours
1	Thermodynamics	- Concept of Thermodynamics for Biological systems: free energy, entropy, enthalpy	3
2	Understanding Biomolecules	- Structure and Measurement of different structural attributes of biomolecules - Biomolecular Interactions	3
3	Spectroscopic techniques – Principle & Applications	- Absorption spectroscopy (Beer-Lambert's law), circular dichroism spectroscopy, colorimetry, light scattering - Ultraviolet-Visible Spectroscopy - Fluorescence spectroscopy, Steady-state and life time - Infrared Spectroscopy, FTIR - Raman spectroscopy - Atomic Absorption Spectroscopy	9
4	Physical methods in Structure Determination – Principle & applications	- - X-ray Crystallography - Crystallographic Elucidation of Molecules - Nuclear Magnetic Resonance (NMR)	5
5	Separation techniques-Principle & Applications	- Sedimentation – types of centrifugation: g and rpm, ultracentrifugation - Diffusion : Dialysis, Immunodiffusion & its importance - Separation of proteins: native and SDS PAGE - Principles of Chromatography - -Types of chromatography - ion-exchange, GC and HPLC, affinity, gel filtration	10
6	Radio Isotopes techniques	- Radiation – Sources, Types and applications of isotopes - Radioactive decay – alpha, beta, gamma & x-rays. - Rate of radioactive decay& radioactive units	5

		- Geiger Muller Counter & Scintillation counter	
7	Physical methods in Imaging Biological structure – Principle & applications.	- Ultrasound - Doppler technique - X-ray - CT/CAT Scan - Echo-opthalmoscope - Electrocardiogram (ECG) - Echoencephalograph (EEG) - Electroencephalogram (EEG) - Magnetic Resonance Imaging (MRI)	10
		TOTAL	**45**

Practical (25 marks)

APPLIED BIOPHYSICS	
Comparison of absorption curves of any two coloured compounds.	2
Determination of structure of bio-molecules using RASMOL	1
Isolation of plant chloroplasts by density gradient centrifugation	1
Dialysis technique	1
Separation of proteins by SDS-PAGE	1
Preparation of TLC plates & separation of plant pigments	1
Separation of proteins using ion-exchange chromatography	2
Review of HPLC technique	1
Study of Atomic Absorption Spectroscopy	1
Problem solving on radioactivity	1
Visit to a X-ray & Ultrasound clinic	1
Case studies; Use of EEG,ECG,MRI/CT Scan and their applications	2
TOTAL	**15**

REFERENCES:

1. MAHESH, S. (2003) *Biotechnology-3 Including Molecular Biology and Biophysics*, New Age International Private Limited, Publishers New Delhi.
2. ARORA, M.P. (2006) *Biophysics*, Himalaya Publishing House, New Delhi.
3. BAJPAI, P. K. (2010). *Biological Instrumentation and Methodology*, Second Revised Edition. S. Chand and Company Limited.
4. UPADHYAY, UPADHYAY & NATH (2010) *Biophysical Chemistry Principles and Techniques*, Fourth Revised Edition, Himalaya Publishing House, New Delhi.
5. SIVASANKAR, B. (2009). *Bioseparations Principles and Techniques,* PHI Learning Private Limited, New Delhi.
6. PLUMMER, D.T. (1993). *An Introduction to Practical Biochemistry,* Sixth Reprint. Tata McGraw-Hill Publishing Company Limited, New Delhi.
7. JAYARAMAN, J. (2011). *Laboratory Manual for Biotechnology,* Second Edition. New Age International Private Limited, Publishers New Delhi.
8. VERMA, A.S., DAS, S. & SINGH, A. (2014). *Laboratory Manual for Biotechnology, First Edition,* S. Chand and Company Private Limited.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER IV

PAPER TITLE: ECOLOGY AND BIODIVERSITY

PAPER CODE: BIO-IV.E-7

NAME OF FACULTY: MS. MADHAVI M. MOTANKAR

MARKS: 75 MARKS (THEORY) + 25 MARKS (PRACTICAL)

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVE: This paper aims at introducing the importance of the basic concepts of ecology and biodiversity and its importance in the field of biotechnology.

LEARNING OUTCOME: On completion of this paper the students will be able to understand the structure, functions and description of human adaptations to the environment through time, evaluate the impact of humans upon the environment caused by different subsistence strategies. Also, they would be able to demonstrate effective knowledge of ecology as it relates to human and environmental interaction and would be able to describe diversity and heritage of the human species. They would learn the basic concept of food chains, transfer of energy and plant geography which will enlighten them with the need of conservation of our ecology and design experiments to address an interesting and novel problem.

BIO-IV.E-7: ECOLOGY AND BIODIVERSITY

Theory (75 marks)

Sr.No.	Topics	Sub Topics	No. of hours
1	Ecology	- Definition & Historical background of Ecology - - Branches of Ecology and their scope	2
2	Our environment – geographical considerations	- Atmosphere - Hydrosphere - Lithosphere - Biosphere	4
3	Ecosystem : Structure and Function	- Concept of ecosystem - Structure of ecosystem-Biotic & Abiotic components - Function & productivity of ecosystem.	4
4	Biotic environmental factors	- Positive interactions - Negative interactions	3
5	Abiotic environmental factors	- Climatic factors - Physiographic factors - Edaphic factors	3
6	Food chains & Ecological Pyramid	- Food chains in ecosystem - Food web & tropic levels - Ecological pyramids - Types of ecological pyramids - Ecological energetics - Energy flow in ecosystems	4
7	Biogeochemical cycles	- Carbon cycle - Nitrogen cycle - Sulphur cycle - Phosphorus cycle - Oxygen cycle	6
8	Natural Resources-Conservation and Management	- Classification of natural resources - Conservation of natural resources - Water resource management - Forest resource management	3

9	Pollution	- Types, causes, effects and control of: - Air pollution - Water pollution - Soil pollution - Radioactive pollution	6
10	Biodiversity	- Definition and levels of Biodiversity - Causes of loss of biodiversity – Genetic dilution, bio-invasions, habitat degradation and loss, climate change, changing cultivation triggered by market orientation, GMO and LMO	6
11	Conservation	- In - situ conservation: PAN, CCA, ESA, Ramsar sites, Biosphere reserves - Ex -situ conservation: role of Zoos, Aquaria, Captive breeding, Gardens, Seed banks, Germplasm collections. - Education, Awareness & Training: Use of media, Capacity building, NEC/NIC in PAs, Involvement of the armed forces, Intersectoral coordination	4
		TOTAL	**45**

Practical (25 marks)

ECOLOGY AND BIODIVERSITY	
To prepare bio-geographical maps of India with respect to ; (i) Major climatic zones (ii) Forest types and comment on it.	1
Soil analysis for organic content by titration.	1
Soil and water analysis for total phosphorus by spectrophotometric methods.	2
Identification and density count of phytoplankton using haemocytometer.	1
Study of various ecological adaptations (Xerophytes, Hydrophytes and Epiphytes).	3
Study of Chemotaxis (microorganism) & phototaxis (earthworm).	1

Study of mode and zone of infections in nitrogen fixing bacteria – *Rhizobium.*	1
Study of interactions: positive: Lichens Negative: Parasitism – *Cuscusta* showing haustoria	1
Designing of a food chain & food web.	1
To study the Frequency, Density and Abundance of different species of a plant community using Quadrate sampling	1
Visit to sacred groves	1
Visit to wild life sanctuary	1
TOTAL	**15**

REFERENCES:

1. ARORA, M.P. (2004) *Ecology*, Himalaya Publishing House, Mumbai.
2. KAPUR, P. & GOVIL, S.R. (2000). *Experimental Plant Ecology,* S.K. Jain for CBS Publishers and Distributors, New Delhi.
3. MISRA, R. (1968). *Ecology Work Book*, Oxford and IBH. New Delhi.
4. SANTRA, S.C. (2001) *Environmental Science*, New Central Book Agency (P) Ltd. Calcutta.
5. SHARMA, P.D. (1975) *Ecology and Environment*, Tenth Revised Edition, Rastogi Publications, Meerut.
6. SINGH H.R. & KUMAR, N. (2003) *Ecology and Environmental Science*, Vishal Publishing Company, Jalandhar.
7. SMITH. R. L.(1996). *Ecology and Field Biology*, Harper Collins, New York.
8. VERMA, P.S. & AGARWAL, V.K. (2013). *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology,* S. Chand & Company Private limited, New Delhi.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER IV

PAPER TITLE: ADVANCED BIOCHEMISTRY

PAPER CODE: BIO-IV.E-8

NAME OF FACULTY: MS. LIESL DE SILVA

MARKS: 75 MARKS THEORY + 25 MARKS PRACTICAL

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

PREREQUISITES: Completion of BIO-I.C-2

COURSE OBJECTIVE: While the core course in Fundamentals of Biochemistry explored the different biomolecules, their structure, function and metabolism, this elective aims to provide clarity to those basics by integrating the processes of metabolism and observing their function under different conditions.

LEARNING OUTCOME: On completion of this course, students will have further delved into the structure of structural proteins and enzymes and will have investigated the integration of various metabolic processes. They will also be able to describe the biochemical basis, diagnosis and management of certain syndromes.

BIO-IV.E-8: ADVANCED BIOCHEMISTRY

Theory (75 marks)

Sr. No	Topic	Sub –Topics	No. of hours
1	Review	- Review of Biomolecules – carbohydrates, proteins, lipids, nucleic acids, vitamins and hormones - Review of metabolism of carbohydrates, proteins, lipids and nucleic acids	2
2	Buffers	- The pH scale - Buffers used in Biochemical Techniques - Henderson - Hasselbalch equation	3
3	Glycosamines and Glycoproteins	Overview, Structure, Function, Synthesis and Degradation of: - Glycosamines - Glycoproteins	6
4	Globular and Fibrous Proteins	Structure and function of: - Collagen - Elastin - Myoglobin - Haemoglobin Binding of oxygen to Myoglobin and Haemoglobin	5
5	Protein Folding and Denaturation	- Interactions stabilizing the tertiary structure of tertiary proteins - Protein folding and misfolding - Denaturation of Proteins	3
6	Enzymes	Advanced concepts - The Active site of enzymes - Specificity of Enzyme Action – types of specificity - Fischer's "Lock and Key Hypothesis" and Koshland's "Induced-Fit Hypothesis" - Monomeric and Oligomeric enzymes - Factors affecting the rates of chemical reactions – collision theory, transition state theory and catalysis - Extraction and purification of enzymes	8

7	Oxidative Phosphorylation	- Electron Transport Chain and ATP production	2
8	Integration of Metabolism	The Feed-Fast Cycle: - Overview, enzymatic changes, activity in the liver, adipose tissue, resting skeletal muscle and brain during absorptive state - Overview, activity in liver, adipose tissue, resting skeletal muscle, brain and kidney during fasting	8
9	Metabolic Disorders	Clinical Characteristics, Diagnosis and Management of: - Ehler's Danlos syndrome (Classic type) - Lesch-Nyhan syndrome - Alzheimer's Disease - Xeroderma pigmentosum	4
10	Human Nutrition	- Dietary Reference Intakes (DRI) - Energy Requirement in Humans - A brief account of dietary fats, dietary carbohydrates and dietary proteins	4
		TOTAL	**45**

Practical (25 marks)

ADVANCED BIOCHEMISTRY	
Calibration of pH meters Measurement of pH of various solutions using pH meter	1
Preparation of buffers	1
Titration curves of lysine and aspartic acid	2
Quantitative estimation of amino acids using ninhydrin reaction	1
Preparation of solutions for experiments on protein estimation and isolation of casein from milk	1
Comparison of Biuret and Lowry's method for any four proteins	2
Isolation of casein from milk	1
Extraction of enzyme (amylase) from suitable source	1
Comparison of enzyme activity and specific activity of crude and purified	1

enzyme	
Estimation of blood cholesterol	1
Case studies: Clinical Characteristics, Diagnosis and Management of: Alzheimer's Disease and Xeroderma pigmentosum	2
Formulation of a diet plan based on dietary reference intakes	1
TOTAL	**15**

REFERENCES:

10. HARVEY, R.A. & FERRIER, D.R. (2011). *Lippincott's Illustrated Reviews, Biochemistry Fifth Edition,* Lippincott Williams and Wilkins.
11. *NCBI GeneReviews* (1993 – 2015), University of Washington, Seattle
12. NELSON, D. L. & COX, M.M. (2000). *Lehninger's Principles of Biochemistry (3rd Edition),* Worth Publishers, New York, USA.
13. PALMER, T. & BONNER, P.L. (2007). *Enzymes – Biochemistry, Biotechnology, Clinical Chemistry, Second Edition,* Woodhead Publishing Limited.
14. PLUMMER, D.T. (2008). *An Introduction to Practical Biochemistry, Third Edition,* Tata McGraw-Hill.

Annexure III

PATTERN OF QUESTION PAPER FOR SEMESTER END EXAMINATION

Q.1	Q.2	Q.3	Q.4	Maximum marks	Total marks
Any 3 of 4 (3 marks each)	Any 2 of 3 (6 marks each)	Any 2 of 3 (6 marks each)	Any 1 of 2 (12 marks each)	45	72

Parvatibai Chowgule College of Arts and Science

(Autonomous)

DEPARTMENT OF BIOTECHNOLOGY

COURSE STRUCTURE

THREE YEAR B.SC. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	**BIO-I.C-1** Basic Microbiology	**BIO-I.C-2** Fundamentals of Biochemistry	--------	--------	--------	--------
II	**BIO-II.C-3** Fundamental Genetics	**BIO-II.C-4** Cell and Molecular Biology	--------	--------	--------	--------
III	**BIO-III.C-5** Immunology		**BIO-III.E-1** Basics of Plant and Animal Sciences	**BIO-III.E-2** Molecular Genetics	**BIO-III.E-3** Biostatistics	**BIO-III.E-4** Evolution and Anthropology
IV	**BIO-IV.C-6** Concepts in Genetic Engineering		**BIO-IV.E-5** Plant and Animal Physiology	**BIO-IV.E-6** Applied Biophysics	**BIO-IV.E-7** Ecology and Biodiversity	**BIO-IV.E-8** Advanced Biochemistry
V	**BIO-V.C-7** Industrial Biotechnology - Basic		**BIO-V.E-9** Molecular Medicine	**BIO-V.E-10** Environmental Biotechnology	**BIO-V.E-11** Introduction to Drug Development	**BIO-V.E-12** Bioinformatics
VI	**BIO-VI.C-8** Bioethics and Biosafety		**BIO-VI.E-13** Advanced Microbiology	**BIO-VI.E-14** Industrial Biotechnology – Advanced	**BIO-VI.E-15** Plant Biotechnology	**BIO-VI.E-16** Animal Cell Culture

APPROVED SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER V

PAPER TITLE: INDUSTRIAL BIOTECHNOLOGY (BASIC)

PAPER CODE: BIO-V.C-7

MARKS: 75 MARKS THEORY + 25 MARKS PRACTICAL

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVES: This paper is designed to introduce the students to the basic concepts in Industrial Biotechnology. The paper covers concepts in Industrial Biotechnology, mainly introducing the basics of upstream processes in fermentation technology on an industrial scale.

LEARNING OUTCOME:

On completion of this module, students will be able to understand the concept of a bioprocess and its importance in today's world of fast pacing technology. They will be able to apply concepts of fermentation technology to the industrial sector and understand how large scale bioprocesses are carried out. This module will be a pre-requisite to the module Industrial Biotechnology (advanced) of semester VI.

BIO-V.C-7: INDUSTRIAL BIOTECHNOLOGY (BASIC)

Sr.No	Topics	Sub Topics	No. of hours
1	Industrial Biotechnology – scope and applications	- Historical developments (Contributions of Indian Scientists) - Understanding concepts related to industrial biotechnology and fermentation processes (Concept of bioprocess) - Scope and applications of industrial biotechnology	3
2	Fermentation equipment	- Structure of an ideal fermentor - Parts of the fermentor and their uses – impellars, spargers, baffles, headspace, controls and sensors (temperature, pH, antifoam) - Types of reactors (definition, description, diagram and uses) - Bubble columns, Airlift, Fluidized bed, Packed bed, Tray bioreactors, Photobioreactors	8
3	Fermentation media	- Characteristics of an ideal fermentation medium - Types of media – crude and synthetic - Composition of fermentation media - Methods for sterilization of media – heat, radiation, chemical methods	5
4	Types of fermentation	- Introduction to the types of fermentation processes - submerged, surface/solid state, batch, fed-batch and continuous, pilot fermentor.	4
5	Screening of	- Primary screening (Definition)	6

	microorganisms for fermentation processes	- Methods of primary screening – crowded plate, auxanography, enrichment, indicator dye - Secondary screening (Definition and features) - Example of secondary screening (Giant colony method) - Strain improvement - overview of the methods	
6	Maintenance of stock cultures	- Aims of preservation of stock cultures - Primary stocks and Working stocks - Techniques of preservation – serial subcultures, sterile soil, water storage, silica gel storage, sterile mineral oil, lyophilization, cryogenic preservation - Inoculum preparation – concept with an example	5
7	Detection and assay of fermentation products	- An overview of the working principle involved in: - Physical and Chemical assays - titration and gravimetric assay, turbidity analysis and cell determination, spectrophotometric assay, chromatographic partition assay - Biological assays - diffusion assays, turbidometric and growth assay, end point assay, metabolic response and enzymatic assays.	5
8	Applications of fermentation technology (Industrial productions on a large scale)	- Organisms, fermentation media, fermentation conditions and production processes in: citric acid, vinegar, penicillin and industrial alcohol	7

9	Introduction to downstream processing	-	An overview of the steps in downstream processing (An introduction to concepts related to separation of cells, disintegration, broth enrichment/extraction, purification, drying and formulation)	2
			TOTAL	**45**

Practical (25 marks)

INDUSTRIAL BIOTECHNOLOGY - BASIC	
Parts of a fermentor	1
A study on the phases of growth of microorganisms during batch fermentation (equipment: erlenmeyer flask, medium: nutrient broth, inoculum: *E.coli*).	2
Preparation and sterilization of medium for a typical fermentation process (batch fermentation)	1
Batch fermentation using fermentor	1
Preparation and sterilization of medium for a typical fermentation process (fed-batch fermentation)	1
Fed-batch fermentation using fermentor	1
Decontamination and sterilization of the fermentor	1
Primary screening of antibiotic producing bacteria by crowded plate technique	1
Secondary screening for antibiotic producers by Giant Colony Technique	1
Production of citric acid (from fruit waste) using *Aspergillus niger*.	1
Production of wine (from pineapple or any other fruit/vegetable) using yeast and estimation of percentage alcohol.	2
Production of vinegar	1
Estimation of total reducing sugars and acidity (total and volatile) in wine, citric acid and vinegar (before and after fermentation)	1
TOTAL	**15**

REFERENCES

1. Casida L.E. (2009). Industrial Microbiology, New Age International (P) Ltd. New Delhi.
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology, Science Publishers Enfield, NH, USA.
3. Patel A.H. (2012). Industrial Microbiology, MacMillan Publishers India Ltd.
4. Prescott & Dunn. (1982). Industrial Microbiology, 4th edition, AVI Publishinhg Co.
5. Ratlege C. & Kristiansen B. (2001). Basic Biotechnology, 2nd edition. Cambridge university press.
6. Stanbury P. F, Whitaker A. & Hall. (1997). Principles of fermentation technology, 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.

APPROVED SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER V

PAPER TITLE: MOLECULAR MEDICINE

PAPER CODE: BIO-V.E-9

MARKS: 75 MARKS THEORY + 25 MARKS PRACTICAL

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

PREREQUISITES: Completion of BIO-III.E-2 (MOLECULAR GENETICS)

COURSE OBJECTIVE: Molecular medicine is the application of molecular biology and molecular genetics to the understanding of human health and disease. It aims to understand the underlying origins and mechanisms of human diseases and to find novel ways of preventing, diagnosing and treating diseases.

LEARNING OUTCOME: On completion of this module, students will be able to understand the underlying genetic factors of common diseases, complex genetic traits and molecular and cellular therapies for the same. They will also gain more clarity on cancer genetics, pharmacogenetics and maintenance of public health.

BIO-V.E-9: MOLECULAR MEDICINE

Sr. No	Topic	Sub –Topics	No. of hours
1	Historical Aspects	- History of Molecular Medicine – the foundations (1869 – 1980s), the modern era (1980s – 2000s) - The Human Genome project (1990 – 2000)	2
2	Gene Structure and Expression	- Exons, Introns - Alternative Splicing - Epigenetic Changes	3
3	Genetic Factors in Common Diseases	- Hypertension - Coronary heart disease - Autism - Alzheimer disease - Haemochromatosis - Age-related Macular Degeneration	6
4	Complex Genetic Traits	- Multifactorial Disorders – Diabetes, Dementia, Schizophrenia - Novel Mechanisms for DNA and Disease – Mitochondrial Inheritance, Genomic Imprinting, Mosaicism, Chimerism	4
5	Cancer Genetics	- Differentiation between Genetic and Environmental Factors in Cancer - Oncogenes – types and function - Tumour-suppressor genes – “two hit hypothesis” - Genetics of Common Cancers – breast, ovarian and prostate cancer	5
6	Introduction to Omics	- Genomics, Proteomics, Metabolomics, Phenomics, Metagenomics	3
7	DNA Tests	- Direct Detection - Indirect Detection - DNA Scanning, Linkage Analysis	4

		- Classes of DNA tests and function of each type - Validity of DNA tests	
8	Molecular and Cellular Therapies	- Recombinant DNA products – Factor VIII (Haemophilia), Vaccines - Somatic Cell Gene Therapy - Examples of Gene Therapy Trials – ADA, Haemophilia, Cancer, Eye disease, HIV - RNA Therapies – RNA interference (RNAi), Ribozymes - Regenerative Medicine – Cloning, Stem Cells	8
9	Pharmacogenetics	- Drug Metabolism - Genetic Variations revealed by Effects of Drugs - Pharmacogenetics – Maturity-onset diabetes of the young (MODY), neonatal diabetes, pharmacogenomics, adverse effects, efficacy	3
10	Public Health	- Preventive Medicine - Population Screening (Cystic Fibrosis, Sickle Cell Anaemia, Newborn screening) - Changing Behaviour (Familial Hypercholesterolemia) - DNA Testing in the Workplace – predisposition to disease, detecting exposure to toxins, litigation, identity	4
11	Delivering Genetics and Genomics to Consumers	- Definitions and Marketplace - Types of Direct-to-Consumer (DTC) DNA Tests - Pros and Cons of DTC DNA Tests	3
		TOTAL	**45**

Practical (25 marks)

MOLECULAR MEDICINE	
Investigation of Genetic Factors in any four common diseases	2
Study of mitochondrial inheritance, genomic imprinting, mosaicism and chimerism with one example of each	2
A study on the types of DNA tests for diagnosis of diseases	3
Investigation of Molecular Mechanisms of any one type of Cancer	2
Understanding concepts relating to genomics and proteomics	1
A study on RNA therapies and regenerative medicine	1
Application of pharmacogenetics in drug metabolism	1
An investigation into the screening programmes adopted in various countries	1
Submission of a report on the molecular mechanisms and therapy for any one disease	2
TOTAL	**15**

REFERENCES

1. Trent, R.J. (2005). Molecular Medicine – an Introductory Text, Elsevier Academic Press.
2. Trent, R.J. (2012). Molecular Medicine – Genomics to Personalized Health Care, Fourth Edition, Elsevier Inc.
3. Turnpenny, P.D. & Ellard, S. (2007). Emery's Elements of Medical Genetics, 13th Edition, Churchill Livingstone Elsevier.

APPROVED SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER V

PAPER TITLE: ENVIRONMENTAL BIOTECHNOLOGY

PAPER CODE: BIO-V.E-10

MARKS: 75 MARKS THEORY + 25 MARKS PRACTICAL

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVES: The main aim of this paper is to introduce the students to the hazards of our environment, the effects of pollution on living systems, solutions to protect the environment for sustainable development.

LEARNING OUTCOME: On completion of this module, students will be able to understand the effects of various types of pollution and gain knowledge in areas like development of biological systems for remediation of contaminated environments and environment-friendly processes such as green manufacturing technologies and sustainable development.

BIO-V.E-10 ENVIRONMENTAL BIOTECHNOLOGY

Sr. No	Topics	Sub Topic	No. of hours
1.	Introduction	The scope of environmental biotechnology	1
2.	Basic Ecological Concepts and Principles	- Structure (biotic and abiotic components) -Food chain and food webs -Ecological pyramids -Productivity and eco-energetic (10% law)	4
3.	Anthropogenic activities, its effects and control	Air pollution - Major air pollutants and their sources. - Impacts of air pollution on human health, animals, plants and climate. - Removal of gaseous contaminants and odour: bioscrubbers, biotrickling filters and biofilters/biobeds Water pollution -Principal forms of water pollutants and their sources. -Waste water monitoring: Concepts of total solid/suspended solid, BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), Total Solids (Dissolved and Suspended) -Wastewater treatment: Aerobic processes (Activated sludge process, rotating biological discs, oxidation ponds, trickling filters) Soil pollution -Concept of soil pollution and their sources: Industrial waste effluents and heavy metals, soil	15

		acidity/alkalinity, soil salinity. -Treatment of solid wastes: Composting and vermitechnology	
4.	Pollution Monitoring	-Bio indicators: Concept and examples (indicators of water quality; air pollution indictors). -Choice of criteria: Visual rating, Genotoxicity, Metabolic rating -Applications (two each), using plant test systems and animal Test Systems. -Tests for assessing Genetic damage: AMES Test, Cyto-genetic assay, Membrane damage. -Concept and applications of molecular biology in environmental monitoring: reporter gene. -Concept and applications of biosensors in pollution detection	8
5	Pollution abatement: Bioremediation and biodegradation	<u>Bioremediation</u> -Definition -Microbial bioremediation -Phytoremediation - Microbial desulphurization of coal (direct and indirect mechanisms) <u>Biodegradation</u> -Introduction to xenobiotic and recalcitrant compounds -Basis of biodegradation: Concepts of use of mixed microbial populations. - Biodegradation of two xenobiotics: Aromatic hydrocarbons (benzene) and alkanes <u>Biosorption</u> -Principle	10

		-Use of Fungi and Algae (2 Examples each). Genetically engineered microorganisms -Super Bug (*Pseudomonas* sps.)	
6.	Ecofriendly Bio-products	-Merits of bioenergy against conventional fuels Process and organisms involved in: -Biogas (Biomethanisation) production: Dome shaped biogas plant -Bio hydrogen production: anaerobic bacteria and photolysis photosynthetic algae -Biodiesel production: Biodiesel from lipids and hydrocarbons - Bioplastics : Merits against synthetic plastics- Biopol and Biolac - Microbial insecticide (any 1 example)	7
		TOTAL	**45**

Practical (25 marks)

ENVIRONMENTAL BIOTECHNOLOGY	
Detection of coliforms for determination of the purity of potable water (MPN, Presumptive, confirmatory and confirmed tests).	4
Determination of dissolved oxygen concentration of water sample by Winkler's method.	1
Determination of biological oxygen demand (BOD) of the given sample.	1
Determination of chemical oxygen demand (COD) of the given sample ($KMnO_4$/ $K_2Cr_2O_7$ method).	1
Determination of TS (total solids) of the given water sample.	1
Isolation of xenobiont degrading bacteria by selective enrichment.	2

Vermicomposting/ compositing.	1
Determination of potassium/nitrates from soil sample.	2
Visit to an effluent treatment plant and preparation of report.	2
TOTAL	**15**

REFERENCES

1. Agarwal S.K. (2009). Environmental Biotechnology, APH Publishing Corporation New Delhi.
2. Anjaneyulu Y. (2005). Introduction to environmental Science, BS publications, India.
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5. Santra S.C. (2001). Environnemental Science, New central book agency (P) Ltd. Calcutta.
6. Singh B.D. (2008). Biotechnology, 3rd edition, Kalyani Publishers.
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APPROVED SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER V

PAPER TITLE: INTRODUCTION TO DRUG DEVELOPMENT

PAPER CODE: BIO-V.E-11

MARKS: 75 MARKS (THEORY) + 25 MARKS (PRACTICAL)

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVES: This paper aims at introducing the importance of the basics of drug discovery and target identification and their importance in the field of biotechnology.

LEARNING OUTCOME: On completion of this paper the students will be able to understand the importance of drug discovery and how it is formulated by identifying the target molecule and used for treating the various genetic diseases which may be used in present life and be able to solve interesting and novel scientific problems.

BIO-V.E-11: INTRODUCTION TO DRUG DEVELOPMENTT

INTRODUCTION TO DRUG DEVELOPMENT			
Sr.No.	**Topics**	**Sub Topics**	**No. of hours**
1.	DNA,RNA & Proteins	- Review of DNA, RNA and Proteins - Review of Transcription and Translation	2
2.	Introduction to Bioinformatics	- Definition, Scope of Bioinformatics - Bioinformatics vs Computational biology - Components of Bioinformatics and Applications	3
3.	NCBI & SRS	- Introduction to NCBI and EMBL - Sequence Retrieval System	3
4.	Nucleic acid and Protein databases	- Gen Bank and EMBL, DDBJ - Swiss-PROT, PDB & PIR	6
5.	Visualization of proteins	- Use of MMDB & PDB - Visualization tools : Cn3D & Rasmol	4
6.	Genomics and Proteomics	- Introduction - Human Genome Project - DNA microarray & EST - Techniques involved in Genomics & Proteomics	6
7.	Insilico Drug Design	- Theory of Drug Design - Use of computers in drug design - Novel techniques to estimate ligand receptor binding	6
8.	Structure based drug designing	- Introduction, structure based drug designing approaches - Target identification and validation - Homology modeling and protein folding - Receptor mapping and active sites analysis	6
9.	Ligand based drug designing	- Introduction to ligand based drug designing approaches - Lead designing and Combinatorial chemistry - High Throughput Screening (HTS) and QSAR	6

		- Database generation and chemical libraries - ADME property.	
10.	Molecular Docking	- Introduction to docking methods to generate new structures - Tools and molecular docking programs - AutoDock	3
		Total	**45**

Practical (25 marks)

INTRODUCTION TO DRUG DEVELOPMENT	
Study of Human Genome Project	1
Introduction to Drug discovery and its applications	1
Study of DNA microarray databases	1
Biological data search using NCBI – Protein or amino acid sequences	1
Biological data search using NCBI – DNA or gene sequences	1
Visualization of protein structures using Cn3D/ Rasmol	2
Study of drug discovery using Chemsketch	2
Drug targeting using ADME software	2
Energy minimization and preparation of ligand	3
Study about molecular docking - Autodocking	1
TOTAL	**15**

REFERENCES

1. Harisha S., (2007). Fundamentals of Bioinformatics, I.K. International Publishing House, Mumbai.
2. Ignacimuthu S., (2005), Basic Bioinformatics, Narosa Publishing House, New Delhi.
3. Rastogi S.C., Mendiratta N. & Rastogi P. (2004). Bioinformatics - Methods and Applications, CBS Publishers.
4. Young D.C. A Guide for Computational and Medicinal Chemists.
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APPROVED SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER V

PAPER TITLE: BIOINFORMATICS

PAPER CODE: BIO-V.E-12

MARKS: 75 MARKS (THEORY) + 25 MARKS (PRACTICAL)

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVES: This paper aims at introducing the importance of the basics of computers, concept of Human Genome Project, storage of biological information and tools and techniques of bioinformatics used and their importance in the field of biotechnology.

LEARNING OUTCOME: On completion of this paper the students will be able to understand the importance of computers and networking and the various types of biological databases used for storing genetic information of various organisms and the use of various tools and techniques used for retrieving the same that maybe used in present life and be able to solve interesting and novel scientific problems.

BIO-V.E-16: BIOINFORMATICS

BIOINFORMATICS			
Sr.No.	**Topics**	**Sub Topics**	**No. of hours**
1.	Introduction to Computers in Biology	- Introduction to use of computers, internet and softwares in biology, medicine and research. - Historical developments in Biology	5
2.	DNA, RNA and Proteins & HGP	- Background of DNA, RNA and Proteins, ORF - Review of Transcription and Translation - Introduction to HGP, Objectives - Achievements of HGP - Ethical and Social issues.	4
3.	Introduction to Bioinformatics	- Definition, Scope of Bioinformatics - Bioinformatics vs Computational biology - Components of Bioinformatics and Applications	3
4.	Information resources	- Introduction, aim and objectives (NCBI, NLM, NIH, EBI and SRS)	6
5.	Biological databases	- Types of data - Types of biological databases - Primary databases : Gen Bank and EMBL, DDBJ - Secondary databases:Swiss-PROT, PDB & PIR - Composite databases: OWL & PROSITE	6
6.	Structural databases	- PDB, MMDB, CATH & SCOP - Visualization of proteins – Cn3D and Rasmol	5
7.	Literature databases	- Pubmed, MedLINE & OMIM	3
8.	BLAST & FASTA	- Introduction, BLAST & FASTA and their types	4
9.	Sequence Alignmnent tools and Phylogeny	- Pairwise sequences alignment, - Multiple sequence alignment using Clustal-W Omega	6

		- Introduction, Definition, construction, structure and types of phylogenetic trees. - Differences between cladogram and phylogenetic tree.	
		TOTAL	**45**

Practical (25 marks)

BIOINFORMATICS	
Introduction to Bioinformatics & its Applications	1
Study of Human Genome Project	1
Usage of NCBI resources	1
Biological data search using NCBI – Protein or amino acid sequences	1
Biological data search using NCBI – DNA or gene sequences	1
Biological data search using NCBI – Literature & Structure databases	2
Database search & Pairwise sequence alignment using NCBI BLAST : BLASTp & BLASTn	2
Multiple sequence alignment using Clustal-W	2
Construction of phylogenetic tree using Clustal-W	1
DNA sequence analysis to find restriction enzymes sites using NEBcutter	1
Visualization of protein structures using Cn3D/ Rasmol	2
TOTAL	**15**

REFERENCES

1. Harisha, S. (2007). Fundamentals of Bioinformatics, I.K. International Publishing House, Mumbai.
2. Ignacimuthu, S. (2005). Basic Bioinformatics, Narosa Publishing House, New Delhi.
3. Mount, D.W. (2004). Bioinformatics – sequence and Genome analysis, CBS Publishers.
4. Murthy,C.S.V. (2003). Bioinformatics, Himalaya Publishing House, Mumbai.
5. Rastogi, S.C., Mendiratta, N. & Rastogi, P. (2004). Bioinformatics: Concepts, Skills and Applications, CBS Publishers.
6. Xiong, J. (2006). Essential Bioinformatics, Cambridge University Press.

APPROVED SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER VI

PAPER TITLE: BIOETHICS AND BIOSAFETY

PAPER CODE: BIO-VI.C-8

MARKS: 75 MARKS (THEORY) + 25 MARKS (PRACTICAL)

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVES: This paper aims at introducing the importance of the basic concepts of bioethics and bio-safety and their relationship with several fields such as ecology, agriculture, medicine, chemistry and advances brought about in the field of biology and medicine. The course deals with answers to ethical questions that arises in the relationships among the life sciences, biotechnology, medicine, politics, law, philosophy, theology and their importance in the field of biotechnology.

LEARNING OUTCOME: On completion of this paper the students will be able to understand the importance of bioethics and biosafety procedures to be followed and describe the basic concepts, its principles, and use in the present life and be able to solve interesting and novel scientific problems.

BIO-VI.C-8: BIOETHICS AND BIOSAFETY

BIOETHICS AND BIOSAFETY			
Sr.No.	Topics	Sub Topics	No. of hours
1.	Introduction to Bioethics	- Introduction to Bioethics - Social and ethical issues in biotechnology	2
2.	Principles of bioethics and ethical conflicts	- Principles of bioethics - Ethical conflicts in biotechnology - Bioethics vs business ethics.	3
3.	Bioethics in Genetic Engineering	- Bioethical issues related to test tube babies - Bioethics in Plant genetic engineering - Bioethics in Animal genetic engineering	3
4.	Introduction to Biosafety	- Introduction, History and Definition of Biosafety - Biosafety Guidelines and Regulations - Operation of Biosafety Guidelines and Regulations - Levels of Physical containment - Levels of Biological containment	7
5.	Safety in Laboratories	- Hazards : Physical, Biological and Chemical	3
6	Introduction to IPR and Protection of Intellectual Property Right	Introduction, history of Intellectual Property Rights - Trade secrets - Patents: Reading a patent & Patenting strategies - Copyrights - Trademarks - Plant variety protection (PVP) - World Intellectual Property Organization (WIPO) - GATT & TRIPs - Patent status – International Scenario - Patenting of Biological materials - Significance of Patents in India	8
7.	International and	- Biosafety Guidelines in India	5

	Indian Biosafety guidelines	- International Biosafety Guidelines : OECD, FAO, WHO, CAC and Other organisations	
8.	Case studies	- Patenting Basmati rice - Revocation of patents-turmeric and neem	3
9.	Protection of Biotechnological Inventions	- Patenting of genes and DNA sequences - Gene patents and Genetic resources - Farmers rights - Plant breeder's rights - Patenting of life forms - Broad patents in Biotechnology	5
10.	Regulatory affairs	- Regulatory requirements for drugs and biologics - Good laboratory practices - Good manufacturing practices	3
11.	Biosafety of GMOs and GEMs	- Planned introduction and field trials of: GMOs and GEMs - Biosafety during industrial production	3
		TOTAL	**45**

Practical (25 marks)

BIOETHICS AND BIOSAFETY	
General safety measures and study of safety notices	2
Study of preventive measures and first aid during laboratory hazards	1
Case study on handling and disposal of radioactive waste	1
Case study on handling and disposal of medical/microbial waste	1
Study of Good Laboratory Practices	1
Study of Good Manufacturing Practices	1

Study of components and design of a Biosafety laboratory	2
A case study on clinical trials in India with emphasis to ethical issues	2
Planning of establishment of a hypothetical biotechnology industry in India	2
Study of steps of a patenting process	2
TOTAL	**15**

REFERENCES

1. Das H.K. (2008). Text book of Biotechnology, 3rd edition, Wiley India Pvt. Limited, New Delhi.
2. Dubey R.C. (1993). A Textbook of Biotechnology, S.Chand and Company, New Delhi.
3. Krishna V.S. (2007). Bioethics & Biosafety in Biotechnology, New Age Publishers, Bangalore.
4. Plummer D.T. (1988). An Introduction to Practical Biochemistry, 3rd Edition, Tata McGraw, New York.
5. Singh B.D. (2003). Biotechnology - Expanding Horizons, 1st edition, Kalyani Publishers, Ludhiana.
6. Thomas J.A. & Fush R.L. (2002). Biotechnology & Safety Assessment, 3rd Edition, Academic press.

APPROVED SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER VI

PAPER TITLE: ADVANCED MICROBIOLOGY

PAPER CODE: BIO-VI.E-13

MARKS: 75 MARKS THEORY + 25 MARKS PRACTICAL

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

OBJECTIVE:

This paper adds information about the role of microorganisms in many food industries both in production and spoilage processes and to understand the importance of the role of microorganisms in food industries both in beneficial and harmful ways.

LEARNING OUTCOME:

The students will be able to apply this knowledge in prevention of microbial spoilage and also exploit the microbes for improved food quality. They will also learn the key role and mechanisms of microorganisms, enzymes in biodegradation of hazardous compounds

BIO-VI.E-13 ADVANCED MICROBIOLOY

Sr. No.	Topic	Sub-topics	No of hours
		Food technology	
1.	History and Development of Food Microbiology	-History of microorganisms in food -Role and significance of microorganisms in foods	2
2.	Factors Influencing Microbial Growth in Food	-Intrinsic and extrinsic factors responsible for food spoilage	4
3.	Microorganisms involved in food spoilage	-Microorganisms involved in food spoilage: fruits, vegetables, meat, eggs, bread	2
4.	Food Borne diseases	-Food poisoning: (Bacterial Toxin Botulism and Staphylococcal toxin) Fungal Toxins: Aflatoxin -Food borne Infections: Gastroenteritis and Salmonellosis	5
5.	Detection of food spoilage	-Methods of detection of food spoilage in any 1 type of food (example milk) -Traditional approaches in detection of spoilage (SCP, Breeds smear, identification of specific organisms by using selective and differential media) -New approaches (examples gene probes, Bioluminescence)	6

6.	Microorganisms as source of food	Nutritive value and use of: -Mushroom -SCP eg. Spirullina	3
7.	Food preservation	- General methods of food preservation	1
8.	Food quality assurance	-Food safety: HACCP system to food protection	3
Applications in Industry, Agriculture and Environment			
9.	Applications of microbial enzymes in industry	- Detergents: proteases, amylases, cellulase and lipase - Leather: alkaline protease, lipase -Food processing: production of glucose syrup, maltose syrup -High Fructose Corn Syrup: production using immobilized enzymes	6
10.	Applications of microbes in Biotransformation, Ore leaching and Desulphurisation of coal	-Biotransformation: - D-sorbitol to L- sorbose, - Antibiotics - Steroids - Ore leaching: merits, applications, removal of copper - Desulphurisation of Coal	6
11.	Recombinant bacteria in production of pharmaceutically important proteins	- Recombinant protein (using prokaryotes): insulin - Recombinant protein (using eukaryotes): human factor VIII	4
12.	Biocontrol of plant diseases using bacteria and viruses	- Bacteria: *Bacillus thuringiensis* - Viruses*: Baculoviruses*	3
		TOTAL	**45**

Practical (25 marks)

ADVANCED MICROBIOLOGY	
Screening of microorganisms for industrially important enzymes • Amylase • Lipase • Protease • Cellulase	4
Immobilization of microbial cells (bacteria) • Calcium alginate/ agarose • Estimation of reducing sugar from starch using immobilized cells	3
Microbiology of food • Plating of spoiled food on selective media • MIC of common food preservatives – (sugar, salt) • MIC of chemical food preservatives – (sodium benzoate, potassium metabisulphite)	3
Milk Microbiology • Standard plate count • Grading of quality of milk using dye reduction test (MBDRT or Resazurin) • Determination of efficiency of pasteurisation by phosphatase test	4
A study on intrinsic and extrinsic factors responsible for food spoilage	1
TOTAL	**15**

REFERENCES

1. Das H.K. (2007). Text book of Biotechnology, 3rd Edition, Wiley India (P) Ltd, New Delhi.
2. Frazier W.C & Westhoff D.C. (2015). Food Microbiology. 5th edition. McGraw Hill Education (India) Private Limited: New Delhi
3. Jay J.M., Loessner, M.J. & Golden D. A. (2005). Modern Food Microbiology, 7th edition. United States: Springer science business media
4. Jogdand S. N. (2004). Medical Biotechnology, Himalaya publishing house Pvt. Ltd, India.
5. Purohit S.S. (2004). Biotechnology: Fundamentals and applications Agrobios, Jodhpur.
6. Ray B. (2004). Fundamental food microbiology, 3rd edition. CRC press: WashingtonD.C
7. Satyanarayan U. (2009). Biotechnology, Books and Allied Pvt Ltd, Calcutta.
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<u>APPROVED SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY</u>

<u>SEMESTER VI</u>

PAPER TITLE: INDUSTRIAL BIOTECHNOLOGY (ADVANCED)

PAPER CODE: BIO-VI.E-14

MARKS: 75 MARKS THEORY + 25 MARKS PRACTICAL

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

PRE REQUISITES: Completion of BIO-V.C-7

COURSE OBJECTIVES: This paper is designed to introduce the students to advanced concepts of Industrial Biotechnology. The paper covers topics that explain downstream processing and basic methods involved in industrial production process. The pre-requisite for this paper in the Industrial Biotechnology (Basic) course

LEARNING OUTCOME:

On completion of this module, students will be familiar with downstream processes that mainly include recovery of the product following upstream processes. They will also understand the method of production of various industrially important substances as well as methods of treatment of industrial waste for suitable disposal into the environment.

BIO-VI.E-14: INDUSTRIAL BIOTECHNOLOGY (ADVANCED)

Sr.No	Topics	Sub Topics	No. of hours
1	Bioprocess and upstream processing (Review)	- Overview of concepts related to bioprocess technology and importance of upstream processing - A review of production processes	2
2	Concepts in downstream processing	- Introduction to downstream processing - Separation of cells – flocculation, floatation, use of filter aids and Filtration - Centrifugation of cells – concept and examples (tubular bowl and basket centrifuges) - Disintegration of cells – concept - Mechanical methods – examples (ulltrasonication, homogenisers, use of ballotini) - Non mechanical methods – examples (thermal lysis, detergent solubilization, organic solvents and enzymatic agents) - Enrichment methods for fermentation broth – evaporation, membrane filtration, liquid-liquid extraction, precipitation & adsorption - Purification methods – chromatography and crystallization	16

		- Drying as a method in downstream processing - Final steps in downstream processing – formulation, packaging and storage	
3	Basics of quality control	- Good Manufacturing Practice & Good Laboratory practices and safety standards - Examples of regulatory agencies governing safety of products produced by bioprocess technology (example: FDA, other agencies) - Limulus amoebocyte lysate (LAL) assay	4
4	Production of industrially important substances	- Production of fermented foods (wheat, milk, fermented vegetables, cocoa, soyabeans, fermented sausages) - Production of whole cell for food (single cell protein) - Production of beer and spirits (basic concepts in production of whiskey, brandy, rum vodka) - Production of microbial insecticides - Manufacture of steroids - Production of vaccines (virus, bacterial, killed bacterial) - Production of enzymes (fermentation, bulk enzymes and fine enzymes, extraction, packaging, finishing, toxicity testing and	19

		standardization)	
5	Treatment of wastes in industry	- Methods for the Determination of Organic Matter Content in Waste Waters - Wastes from Major Industries - Systems for the Treatment of Wastes (aerobic breakdown of raw waste waters) - Treatment of the Sludge (anaerobic Breakdown of Sludge) - Waste Water Disposal (example: pharmaceutical Industry)	4
		TOTAL	**45**

Practical (25 marks)

INDUSTRIAL BIOTECHNOLOGY (ADVANCED)	
Introduction to downstream processing	1
Demonstration of HPLC	1
Liquid – liquid extraction of Penicillin (produced from upstream)	2
Assay of extracted Penicillin (Minimum Inhibitory Concentration method) using any test organism (*E.coli* or *S.aureus*)	1
Antibiotic (Penicillin) assay using disc diffusion or agar cup method	1
Distillation of wine (for production of brandy)	2
Fermented vegetables (sauerkraut or pickle)	1
Production and analysis of yoghurt	2
Production of bread (bread making)	2
Screening and maintenance of algal cultures for SCP.	2
TOTAL	**15**

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1. Cruger W. & Cruger, A. (2007). A Text book of Industrial Microbiology. Sinauer associates publications
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. Science Publishers Enfield, NH, USA.
3. Prave P, Faust U., Sitting W & Sukatsch D.A. (2004). Fundamentals of Biotechnology. VCH publishers.
4. Ratlege C. & Kristiansen, B. (2001). Basic Biotechnology. 2nd edition. Cambridge university press.
5. Sivasankar B. (2005). Bioseparations: Principles and techniques. Prentice hall of India Pvt. Ltd. New Delhi.
6. Stanbury P. F, Whitaker A. & Hall. (1997). Principles of fermentation technology. 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.

APPROVED SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER VI

PAPER TITLE: PLANT BIOTECHNOLOGY

PAPER CODE: BIO-VI.E-15

MARKS: 75 MARKS THEORY + 25 MARKS PRACTICAL

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVES:

This paper aims at introducing the concept of *in vitro* culture of plants including set up of a plant tissue culture laboratory, labware, instruments and sterilization techniques. This paper will help the students to understand that various parts of the plant may be cultured, with each type of culture having specific applications. Plant tissue culture also lends itself to genetic engineering techniques for production of transgenic plants which have various applications.

LEARNING OUTCOME:

On completion of this module, the student will be able to understand all about plant biotechnology in terms of set up of a laboratory, culture of explants and genetic engineering methods for production of transgenic plants.

BIO-VI.E-15: PLANT BIOTECHNOLOG

Sr. No	Topic	Sub –Topics	No. of hours
1	History of Plant Tissue Culture	- International and Indian scientists	2
2	Laboratory Organization	- Washing and drying facility, general laboratory and media preparation area, transfer area. - Culture room, growth chambers and Green house (ideal conditions for incubation and maintenance of cultures/plants).	4
3	Sterilization Techniques	- Sterilization Techniques used in Plant Tissue culture – steam, dry, filter, ultra violet, alcohol, flame and chemical (explants)	2
4	Plant Tissue Culture Media	- Major and minor inorganic nutrients, vitamins, carbon source, hormones, complex organic additives and their functions - Composition of some commonly used plant tissue culture media – MS, White's, Nitsch, Gamborg B5	4
5	Totipotency	- Totipotency and its Importance - Various parts of the plant serving as Explants	2
6	Organ Culture and its Applications	- *Root* - Shoot tip/meristem - Anther and pollen - Ovary and ovule - Embryo	5
7	Callus and Cell Suspension Cultures	- *Callus culture – principle, characteristics of callus tissue, applications* - Cell suspension culture - Principle, isolation, growth patterns, concept of batch and continuous culture,	4

		viability testing	
8	Somaclonal Variation	- Concept, isolation of variants, mechanisms of somaclonal variation and applications	2
9	Organogenesis	- Root and shoot regeneration and applications	1
9	Somatic Embryogenesis and Artificial Seeds	- Somatic Embryogenesis – principle, procedure and applications - Artificial seeds – methods of production and applications	2
10	Protoplast Culture and Somatic Hybridization	- Protoplast Culture - Principle, isolation of protoplasts (mechanical and enzymatic), methods of culture, checking viability - Somatic hybridization - protoplast fusion (spontaneous and induced); selection of hybrid protoplasts, applications of somatic hybridization.	4
11	Applications of Tissue Culture in Plant Sciences	- Micropropagation, gene conservation banks, forestry	2
12	Production of Secondary Metabolites	- Classification of secondary metabolites with examples - Production using culture methods - callus culture, cell suspension culture, hairy root culture (*A. rhizogenes*), immobilized cell systems	2
13	Gene Transfer in Plants	- Introduction to *Agrobacterium tumefaciens* and Ti plasmid - *Agrobacterium* based vectors (co-integrate and binary vectors) - Co-culture method and in planta transformation - Direct methods of gene transfer – electroporation, chemical methods, particle gun method and	4

		microinjection	
14	Applications of Transgenic Plants	- Insect resistance (BT toxin), drought and salt tolerance, herbicide resistance, increasing shelf life of fruits, improvement of vitamin content (golden rice) and edible vaccines	5
		TOTAL	**45**

Practical (25 marks)

PLANT BIOTECHNOLOGY	
Washing, Packing and Sterilization of Glassware	1
Preparation of Stock solutions for Murashige and Skoog (MS) medium	1
Preparation, sterilization and pouring of MS medium	1
Aseptic germination of seedling	1
Callus induction from hypocotyl and carrot cambial explants and subculturing	2
Shoot tip culture	2
Regeneration of shoot/root from callus	2
Setting up of cell suspension culture and checking viability by Evan's blue method	2
Setting up an *in vitro* culture from seed embryo (embryo culture)	1
Encapsulation of somatic/true embryo (synthetic seeds)	1
Regeneration of Plants from Synthetic Seeds	1
TOTAL	**15**

REFERENCES

1. Chawla, H.S. (2002) Introduction to Plant Biotechnology, Science Publishers Inc. USA.
2. De, K.K. (2008) Plant Tissue Culture, New Central Book Agency Pvt. Ltd.
3. Jha, T.B. & Ghosh,B. (2005) Plant Tissue Culture, University Press (India) Pvt. Ltd.
4. Singh, B.D. (2005) Plant Biotechnology, Kalyani Publishers.

APPROVED SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

SEMESTER VI

PAPER TITLE: ANIMAL CELL CULTURE

PAPER CODE: BIO-VI.E-16

MARKS: 75 MARKS THEORY + 25 MARKS PRACTICAL

CREDITS: 3 (THEORY) + 1 (PRACTICAL)

COURSE OBJECTIVES: This paper is designed to introduce the students to the basic concepts of Animal Cell Culture. The paper covers topics that explain animal cell culturing and methods involved in basic culturing of animal cells with a few applications to life sciences.

LEARNING OUTCOME:

On completion of this module, students will be able to understand the basics in animal cell culture, comprehend methods used in culturing animal cells and the importance of the same. They will be able to apply concepts related to culturing animal cells to the latest developments made in this field. They will also understand the impact it has made to the development of mankind, especially in development of disease diagnostics and therapeutics.

BIO-VI.E-16: ANIMAL CELL CULTURE

Sr.No	Topics	Sub Topics	No. of hours
1	Introduction to Animal Cell Culture	- Animal Tissue and Cell Culture (Definition and Concepts in brief) - History and Scope of Animal Tissue Culture	3
2	Requirements for Animal Cell Culture	- Basic layout of an animal cell culture laboratory (washing room, media preparation & sterilization room, inoculation and aseptic culture room) - Equipments, culture vessels for tissue culture	4
3	Basics of an Animal Cell – (structure, organization and function pertaining to animal cell culture)	- Structure and organization of animal cell - An overview of developmental biology (importance in understanding differentiation of cells in culture)	3
4	Media in Animal Cell Culturing	- Physico-chemical properties of culture media (pH, CO_2, O_2 & Temperature) - Growth media – (Types, advantages and disadvantages of each type) Natural and artificial media - Natural media – clots, biological fluid, tissue extracts, complex natural media - Artificial media – serum containing, serum-free media, chemically defined and protein-free media	6

		- Basal salt solutions (BSS) – constituents (vitamins, amino acids, trace elements, inorganic ions), importance, uses and examples - Serum as a complex supplement - Growth factors in promoting proliferation of cells – uses and examples (EGF,FGF, PDGF)	
5	Basic techniques in Animal Cell Culture	- Techniques in mammalian cell culture – source of cells, dissection/isolation of cells, mechanical and enzymatic disaggregation - Types of cell cultures (organ culture, whole embryo culture, histotypic cultures, explants cultures)	6
6	Cell line cultures	- Primary and Established cell line cultures - Establishment of continuous cell lines – spontaneous transformation, chemical transformation, viral transformation, non-chemical methods - Characteristics & maintenance of Established/ continuous cell lines - Characteristics of normal and transformed cells (Properties of Transformed cells)	6
7	Characterization and Growth measurement of cultured cells	- Characterization – Genetic and enzymatic methods (cytogenetics, karyotyping, Isoenzymes and immunological tests) - Growth measurement – Direct method	6

		(particle counter, dye exclusion test, cytotoxicity assay) - Growth measurement – Indirect method (MTT assay)	
8	Normal cell growth, phases of growth in culture and synchronization of cells	- Eukaryotic cell cycle and basics of cell synchronization - Apoptosis in cultured cells – Reasons for cell suicide - Phases of cell growth (lag, log, stationary, decline), population doubling level, morphology	3
9	Cell separation methods	- Physical method of cell separation – separation based on cell size, cell density, cell surface charge, cell affinity - Separation by cytofluorometry	2
10	Applications of Animal Cell Culture	- Stem cell culture (applications in Animal Cell Culture) - Artificial skin - Artificial cartilage - Special secondary metabolites / products (insulin, growth hormone, interferon, t-plasminogen) - Other valuable products obtained using animal cell cultures (emphasis on monoclonal and polyclonal antibodies)	6
		TOTAL	**45**

Practical (25 marks)

Animal Cell Culture	
Washing of glassware and culture wares, preparation of animal cell culture media, sterilization	2
Introduction to use of instruments and sterile techniques in animal cell culture	1
Preparation of Basal Salt Solutions (DPBS) and filter sterilization	1
Preparation of culture media for animal cell culture (DMEM / RPMI 1640) using BSS.	1
Preparation of serum from goat blood & filter sterilization for animal cell culture	1
Culturing lymphocytes from blood cells using RPMI 1640	1
A comprehensive observations on extra embryonic membranes of chick	1
Dissection of chick embryo for culturing fibroblast cells	1
Estimation of cell viability using trypan blue (dye exclusion) & calculations of seeding density for animal cell cultures	2
Establishing a monolayer culture using warm trypsinization method	1
Establishing a monolayer culture using cold trypsinization method	1
Subculture of monolayer culture	1
An investigation into the use of any 1 commercially available cell line for animal cell culture	1
TOTAL	**15**

REFERENCES

1. Das, H.K. (2005). Text book of Biotechnology, Wiley India Pvt. Ltd.
2. Freshney, I.R. (2005). Culture of animal cell –A Manual of Basic Techniques, 5th Edition, Wiley- Liss Publications.
3. Gangal, S. (2010). Principles and Practice of Animal Tissue Culture, 2nd edition, Universities Press.
4. Shivangi, M. (2006). Animal Cell and Tissue Culture, Agrobios, India.
5. Singh, B.D (2013). Biotechnology, Expanding horizons, Kalyani Publishers, New Delhi.

B.SC. DEGREE COURSE IN BIOTECHNOLOGY - COURSE STRUCTURE

(To be applicable from the academic year 2018)

SEMESTER	CORE		ELECTIVE			
I	**BIO-I.C-1** Biomolecules	**BIO-I.C-2** Cell Biology	--------	--------	--------	--------
II	**BIO-II.C-3** Fundamental Genetics	**BIO-II.C-4** Basic Microbiology	--------	--------	--------	--------
III	**BIO-III.C-5** Molecular Biology		**BIO-III.E-1** Basics of Plant and Animal Sciences	**BIO-III.E-2** Metabolism of Biomolecules	**BIO-III.E-3** Biostatistics	**BIO-III.E-4** Enzymology
IV	**BIO-IV.C-6** Immunology		**BIO-IV.E-5** Plant and Animal Physiology	**BIO-IV.E-6** Tools & Techniques in Biotechnology	**BIO-IV.E-7** Evolution and Anthropology	**BIO-IV.E-8** Molecular genetics
V	**BIO-V.C-7** Concepts in Genetic Engineering		**BIO-V.E-9** Molecular medicine	**BIO-V.E-10** Environmental Biotechnology	**BIO-V.E-11** Plant Biotechnology	**BIO-V.E-12** Bioinformatics
VI	**BIO-VI.C-8** Industrial Biotechnology		**BIO-VI.E-13** Bioethics and Bio-safety	**BIO-VI.E-14** Advanced Cell Biology	**BIO-VI.E-15** Food Biotechnology	**BIO-VI.E-16** Animal Cell Culture

Annexure I

BIO-I.C-1: BIOMOLECULES

COURSE TITLE: BIOMOLECULES (THEORY)
COURSE CODE: BIO-I.C-1
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVES: This paper provides basic foundation on biomolecules of life with reference to their properties, and biological functions. The course also provides detailed knowledge on how cellular structure and function arise as a result of the properties of cellular macromolecules.

LEARNING OUTCOMES: On the successful completion of the course the students will get an overall understanding of structure of atoms, molecules and chemical bonds, enzyme kinetics, bio polymers and metabolic reactions in a living system.

BIO-I.C-1: BIOMOLECULES (THEORY)

Unit 1: The foundations of Biochemistry **2hrs**

Landmarks in the history of Biochemistry (contributions particularly by Louis Pasteur, Carl Neuberg, Wilhelm Kuhne, Eduard Buchner);Urey -Miller‘s experiment.

Unit 2: Water and Molecular interactions **3 hrs**

Structure and unique properties; Covalent bonds, Hydrogen bonds, Ionic bonds, Hydrophobic bonds and Vander waal’s interactions.

Unit 3: Carbohydrates **7hrs**

Monosaccharides: Structure of aldoses and ketoses, ring structure of sugars; Stereochemistry: mutarotation, anomers, epimers and enantiomers;formation of disaccharides, reducing and non-reducing disaccharides; Polysaccharides: homo and hetero-polysaccharides, structural and storage polysaccharides.

Unit 4: Proteins **8hrs**

Amino acids**:**Structure and nomenclature, General properties, Zwitter ions, derivatives of amino acids and their biological role; Proteins**:** Peptide bond formation, structural Levels of protein;

Polypeptides:Structure and function ofCollagen, Elastin, Myoglobin and Haemoglobin; binding of oxygen to Myoglobin and Haemoglobin; Protein folding and misfolding;denaturation of Proteins.

Unit 5:Lipids **5hrs**

Fatty acids (saturated & unsaturated); Simple Lipids: Fats, oils, waxes; Compound Lipids: Phospholipids & Glycolipids; Derived Lipids: Steroids.

Unit 6: Nucleic acids **8hrs**

DNA structures and their importance, different types of RNA, unusual DNA structures, other functions of nucleotides: source of energy, component of coenzymes, second messengers.

Unit 7: Vitamins **5hrs**

Structure and active forms of water soluble and fat soluble vitamins; deficiency diseases and hypervitaminosis

Unit 8:Hormones **2hrs**

Classification and functions

Unit 9:Enzymology **5hrs**

Classification of enzymes; Mechanism of enzyme action,Lock & key theory & Induced fit theory; Factors affecting enzymes activity (pH, temperature enzyme concentration, substrate concentration); MM equation, Lineweaver-Burk plot;Enzyme Inhibition and its types;Ribozymes &Isoenzymes.

BCH-I.C-1: BIOMOLECULES (PRACTICAL)

COURSE TITLE: BIOMOLECULES (PRACTICAL)

COURSE CODE: BIO-I.C-1

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Introduction to safety measures in laboratories

Preparation of buffers &solutions (normal, molar, ppm , %)

Qualitative tests for carbohydrates, lipids, proteins and nucleic acids

Principle and working of a colorimeter and spectrophotometer

Determination of λmax and Molar extinction coefficient of a given compound

Estimation of reducing sugar - DNSA method

Estimation of protein – Folin Lowry's method

Titration curve of any one amino acid

Determination of peroxide value of oil

Effect of pH and temperature on amylase activity

REFERENCES

- Nelson, D. L. & Cox, M.M. (2000), Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
- Stryer, L. (1995). Biochemistry, W.H. Freeman and Co., New York, USA.
- Jain, J.L (1999), Fundamentals of Biochemistry, S.Chand and Company, Ltd., New Delhi.
- Murray, R.K, Granner, D.K, Mayes, P.A. &Rodwell, V.W. (2003), Harper's Illustrated Biochemistry, McGraw-Hill Companies.
- Sadasivam,S. andManickam, A. (1996), Biochemical Methods, New Age International (P) Limited
- Jayaraman, J. (1971), Laboratory Manual in Biochemistry, John Wiley & Sons, Limited.
- Plummer, D.T. (1993). An Introduction to Practical Biochemistry, Sixth Reprint. Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Harvey, R.A. & Ferrier, D.R. (2011). Lippincott's Illustrated Reviews, Biochemistry Fifth Edition, Lippincott Williams and Wilkins.

BIO-I.C-2: CELL BIOLOGY

COURSE TITLE: CELL BIOLOGY (THEORY)
COURSE CODE: BIO-I.C-2
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVES: The course will give a detailed description of the organization of the cell, the structure and functions of various organelles. The course also focuses on the communication cells and the importance of cell division

LEARNING OUTCOMES: Students will have a clear knowledge on the function of each cell organelle with proper coordination and establish the concept of how proper conformations of lipids and proteins in a membrane are needed for optimum functioning

BIO-I.C-2: CELL BIOLOGY(THEORY)

Unit 1: Introduction to cell biology **6 hrs**

Cell theory; ultra-structure of prokaryotic and eukaryotic cell; cell matrix proteins; components of extracellular matrix.

Unit 2:Ultra-structure and function of organelles **15 hrs**

Cilia and Flagella; Endoplasmic reticulum; Golgi apparatus; lysosomes;Microbodies; Mitochondria; Ribosomes; Centrioles and basal bodies; Nucleus; Chloroplasts and Peroxisomes.

Unit 3:Cell wall & Plasma membrane **9 hrs**

Chemical composition; structure and functions of the cell wall and plasma membrane; monolayer; planer bilayer and liposomes as model membrane systems; Fluid mosaic mode; lipid rafts; membrane fluidity; factors affecting membrane fluidity; techniques used to study membrane dynamics – FRAP.

Unit 4: Cell cycle **5 hrs**

Overview of the cell cycle; prokaryotic & eukaryotic cell cycle; events of mitotic & meiotic phases, cytokinesis.

Unit 5: Cell-Cell interaction **10 hrs**

Interactions of cells with extracellular materials: integrins, focal adhesions and hemidesmosomes; interactions of cells with other cells: selectins, the immunoglobulin superfamily, cadherins, adheren junctions and desmosomes; tight junctions, gap junctions and plasmodesmata.

BIO-I.C-2: CELL BIOLOGY (PRACTICAL)

COURSE TITLE: CELL BIOLOGY (PRACTICAL)

COURSE CODE: BIO-I.C-2

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Examination of prokaryotic cell, eukaryotic cell and cell organelles using Photomicrographs

Visualization of animal and plant cell using methylene blue

Study of cell viability using phenol red / trypan blue

Visualization of Permanent slides of:

A. Different cell types: Epithelium, Endothelium, Muscle cells, Nerve cell

B. Different stages of cell division

Identification of different stages of mitosis in onion root tip `

Identification of different stages of meiosis in onion flower buds

Isolation of chloroplast from spinach leaves

Prokaryotic cell harvesting &lysis using osmotic (salt) and Chemical (detergent) methods

REFERENCES

- Karp, G. & Harris, D. (2008) Cell and Molecular Biology – Concepts and Experiments, John Wiley & Sons Inc, New York.
- Robertis, E.D.P. &Robertis, E.M.F. (1998). Cell Biology and Molecular Biology, 8th edition, Sauder College.
- Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5thedition. ASM Press & Sunderland, Washington, D.C.
- Verma P.S. and Agarwal V. K. (1998).Cell Biology, Genetics, Molecular Biology, Evolution and ecology. 14 thed

BIO-II.C-3: FUNDAMENTAL GENETICS

COURSE TITLE: FUNDAMENTAL GENETICS (THEORY)
COURSE CODE: BIO-II.C-3
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVE: Genetics allows for the understanding of the structure and function of genes and chromosomes as well as the harmful effects of mutations which can cause various genetic disorders.

LEARNING OUTCOME: On completion of this module, students will be able to demonstrate an understanding of inheritance patterns and the basic principles of genetics. They will learn about the different mutations, its effects on cells and the application of the same to research.

BIO-II.C-3: FUNDAMENTAL GENETICS(THEORY)

Unit 1: Introduction to Genetics **2 hrs**

Scope and importance of Genetics; terminology.

Unit 2:Mendelian Genetics **8 hrs**

Mendel's experiments; principle of segregation; monohybrid crosses (dominance, recessiveness, co-dominance, incomplete dominance); principle of independent assortment; multiple alleles – ABO blood type and Rh factor alleles in humans; genotypic interaction – epistasis, pleiotropy and extra-nuclear inheritance.

Unit 3: Chromosomes **4 hrs**

Chromosome number; morphology; chromosome material and chemical composition; giant chromosomes.

Unit 4: Cell Cycle and cell division **4 hrs**

Cell cycle - The G1, S and G2 phase; Mitosis and Meiosis, Cell cycle checkpoints.

Unit 5: Introduction to the Concepts of: **2 hrs**

Inbreeding, heterosis, hybrid vigour.

Unit 6: Linkage and Crossing Over **4 hrs**

Concept of linkage and crossing over, Sutton-Boveri Chromosome theory of inheritance; coupling and repulsion hypothesis; types of linkage (complete and incomplete); types of crossing over; mechanism of meiotic crossing over & significance.

Unit 7: Sex Determination, Sex Linkage and Pedigree Analysis **8 hrs**

Sex determination (pattern and sex chromosomes); sex determination in human beings and flowering plants; dosage compensation; sex-linked inheritance – Haemophilia, Duchenne Muscular Dystrophy, Fragile X Syndrome, Colour blindness; pedigree Analysis – penetrance and expressivity; family tree; dominant inheritance; recessive inheritance.

Unit 8: Structural and Numerical Chromosomal Mutations **4 hrs**

Types of structural changes (deletion, duplication, inversion, translocation, variation in chromosome morphology); types of numerical changes (euploidy and aneuploidy).

Unit 9: Human Genetics **4 hrs**

Gene action and related diseases (Alkaptonuria, Phenylketonuria, Sickle Cell Anaemia); autosomal and sex chromosomal anomalies involving numerical and structural aberrations. (Down's, Cri-du-chat, Klinefelter's and Turner's syndromes).

Unit 10: Population Genetics **5 hrs**

Gene pool; theory of allele frequencies (gene and genotypic frequencies); the Hardy-Weinberg principle and its application; exceptions to the Hardy-Weinberg principle -natural selection; random genetic drift; problems on Hardy-Weinberg principle; speciation-definition of species and mode of speciation (allopatric, sympatric).

BIO-II.C-3: FUNDAMENTAL GENETICS (PRACTICAL)

COURSE TITLE: FUNDAMENTAL GENETICS (PRACTICAL)

COURSE CODE: BIO-II.C-3

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Study of a dissection microscope.

Study of barr bodies in sex determination.

Pedigree analysis and problem solving.

Karyotype analysis of chromosomal abnormalities.

Study of Polytene chromosomes.

Problem solving on Mendel's Laws & Hardy-Weinberg's Law

Study of mendelian traits in human population

REFERENCES

- Gardner, E. J., Simmons, M. J. &Snustad, D. P. (2013). Principles of Genetics, 8th Edition, John Wiley and Sons.
- Hotter, P. (2007. Dictionary of Genetics, IVY Publishing House, Delhi
- Jayaraman, K. &Jayaraman, R. (1979). Laboratory manual in Molecular Genetics, John Wiley and Sons.
- Tamarin, R.H. (2002). Principles of Genetics, 7th Edition, Tata McGraw-Hill Publishing Company Ltd.
- Verma, P.S. &Agarwal, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Pvt. Ltd.

BIO-II.C-4: BASIC MICROBIOLOGY

COURSE TITLE: BASIC MICROBIOLOGY (THEORY)
COURSE CODE: BIO-II.C-4
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVE: The main aim of this paper is to introduce the students to the vast world of Microbiology. This course covers a range of topics in Basic Microbiology from the historical perspective to the structure and composition of microorganisms, their interactions with the environment and their impact on humans.

LEARNING OUTCOME: On completion of this module, students will be able to understand the scope and importance of Microbiology, classification schemes, cultivation, preservation and maintenance of the microbial cultures.

BIO-II.C-4: BASIC MICROBIOLOGY(THEORY)

Unit 1: History and Scope of Microbiology **2 hrs**

Historical account from 16^{th} – 18^{th} century.

Unit 2: Basics of Microscopy **3hrs**

Principle of working of light microscope (Bright-field, Dark-field, Phase-contrast, Fluorescence).

Unit 3: Bacterial Taxonomy **8hrs**

Introduction to Archaea; taxonomic ranks; classification systems (Phenetic, Numerical, Phylogenetic); Bergey's Manual of Systematic/ Determinative Bacteriology and rDNA sequencing.

Unit 4: Organization and Ultrastructure of a Bacterial cell **8 hrs**

Cell wall: structure and chemical composition in Gram positive and Gram negative bacteria; introduction to cell membrane, pili, fimbriae and capsule; flagella structure and function; nucleoid and plasmids: nature and function; endospore: structure, sporulation and germination; reserve materials.

Unit 5: Reproduction in bacteria **4hrs**

Binary fission; definitions: cell growth, growth rate, generation time; bacterial growth curve; characteristics of growth phases; diauxic growth curve, continuous and synchronous growth.

Unit 6: Bacteria in Extreme Environments **3 hrs**

Thermophiles, barophiles, halophiles, acidophiles and alkaliphiles.

Unit 7:Cultivation of microorganisms **8hrs**

Sterilisation;disinfection; decontamination: principle and methods; types of culture media: synthetic/defined, complex solid, liquid, enrichment, selective, differential; cultivation of microorganisms: broth culture, agar plate, pour plate; determination of viable count: serial dilution; spread plating; determination of colony forming units (cfu) and calculation of viable count; isolation of pure cultures: streak plate; colony morphology.

Unit 8: Viruses **5 hrs**

Basic classification and structure of viruses (prokaryotic and eukaryotic); characteristic features of λphage; viral replication (lytic and lysogenic).

Unit 9: Maintenance and preservation of microbial cultures **4hrs**

Slant and stab cultures;periodic transfer; storage in sterile soil; overlaying with mineral oil; glycerol stocks;preservation in liquid nitrogen; lyophilisation.

BIO-II.C-4: BASIC MICROBIOLOGY (PRACTICAL)

COURSE TITLE: BASIC MICROBIOLOGY (PRACTICAL)

COURSE CODE: BIO-II.C-4

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Introduction to laminar air flow unit, autoclave, pH meter, incubator, microwave
Introduction to microscope
Preparation and sterilization of glassware
Preparation of media and autoclaving
Preparation of agar plates and open air cultures
Serial dilution technique and spread plating
Bacterial isolation techniques: streaking methods - simple continuous, T-streak, quadrant, radiant.
Preparation and staining of specimen- simple staining, Grams staining, endospore staining
Biochemical tests for bacterial identification: IMViC test, carbohydrate test
Isolation and staining of Fungi by lactophenol cotton blue
Cleaning and decontamination

REFERENCES

- Anantnaryan, R. &Paniker, C.K.J. (2005). Text book of Microbiology, 7th edition, Orient Blackswan.
- Aneja, K. R. (2007). Experiments in Microbiology, Plant Pathology and Plant Tissue Culture, New Age International.
- Gunasekaran, P. (1995). Laboratory Manual in Microbiology, New Age International.
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- PelczaR, M.J., Chan E, C.S. & Krieg, N.R. (1993). Microbiology, Fong and Sons Printers Pvt. Ltd.
- Stanier, R.Y. (1993) General Microbiology, Cambridge University.
- Willey, J. M., Sherwood, L., Woolverton, C. J. & Prescott, L. M. (2008). Prescott, Harley, and Klein's Microbiology, New York, McGraw-Hill Higher Education.

BIO-III.C-5: MOLECULAR BIOLOGY

COURSE TITLE: MOLECULAR BIOLOGY (THEORY)
COURSE CODE: BIO-III.C-5
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVE: This paper provides insight on replication, transcription and translation process in prokaryotes and eukaryotes, various mutations and their repair mechanisms.

LEARNING OUTCOME: On completion of this module, students will be able to understand the nature of genetic materials and the basic concepts in Molecular Biology.

BIO-III.C-5: MOLECULAR BIOLOGY (THEORY)

Unit 1: Basic Concepts in Molecular Biology **8 hrs**

Experiments proving DNA as genetic material: S. F. Griffith's transforming principle; Avery and Hershey and Chase Experiment; evidences for RNA as the genetic material of some viruses; Chargaff's experiments and law; Watson – Crick Model.

Unit 2: DNA Replication **8 hrs**

Experimental evidence for semi-conservative DNA replication in *E.coli*- Meselson and Stahl's experiment; the basic requirements of DNA replication: template, DNA polymerases: structure and function, ancillary proteins associated with replication; mechanism of replication in prokaryotes: initiation, elongation and termination; mechanism of DNA replication in eukaryotes; replication of circular DNA (rolling circle model).

Unit 3: Transcription **8 hrs**

Mechanism of prokaryotic transcription- transcription factors and machinery;formation of initiation complex; RNA polymerase enzyme; initiation; elongation and termination;transcription in eukaryotes- eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription;RNA processing: capping, splicing, polyadenylation.

Unit 4: Protein Synthesis **9 hrs**

Central dogmaand genetic code;mechanism of protein synthesis in prokaryotes - initiation, elongation and termination;mechanism of protein synthesis in eukaryotes- activation of amino acids, initiation, elongation and termination; post-translational modifications- phosphorylation, acylation, glycosylation & disulphide linkage.

Unit 5: DNA Damage and its Repair **6 hrs**

Mutations and types of mutations: spontaneous and induced mutation, missense, silent, frameshift, reversion; physical and chemical mutagens (ethidium bromide, alkylating agents, baseanalogs); DNA Repair Mechanisms: Mismatch, photo-reactivation repair, Excision repair.

Unit 6: Regulation of Gene Expression **3 hrs**

Lactose operon; Tryptophan operon

Unit7: Mechanism of Gene transfer **3 hrs**

Conjugation; transformation; transduction

BIO-III.C-5: MOLECULAR BIOLOGY (PRACTICAL)

COURSE TITLE: MOLECULAR BIOLOGY (PRACTICAL)

COURSE CODE: BIO-III.C-5

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Isolation of genomic DNA from prokaryotes

Isolation of genomic DNA from eukaryotes

Isolation of genomic RNA

Agarose gel electrophoresis

Determination of molecular size of DNA by agarose gel electrophoresis

Mutagenesis in *E.coli* cells – UV survival or chemical mutagens

Purity of DNA by spectrophotometric method

REFERENCES

- Krebs, J.E., Goldstein, E.S. & Kilpatrick, S.T. (2014). Lewin's Genes XI, Jones and Bartlett India Pvt. Ltd.
- Nelson, D. L. & Cox, M.M. (2000). Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
- Karp, G. & Harris, D. (2008) Cell and Molecular Biology – Concepts and Experiments, John Wiley & Sons Inc, New York.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Watson, J.D., Hopkins, N.H. et al. (2008). Molecular Biology of the Gene, Garland Publishing (Taylor & Francis Group), New York & London.
- Verma, P.S. &AgarwaL, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Pvt. Ltd.

BIO-III.E-1: BASICS OF PLANT AND ANIMAL SCIENCES

COURSE TITLE: BASICS OF PLANT AND ANIMAL SCIENCES (THEORY)
COURSE CODE: BIO-III.E-1
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVE: This paper will provide students with an insight into the Plant and Animal Kingdoms and their classification into different phyla. They will understand the variety of habitats that support the growth and reproduction of different plants and animals and will also look into the general characteristics and adaptations exhibited by these organisms.

LEARNING OUTCOME: On completion of this module, students will be able to distinguish between various phyla of the plant and animal kingdom and will also delve into the characteristics of these phyla. They will understand the differences in morphology and anatomy in Angiosperms and specific features present in non-chordates and chordates.

BIO-III.E-1: BASICS OF PLANT AND ANIMAL SCIENCES(THEORY)

Unit 1: Introduction **2 hrs**

Introduction to the plant and animal kingdom; introduction to classification systems

Unit 2: Plant Kingdom **8 hrs**

Study of the general characteristics of Algae, Fungi, Lichens, Bryophytes, Pteridophytes, Gymnosperms

Unit 3: Morphology and Anatomy in Angiosperms **10 hrs**

Vegetative morphology of roots; stem and leafreproductive morphology of flower; inflorescence, fruits;comparative anatomy of roots, stem and leaves in monocots and dicots; secondary growth in angiosperms

Unit 4: Animal Kingdom - Non chordates **7 hrs**

Study of habitat and general characteristics of Protozoa, Porifera, Cnidaria, Platyhelminthes Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata

Unit 5: Animal Kingdom–Chordates **4 hrs**

Study of habitat and general characteristics of: superclass Pisces; class Amphibia; class Reptilia; class Aves; class Mammalia

Unit 6: Salient features of non-chordates **8 hrs**

Study of salient features of non-chordates: disease-causing Protozoa, Platyhelminthes and nematodes (Aschelminthes); circulation in Porifera -water vascular system in Echinodermata; Excretion in Aschelminthes and Annelida; torsion in Gastropoda (Mollusca); metamorphosis in insects and economic importance (Arthropoda); corals and coral reefs (Cnidaria)

Unit 7: Salient features of Chordates **6 hrs**

Study of salient features of chordates: economic importance of fishes; parental care in amphibians; venomous and non-venomous reptiles; migration in birds; dentition in mammals

BIO-III.E-1: BASICS OF PLANT AND ANIMAL SCIENCES (PRACTICAL)

COURSE TITLE: BASICS OF PLANT AND ANIMAL SCIENCES (PRACTICAL)

COURSE CODE: BIO-III.E-1

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Study of algal types through temporary mounting: (*Chlorella* and *Anabaena*)

Microscopy study of thallus structures in Riccia and Cycas

Preparation of mycorrhizal slides by trypan blue method

T.S of monocot and dicot root

T.S of monocot and dicot stem

T.S of monocot and dicot leaf

Observation of permanent slides: Anther, ovules, embryo sac, embryo

Study of specimens with reference to habit, habitat, characteristic features: two examples from each Invertebrate major phyla

REFERENCES

- Barnes, R.D. (2000). Invertebrate Zoology, Hall Saunders International Editions.
- Jordan, E.L. &Verma, P.S. (2000). Invertebrate Zoology, S. Chand & Co. Pvt. Ltd. New Delhi.
- Jordan, E.L. &Verma, P.S. (2006). Chordate Zoology, New Edition, S. Chand & Co. Pvt. Ltd. New Delhi.
- Pandey, S.N. &Chadha, A. (1993). A Textbook of Botany, Plant Anatomy and Economic Botany, Volume III, Vikas Publishing House Pvt. Ltd.
- VERMA, V. (2010). Botany, Ane Books, Pvt. Ltd.

BIO-III.E-2: METABOLISMOFBIOMOLECULES

COURSETITLE: METABOLISMOFBIOMOLECULES (THEORY)
COURSE CODE: BIO-III.E-2
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45
PRE-REQUISITES: Completion of BIO-I.C-1- Biomolecules

COURSE OBJECTIVE: The aim of this paper is to understand simple concepts related to metabolism, its importance in the proper functioning of each cell and its regulation by enzymes.

LEARNING OUTCOME: On completion of this course, students will be able to understand the metabolism of biomolecules of life and comprehend how any defect in a pathway could lead to diseases. They will be equipped with the knowledge, skills and understanding of clinical aspects of biochemistry.

BIO-III.E-2: METABOLISMOFBIOMOLECULES(THEORY)

Unit 1: Basic concepts and design of metabolism **2 hrs**
Definition of metabolism;catabolism; anabolism; ATP as energy currency; energy relationship between catabolic and anabolic pathways

Unit 2: Carbohydrate metabolism **8 hrs**
Glycolysis; gluconeogenesis; pentose-phosphate pathway; glycogen synthesis and breakdown and its regulation;tri-carboxylic acid cycle;glyoxylate pathway

Unit 3: Oxidative phosphorylation **5 hrs**
The respiratory chain in mitochondria; proton gradient powering ATP synthesis; Transfer of cytosolic reducing equivalents to mitochondria: glycerol-3- phosphate and malate-aspartate shuttle

Unit 4: Fatty acid synthesis and degradation **8 hrs**
Digestion; mobilisation and transport of cholesterol and triacylglycerols;oxidation of fatty acids; ketone bodies; biosynthesis of fatty acids - elongation and unsaturation of fatty acids.

Unit 5: Amino acid catabolism and anabolism **4 hrs**

Overview of biosynthesis and catabolism of amino acids; Urea cycle

Unit 6: Nucleotide metabolism **4 hrs**

Biosynthesis - *de novo* and salvage pathways; degradation.

Unit 7: Integration of Metabolism **8 hrs**

The Feed-Fast Cycle: overview; enzymatic changes; activity in the liver; adipose tissue; resting skeletal muscle and brain during absorptive state;overview; activity in liver, adipose tissue, resting skeletal muscle, brain and kidney during fasting.

Unit 8: Metabolic Disorders **6 hrs**

Clinical characteristics; diagnosis and management of: Ehler'sDanlos syndrome (Classic type), Lesch-Nyhan syndrome, Alzheimer's disease; Xerodermapigmentosum; Crutzfeldt-Jakob disease; Gout

BIO-III.E-2: METABOLISMOFBIOMOLECULES (PRACTICAL)

COURSE TITLE: METABOLISMOFBIOMOLECULES (PRACTICAL)
COURSE CODE: BIO-III.E-2
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Estimation of protein – Biuret method
Estimation of DNA by Diphenylamine method
Estimation of Urea (serum/urine)
Estimation of Uric acid (serum/urine)
Estimation of blood glucose
Isolation of lecithin from egg yolk
Isolation of cholesterol from egg yolk
Separation of fatty acids by TLC
Estimation of blood cholesterol
Case studies: Clinical Characteristics, Diagnosis and Management of:
Alzheimer's Disease and Xerodermapigmentosum ,Ehler'sDanlos syndrome, Crutzfeldt-Jakob disease

REFERENCES

- Jain, J.L (1999). Fundamentals of Biochemistry, S.Chand and Company, Ltd., New Delhi.
- Nelson, D. L. & Cox, M.M. (2000). Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
- Stryer, L. (1995). Biochemistry, W.H. Freeman and Co., New York, USA.
- Harvey, R.A. & Ferrier, D.R. (2011). Lippincott's Illustrated Reviews, Biochemistry Fifth Edition, Lippincott Williams and Wilkins
- Plummer, D.T. (2008). An Introduction to Practical Biochemistry, Third Edition, Tata McGraw-Hill.
- NCBI GeneReviews (1993 – 2015), University of Washington, Seattle

BIO-III.E-3: BIOSTATISTICS

COURSE TITLE: BIOSTATISTICS (THEORY)
COURSE CODE: BIO-III.E-3
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVES: The main aim of this paper is to introduce the students to the concept of Biostatistics. This paper covers a range of topics which will introduce the theory behind each topic and the concept in each case through problem solving.

LEARNING OUTCOME: On completion of this module, students will be able to understand the importance of Biostatistics and the application of the same to the field of Biotechnology. They paper is so designed so as to understand the concepts that can be applied to relevant research work and to evaluate different parameters that are studied in quantitative research.

BIO-III.E-3: BIOSTATISTICS (THEORY)

Unit 1: Scope & importance of Biostatistics **2 hrs**

Definition; importance and applications of Biostatistics

Unit 2: Introduction to Sampling **3 hrs**

Concepts of: statistical population, sample; advantages and disadvantages of sampling; types of data; collection of data: primary & secondary data; types of sampling – simple; random sampling; stratified random sampling; systematic sampling; cluster sampling.

Unit 3: Graphical & Diagrammatic representation of data **3 hrs**

Tabulation of data; graphical and diagrammatic representation of data; construction of graphs using MS Excel

Unit 4: Measures of central tendency **8 hrs**

Characteristics of ideal measure; arithmetic mean – simple, weighted, combined, and corrected mean; limitations of arithmetic mean; median – calculation for raw data, for grouped data, for continuous series, limitations of median; mode –computation of mode for individual series, by grouping method in a continuous frequency distribution, limitations of modes;relationship between mean, median and mode; geometric mean; harmonic mean; quartiles; deciles; percentiles

Unit 5: Measure of dispersion **8 hrs**

Range, mean deviation, coefficient of mean deviation, standard deviation (individual observations, grouped data, continuous series), variance, coefficient of variance, limitation; Skewness – definition; positive; negative; Karl pearson’s coefficient, Bowley’s Coefficient

Unit 6: Correlation & regression analysis **12 hrs**

Correlation; covariance; correlation coefficient for ungrouped data; Spearson’s rank correlation coefficient; scatter and dot diagram (graphical method); regression; examples from biological sciences

Unit 8: Hypothesis testing **10 hrs**

Parameter and statistics; sampling theory;sampling and non-sampling error; confidence limits testing of hypothesis; test of significance; students’ T-test; paired t-test;F test; Chi-square test and ANOVA

BIO-III.E-3: BIOSTATISTICS (PRACTICAL)

COURSE TITLE: BIOSTATISTICS (PRACTICAL)
COURSE CODE: BIO-III.E-3
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Problem solving on arithmetic mean, median, mode (measures of central tendency) with reference to biological data

Problem solving on measures of central tendency with reference to biological data using MS Excel

Problem solving on measures of dispersion with reference to biological data

Graphical presentation of data – Construction of various types of graphs and charts based on the given data (Manually and using MS Excel)

Problem solving on ANOVA and Chi square test

REFERENCES

- Banerjee, P.K. (2011). Introduction to Biostatistics, A textbook of biometry, New Delhi, India: S. Chand & Company Ltd.
- Khan &Khanum (2004). Fundamentals of Biostatistics, Delhi: Ukaaz publications.
- Rajan, K. (2007). Biostatistics Theory and Problems, New Delhi: India, Himalaya Publishing House.
- Rastogi, V.B. (2011). Fundamentals of Statistics, Ane Books Pvt. Ltd.
- Ross, S. M. (2010). Introductory Statistics. Third edition, Academic press.

BIO-III.E-4: ENZYMOLOGY

COURSE TITLE: ENZYMOLOGY (THEORY)
COURSE CODE: BIO-III.E-4
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVE: The objective of the course is to provide a basic concept of the enzyme structure, function, kinetics, inhibition and their applications of in diagnostics.

LEARNING OUTCOME: The student will be able to describe structure, functions and the mechanisms of action of enzymes. The student will learn kinetics of enzyme catalyzed reactions and enzyme inhibitory and regulatory process.

BIO-III.E-4: ENZYMOLOGY(THEORY)

Unit 1: Introduction to enzymes **6 hrs**

Nature of enzymes - protein and non-protein (ribozyme); co-enzymes, cofactor & prosthetic group; apoenzyme;holoenzyme;ribozymes &isoenzymes;specificity of enzymes; classification of enzymes

Unit 2: Features of enzyme catalysis **6 hrs**

Fischer's lock and key hypothesis; Koshland's induced fit hypothesis; factors affecting the rate of reactions;(time, enzyme concentration, substrate concentration, pH, temperature).

Unit 3: Enzyme kinetics **10 hrs**

Principles of reaction rates; order of reactions and equilibrium constants; derivation of Michaelis-Menten equation and Lineweaver- Burk plot; significance of Km and Vmax, Kcat and turnover number

Unit 4: Enzyme inhibition **10 hrs**

Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and suicide, end product); mechanism based inhibitors - antibiotics as inhibitors; types of irreversible inhibition; allosteric inhibition

Unit 5: Mechanisms of enzyme action and regulation **6 hrs**

Mechanism of action of chymotrypsin;regulation of enzyme activity and its importance - aspartate transcarbamoylase

Unit 6: Applications of enzymes **7 hrs**

Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases); enzyme immunoassay (HRPO); applications of enzymes in industry – detergents, leather, food

BIO-III.E-4: ENZYMOLOGY (PRACTICAL)

COURSE TITLE: ENZYMOLOGY (PRACTICAL)

COURSE CODE: BIO-III.E-4

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Partial purification of any one enzyme from suitable source- ammonium sulphate precipitation, dialysis

Assay of enzyme activity and specific activity

Effect of pH on enzyme activity

Effect of temperature on enzyme activity

Effect of substrate concentration and determination of Km and V_{max}

SDS-PAGE

REFERENCES

- Nelson, D. L. & Cox, M.M. (2000), Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
- Jain, J.L (1999), Fundamentals of Biochemistry, S.Chand and Company, Ltd., New Delhi.
- Murray, R.K, Granner, D.K, Mayes, P.A. &Rodwell, V.W. (2003), Harper's Illustrated Biochemistry, McGraw-Hill Companies.
- Plummer, D.T. (1993). An Introduction to Practical Biochemistry, Sixth Reprint. Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Harvey, R.A. & Ferrier, D.R. (2011). Lippincott's Illustrated Reviews, Biochemistry Fifth Edition, Lippincott Williams and Wilkins.

BIO-IV.C-6: IMMUNOLOGY

COURSE TITLE: IMMUNOLOGY (THEORY)
COURSE CODE: BIO-IV.C-6
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVES: This paper aims at introducing the basic concepts of the immune system and its defense mechanisms. This will help them understand and reason out concepts related to diseases. A section on vaccination, monoclonal and polyclonal antibodies stresses on the importance of these for treatment of lethal diseases.

LEARNING OUTCOME: On completion of this module, the student will be able to understand all about the immune system and various antigen-antibody interactions involved in certain immune reactions.

BIO-IV.C-6: IMMUNOLOGY(THEORY)

Unit 1: Immune system **8 hrs**

Introduction to the immune system - historical perspective; types of immunity (innate and acquired); barriers of innate immunity – anatomic, physiologic, phagocytic, inflammatory; collaboration between innate and adaptive immunity; introduction to humoral and cell mediated immunity

Unit 2: Cells and organs of the immune system **8hrs**

Cells (myeloid and lymphoid lineage); immunoreactive cells (macrophages, granulocytes, NK Cells); primary lymphoid organs (bone marrow and thymus); secondary lymphoid organs; (spleen, lymph nodes, GALT and MALT).

Unit 3: B cells and T cells **5hrs**

B-cells & T-cells – structure; function and significance; maturation, activation of B-cells and T-cells

Unit 4: Antigen-antibody interactions **8 hrs**

Introduction to antigens and antibodies; structure, types, classes, properties and variants (e.g. immunogens, antigens, haptens, adjuvants); paratope and epitope; antigen – antibody interaction; forces involved in antigen-antibody reaction; concept of affinity, avidity, precipitation, agglutination reactions; applications in diagnostics

Unit 5: MHC and Hypersensitivity **4 hrs**

Major histocompatibility complex (MHC); introduction and discovery of human histocompatibility complex; structure of MHC I and II; presence of MHC I and II on different cells and their significance; hypersensitivity - Introduction

Unit 6: Complement system **4 hrs**

The complement system; functions, components and activation pathways (classical, alternate &lectin)

Unit 7: Vaccines & monoclonal antibodies **4 hrs**

Introduction to vaccines and types of vaccines; Polyclonal & Monoclonal antibodies (hybridoma technology)

Unit 8: Autoimmunity and immunodeficiency **4hrs**

Introduction to autoimmunity with examples; introduction to immunodeficiency types with examples

BIO-IV.C-6: IMMUNOLOGY (PRACTICAL)

COURSE TITLE: IMMUNOLOGY (PRACTICAL)

COURSE CODE: BIO-IV.C-6

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Study of lymphoid organs and cells of the Immune System

Total count of WBC & RBCs using haemocytometer

Differential count of WBC

Blood grouping & Rh factor

Preparation of serum

Single Radial Immunodiffusion

Ouchterolony’s double diffusion method

Immunoelectrophoresis

ELISA (Demonstration)

Serological tests involving precipitations (Pregnancy &Widal)

Estimation of Haemoglobin by Sahali’s method

REFERENCES

- Arora, M.P. (2006). Cell Biology, Immunology and Environmental Biology, Himalaya Publishing House.
- Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Kuby, J (2000).Immunology, W.H. Freeman & Company, New York.
- Rao, C.V. (2011). Immunology, Narosa Book Distributors Pvt. Ltd.
- Roitt, I.M., Brostoff, J. & Male, D.K. (1993). Immunology, Mosby-Year book Europe Limited.

BIO-IV.E-5: PLANT AND ANIMAL PHYSIOLOGY

PAPER TITLE: PLANT AND ANIMAL PHYSIOLOGY (THEORY)
PAPER CODE: BIO-IV.E-5
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45
PRE-REQUISITES: Completion of BIO-III.E-1- Basics of Plant and Animal Sciences

COURSE OBJECTIVES: The main aim of this paper is to introduce the students to the physiology of plant and animal systems with special emphasis on humans, thereby allowing them to understand how plant and animal systems function.

LEARNING OUTCOME: On completion of this module, students will be able to understand plant and animal physiology. The organs and processes involved in each case. They will also be able to comprehend and distinguish organs and organs systems while understanding the biological functions associated with every system.

BIO-IV.E-5: PLANT AND ANIMAL PHYSIOLOGY(THEORY)

PLANT PHYSIOLOGY

Unit 1: Plant – Water Relations **2 hrs**

Absorption (passive and active); ascent of sap and transpiration

Unit 2: Photosynthesis & photorespiration **8 hrs**

Chloroplast pigments; photosystem I and II; electron flow through cyclic and non-cyclic; photophosphorylation; CO_2 fixation in C3 and C4 plants; CAM and glycolate pathways

Unit 3: Physiology of flowering in angiosperms **3 hrs**

Photoperiodism; vernalization and dormancy; molecular models of flowering: ABC model

Unit 4: Plant hormones and regulation of plant growth **4 hrs**

Hormonal; (auxin,cytokinin, gibberllins, ethylene and abscissic acid); regulation of plant growth and development

Unit 5: Secondary metabolites in plant **4 hrs**

Classification of secondary metabolites and sources of: phenolics, porphyrins ,terpenoids , alkaloids

ANIMAL PHYSIOLOGY

Unit 6: Digestive system **3 hrs**

The digestive system and associated glands in mammals

Unit 7: Muscular system **2 hrs**

Introduction to the muscular system; types of muscles, muscle movement

Unit 8: Respiration and circulation **5 hrs**

The respiratory system – organs and their function; the circulatory system – components and their function

Unit 9: Excretory system **3 hrs**

The excretory system and associated functions

Unit 10: Nervous system **5 hrs**

The nervous system and associated functions

Unit 11: Gametogenesis and reproductive physiology **6 hrs**

Spermatogenesis and oogenesis; mammalian reproductive physiology – male and female reproductive system; an overview of developmental biology and regulatory mechanisms

BIO-IV.E-5: PLANT AND ANIMAL PHYSIOLOGY (PRACTICAL)

COURSE TITLE: PLANT AND ANIMAL PHYSIOLOGY (PRACTICAL)
COURSE CODE: BIO-IV.E-5
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Study of physiology of plants using charts
Study of rate of photorespiration in plants
Study of osmosis: endosmosis and exosmosis in plants
Osmolarity of RBC's (Effect of different salt solutions of RBC's)
Isolation of Rhizobium from root nodules and Gram's staining
Qualitative phytochemical analysis in medicinal plants
Analysis of the animal physiology systems in man using charts – the reproductive, digestive, respiratory, circulatory, excretory, nervous and muscular systems.
Observation of permanent slides – Transverse section of mammalian gonads
Developmental stages in Frog (cleavage, blastula, gastrula)
Analysis of components of blood – WBC's and RBC's & observations on each
Analysis of human blood pressure and pulse rate in man

REFERENCES

Plant physiology:

- Galston, A.W. (1989). Life Processes in Plants, Scientific American Library, Springer-Verlag., New York, USA.
- Hopkins, W.G. (1995). Introduction to Plant Physiology, John Wiley & Sons, Inc., New York, USA.
- Moore, T.C. (1989). Biochemistry and Physiology of Plant Hormones (Second edition), Springer-Verlag., New York.
- Pandey, S.N., Mishra, S.P. &Trivedi, P.S. (1982), College Botany, Tata McGraw-Hill, New Delhi.

Animal Physiology:

- Arora, M.P. (2011). Animal physiology, Himalaya publishing house.

- Sembulingam, K. &Sembulingam, P. (2012). Essentials of Medical Physiology, Sixth edition., Jaypee brothers medical publishers (P) Ltd, New Delhi
- Verma, S.K., Tyagi, A.K. &Agarwal, B.B.L. (2000). Animal Physiology, S. Chand and Company

BIO-IV.E-6: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY

COURSE TITLE: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (THEORY)
COURSE CODE: BIO-IV.E-6
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVE: This paper aims at introducing the importance of the basic concepts of instruments and their applications in the field of biotechnology.

LEARNING OUTCOME: On completion of this paper the students will be able to understand the various principles and applications of separation & spectroscopic techniques along with the uses of radioactivity which have wide applications in biomedical research.

BIO-IV.E-6: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (THEORY)

Unit 1: Basics of biochemical studies **6 hrs**

Units of measurement; weak electrolytes- the biochemical importance of weak electrolytes; ionisation of weak acids and bases; calculation of pH; ionisation of a weak electrolyte; buffer solutions;buffer capacity;buffer action; measurement of pH

Unit 2: Centrifugation **5 hrs**

Principle of centrifugation; centrifugal force and sedimentation rate; preparative and analytical ultracentrifuges; differential and density gradient centrifugation

Unit 3: Chromatography **7 hrs**

Principle and technique of : paperchromatography, TLC, gel filtration chromatography, ion exchange chromatography, affinity chromatography, HPLC, GLC

Unit 4: Spectroscopy **5 hrs**

Principle and technique of UV, fluorescence, infrared, Raman and AAS

Unit 5: Electrophoresis **8 hrs**

Gel electrophoresis- agarose and PAGE (SDS and native); isoelectric focusing and 2D PAGE

Unit 6: Probes and hybridization **8 hrs**

Introduction to hybridization probes; radioactive and non-radioactive probes; FISH; southern; northern; western blotting and hybridization

Unit 7: Radioisotopes techniques **6 hrs**

Radiation – sources; types and applications of isotopes; radioactive decay – alpha, beta, gamma and x-rays; rate of radioactive decay and radioactive units; Geiger Muller counter and scintillation

BIO-IV.E-6: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (PRACTICAL)

COURSE TITLE: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (PRACTICAL)

COURSE CODE: BIO-IV.E-6

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Comparison of absorption curves of any two coloured compounds

Isolation of plant chloroplasts by density gradient centrifugation

Preparation of TLC plates & separation of plant pigments

Gel filtration chromatography- Demonstration

Review of HPLC technique

Study of Atomic Absorption Spectroscopy

Dialysis of protein and SDS-PAGE

Southern blotting technique- Demonstration

REFERENCE BOOKS:

- Mahesh, S. (2003) Biotechnology-3 Including Molecular Biology and Biophysics, New Age International Private Limited, Publishers New Delhi.
- Arora, M.P. (2006) Biophysics, Himalaya Publishing House, New Delhi.
- Bajpai, P. K. (2010). Biological Instrumentation and Methodology, Second Revised Edition. S. Chand and Company Limited.
- Upadhyay, Upadhyay& NATH (2010) Biophysical Chemistry Principles and Techniques, Fourth Revised Edition, Himalaya Publishing House, New Delhi.
- Sivasankar, B. (2009). Bioseparations Principles and Techniques, PHI Learning Private Limited, New Delhi.
- Plummer, D.T. (1993). An Introduction to Practical Biochemistry, Sixth Reprint. Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Jayaraman, J. (2011). Laboratory Manual for Biotechnology, Second Edition. New Age International Private Limited, Publishers New Delhi.
- Verma, A.S., Das, S. & Singh, A. (2014). Laboratory Manual for Biotechnology, First Edition, S. Chand and Company Private Limited.

BIO-IV.E-7: EVOLUTION AND ANTHROPOLOGY

COURSE TITLE: EVOLUTION AND ANTHROPOLOGY (THEORY)
COURSE CODE: BIO-IV.E-7
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVE: This paper aims at introducing the importance of the basic concepts of Evolution and anthropology and its importance in the field of biotechnology which will increase the awareness of the principles of human evolution and the biological adaptations that humans have made through time to various biotic and abiotic factors. .

LEARNING OUTCOME: On completion of this paper the students will be able to understand the evolutionary history, describe the historical development of anthropology and be able to characterize how each subfield contributes to the unified discipline,compare past and present cultures, including ecological adaptations with a scientific approach. The students would be able to explain quantitative and qualitative methods in the analysis of anthropological data and critically evaluate the logic of anthropological research and apply anthropological research to contemporary environmental, social, or health issues worldwide.

BIO-IV.E-7: EVOLUTION AND ANTHROPOLOGY (THEORY)

Unit 1: Evolution of Life **5 hrs**

Organic evolution; evidences; mechanism & theories; chemical evolution; biological evolution; types of Organic evolution

Unit 2: Evolution of Species **5 hrs**

Lamarckism; Darwinism; modern synthetic theory; mutational theory;introduction to molecular clock

Unit 3: Evolution above species level **5 hrs**

Adaptive radiations with examples macroevolutions;microevolution;Simpson's adaptive grid;macroevolution

Unit 4: Speciation **4 hrs**

Nature of Speciation**;**modes of speciation (instantaneous and gradual)**;** types of barriers and isolation

Unit 5: Selection **4 hrs**

Types **–** selection; natural selection (directional, disruptive, stabilizing) and artificial

Unit 6: Geographical and Geological Time Scale **3 hrs**

An overview of the geographical and geological time scale

Unit 7: Fossils **6 hrs**

Formation; conditions; nature and types of fossils; determination of age of rocks and fossils (carbon dating); evidences of evolution from fossils

Unit 8: Introduction to anthropology **2 hrs**

Definition; areas and applications; relationship of biological anthropology with other sciences

Unit 9: Evolution of Man **6 hrs**

Phylogenetic status; characteristics and geographical distribution of the following: Homo erectus, Neanderthal man, Rhodesian man, Homo sapiens

Unit 10: The role of biotechnology in anthropology **5 hrs**

Phylogenetic trees; mitochondrial DNA; Y chromosome analysis

BIO-IV.E-7: EVOLUTION AND ANTHROPOLOGY (PRACTICAL)

COURSE TITLE: EVOLUTION AND ANTHROPOLOGY (PRACTICAL)
COURSE CODE: BIO-IV.E-7
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Study of the various theories of evolution
Evidences for Evolution - Study of Darwin's theory of evolution with examples
Evidences for Evolution - Study of L.S.B. Leakey's work in establishing human evolutionary development in Africa
Problems based on Selection
Study of genetic evolution across species
Construction of phylogenetic trees
Study of types of fossils
Study of dentition of different types of mammals – (Herbivores, Carnivores and Omnivores)
Visit to museum in Old Goa for anthropological studies
Comparative studies of prehominids and hominids
Comparative studies of haemoglobins

REFERENCES

- Bhasin M.K. &Chahal, S.M.S.(1996), Manual of Human Blood Analysis, Kamla Raj, Delhi.
- Haviland. (2008). Introduction to Anthropology, Paperback.
- Routlege& Paul, K. (1971), Notes and Queries in Anthropology, London.
- Srivastava, V.K. (2004), Methodology and Fieldwork, Oxford.
- Stanford, C., Allen, J.S. & Anton, S.C. (2009), Exploring Biological Anthropology: The Essentials, Prentice Hall.
- Verma, P.S. and Agarwal, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Private limited, New Delhi.

BIO-IV.E-8: MOLECULAR GENETICS

COURSE TITLE: MOLECULAR GENETICS (THEORY)
COURSE CODE: BIO-IV.E-8
MARKS: 75
CREDITS: 3
PRE-REQUISITES: Completion of BIO-II.C-3 and BIO-III.C-5
TOTAL HOURS: 45

COURSE OBJECTIVE: Having completed the two prerequisite courses - Fundamental Genetics and Molecular Biology, students will be able to apply their knowledge and skills to this paper. It focuses on various aspects of human genetics and explores the techniques and tools at the molecular level that can be used to identify them.

LEARNING OUTCOME: On completion of this course, students will understand the molecular aspects of genetics including DNA variation and mutations. They will also be able to apply their knowledge of various molecular techniques in order to diagnose specific genetic disorders and to calculate risk factors in genetic counseling for individuals with a family history of these disorders.

BIO-IV.E-8: MOLECULAR GENETICS(THEORY)

Unit 1: Introduction **2 hrs**

Introduction to molecular genetics – organization of a eukaryotic genome (human genome)

Unit 2: Chromosomes and cell division **9 hrs**

Classification and nomenclature of chromosomes; methods of chromosome analysis (chromosome banding techniques – G, R, Q, C and high resolution banding); brief account of cell cycle; mitosis and meiosis; mechanisms of aneuploidy – non-disjunction; non-conjugation; anaphase lag; premature division of centromere; syndromes caused by aneuploidy – prevalence, causes and clinical features of Down’s syndrome, Edward’s syndrome and Patau syndrome; causes of polyploidy; structural abnormalities – reciprocal and Robertsonian translocations; Brief account of mosaicism and Chimerism

Unit 3: Review of central dogma of molecular biology **1 hr**

Brief review of structure of DNA and replication, transcription and translation processes

Unit 4: DNA Variation **3 hrs**

Variation in DNA: genetic polymorphism; restriction Fragment Length Polymorphism (RFLP); short tandem repeat polymorphism (STR); variable number tandem repeat (VNTR)

Unit 5: Techniques and tools in molecular biology **8 hrs**

Techniques and Tools in Molecular Biology used in Genetic Diagnoses: genetic material studied for diagnoses– DNA, RNA and cDNA;DNA fragmentation and separation by electrophoresis and membrane transfer; selective amplification of a nucleotide sequence using PCR; molecular hybridization techniques and applications:Labeled probes,fluorescence in situ hybridization (FISH),southern blot hybridization, dot blot and reverse dot blot, ARMS and OLA techniques, DNA microarrays

Unit 6: The Diagnosis of Inherited Diseases **6 hrs**

Clinical description; molecular basis and genotype-phenotype correlation of:cystic fibrosis, α-thalassemia and β-thalassemia, duchenne Muscular dystrophy, Huntington's disease

Unit 7: Genetic counseling **7 hrs**

Screening (pre and post natal) for genetic abnormalities; establishing the diagnosis (family history and pedigree chart); calculation, presentation and quantification of risk (Bayesian determination of recurrent risks for genetic disorders within families); placing risks in context and discussion of options; patient support groups; directive and non-directive genetic counseling; special problems in genetic counseling

Unit 8: Gene Therapy **3 hrs**

An overview of gene therapy and its applications in treating genetic disorders e.g. SCID

Unit 9: Forensic genetics **6 hrs**

Brief History; biological evidence – sources, collection, identification, characterization; DNA fingerprinting using PCR-based and non-PCR-based techniques

BIO-IV.E-8: MOLECULAR GENETICS (PRACTICAL)

COURSE TITLE: MOLECULAR GENETICS (PRACTICAL)

COURSE CODE: BIO-IV.E-8

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Extraction of DNA from human blood and saliva

Visualization of extracted DNA on agarose gels

Principle of Southern blot

Study of diagnostic tools based on DNA polymorphisms

Principle of preparation of human metaphase chromosomes

Steps in molecular diagnosis of and further genetic counseling for:

1) Cystic fibrosis

2) α-thalassemia and β-thalassemia

3) Duchene muscular dystrophy

4) Huntington's disease

Risk calculation: using Bayes method for any two clinical case studies

Clinical features of Down's syndrome, Edward's syndrome and Patau syndrome and mechanisms leading to aneuploidy

Research: Current status of gene therapy for any two genetic disorders

REFERENCES

- Goodwin, W., Linacre, A. &Hadi, S. (2007). An Introduction to Forensic Genetics, John Wiley & Sons, Ltd.
- Pasternak, J.J. (2005). An Introduction to Human Molecular Genetics, Mechanisms of Inherited Diseases, Second Edition, John Wiley % Sons, Inc.
- Serre, J.L. (2006). Diagnostic Techniques in Genetics, John Wiley & Sons, Ltd.
- Turnpenny, P.D. &Ellard, S. (2007). Emery's Elements of Medical Genetics, 13th Edition, Churchill Livingstone Elsevier.

BIO-V.C-7: CONCEPTS IN GENETIC ENGINEERING

COURSE TITLE: CONCEPTS IN GENETIC ENGINEERING (THEORY)
COURSE CODE: BIO-V.C-7
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45
PRE-REQUISITES: Completion of BIO-III.C-5- Molecular Biology

COURSE OBJECTIVES: The paper aims to introduce the students to the principles and techniques involved in Genetic Engineering through the use of genetic material and vehicles for suitable manipulation of genes.

LEARNING OUTCOME: On completion of this module, students will be able to understand how genes are genetically engineered and the need for the same. The practical component will train them towards performing with understanding genetic manipulations of genes.

BIO-V.C-7: CONCEPTS IN GENETIC ENGINEERING (THEORY)

Unit 1: Introduction to genetic engineering **2 hrs**

Aims; principles; applications; ethical issues involving recombinant DNA technology and genetic engineering

Unit 2: DNA modifying enzymes **3 hrs**

Nucleases- endonucleases (restriction enzymes recognition sequences, cleavage pattern); exonucleases**;**DNA ligases**;**reverse transcriptases**;**polynucleotide kinases**;**alkaline phosphatases**;**nucleotidyltransferases

Unit 3: Vehicles for gene cloning **10 hrs**

Vectors - properties of ideal cloning vectors**;** plasmids – properties, classification**;** Vector for Prokaryotes - pBR322, pUC 18**;** bacteriophages as cloning vectors - lambda bacteriophages; features-insertional vectors and replacement vectors & M13 Bacteriophage; cosmids, phagemids and phasmids- definition, features with examples; vectors for cloning in *Saccharomyces cerevesiae* (examples and features)**;** shuttle vectors - any one example; vectors for plant – Ti plasmid

Unit 4: DNA insertion into vector **3 hrs**

Ligation; linkers; adaptors, homopolymer tailing

Unit 5: Transformation methods **8 hrs**

Methods, advantages and disadvantages: competence (transformation in bacteria); microinjection; lipofection; electroporation; macroinjection; sonication; silicon carbide fibre vortex; DNA co-precipitation; ultrasonication; laser induced; *Agrobacterium* mediated transfers

Unit 6: Identification of recombinants **4 hrs**

Principle and importance of identification of recombinants; antibiotic resistance (amp, tet resistance); lac Z selection; colony hybridization;*cI*selection

Unit 7: DNA isolation methods and analysis **5 hrs**

Isolation of genomic DNA & plasmid DNA; principle of plasmid isolation; spectrophotometric analysis of DNA; agarose gel electrophoresis; purification of DNA

Unit 8: Amplification of nucleotide sequences **3 hrs**

Polymerase chain reaction (principles, components & method of PCR)

Unit 9: DNA sequencing **5 hrs**

Significance and importance of DNA sequencing**;** Maxam Gilbert's method**,** Sanger's method**,** Automatic DNA sequencer

Unit 10: Genomic / cDNA libraries **2 hrs**

Preparation of genomic library;cDNA library**;**screening of libraries

BIO-V.C-7: CONCEPTS IN GENETIC ENGINEERING (PRACTICAL)

COURSE TITLE: CONCEPTS IN GENETIC ENGINEERING (PRACTICAL)

COURSE CODE: BIO-V.C-7

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Plasmid DNA isolation by alkaline lysis method

Plasmid DNA isolation by boiling method

Plasmid DNA separation on agarose gel

Molecular size determination of the plasmid

Preparation of competent cells in bacteria

Transformation in bacteria using suitable plasmid (pUC 18)

Selection of transformed colonies

Deciphering the DNA sequence from a sequencing gel photograph by Maxam and Gilbert's method and Sanger's method

Demonstration of Polymerase Chain Reaction (PCR)

REFERENCES

- Brown, T.A. (2006) Manipulation of purified DNA. In:Gene cloning & DNA analysis An Introduction, 5th Ed. Blackwell publishing, Ltd, UK
- Jogdand, S.N. (2008). Gene Biotechnology, 2nd edition, Himalaya Publishing House, Mumbai.
- Primrose, S.B. & Twyman, R.M. (2009). Principles of Gene Manipulation and Genomics, Blackwell Publishing.
- Purohit, S.S. (2009). Biotechnology: Fundamentals and Applications, Student Edition.
- Singh, B.D. (2008). Biotechnology: Expanding Horizons, Kalyani publishers.
- Watson, J.D., Tooze, J. & Kurtz, D.T. (1983). Recombinant DNA: A short Course, Scientific American Books (WH Freeman), New York.

BIO-V.E-9 MOLECULAR MEDICINE

COURSE TITLE: MOLECULAR MEDICINE (THEORY)
COURSE CODE: BIO-V.E-9
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45
PRE-REQUISITES: Completion of BIO-IV.E-8 -Molecular Genetics

COURSE OBJECTIVE: Molecular medicine is the application of molecular biology and molecular genetics to the understanding of human health and disease. It aims to understand the underlying origins and mechanisms of human diseases and to find novel ways of preventing, diagnosing and treating diseases.

LEARNING OUTCOME: On completion of this module, students will be able to understand the underlying genetic factors of common diseases, complex genetic traits and molecular and cellular therapies for the same. They will also gain more clarity on cancer genetics, pharmacogenetics and maintenance of public health.

BIO-V.E-9 MOLECULAR MEDICINE (THEORY)

Unit 1: Historical aspects **2hrs**

History of molecular medicine – the foundations (1869 – 1980s);the modern era (1980s – 2000s)**;** The Human Genome project (1990 – 2000)

Unit 2: Gene structure and expression **3 hrs**

Exons, introns, alternative splicing**,** epigenetic changes

Unit 3: Genetic factors in common diseases **6 hrs**

Hypertension; coronary heart disease; autism;alzheimer disease;haemochromatosis; age-related macular degeneration

Unit 4: Complex genetic traits **4 hrs**

Multifactorial disorders – diabetes, dementia, schizophrenia;novel mechanisms for DNA and disease – mitochondrial inheritance, genomic imprinting, mosaicism, chimerism

Unit 5: Cancer genetics **5 hrs**

Differentiation between genetic and environmental factors in cancer; oncogenes – types and function; tumour-suppressor genes – “two hit hypothesis”; genetics of common cancers – breast, ovarian and prostate cancer

Unit 6: Introduction to omics **3 hrs**

Genomics, Proteomics, Metabolomics, Phenomics, Metagenomics

Unit 7: DNA Tests **4 hrs**

Direct Detection; indirect detection - DNA scanning; linkage analysis; classes of DNA tests and function of each type; validity of DNA tests

Unit 8: Molecular and cellular therapies **8 hrs**

Recombinant DNA products – Factor VIII (Haemophilia); vaccines; somatic cell gene therapy; examples of gene therapy trials – ADA, haemophilia, cancer, eye disease, HIV; RNA therapies – RNA interference (RNAi), ribozymes; regenerative medicine – cloning, stem cells

Unit 9:Pharmacogenetics **3 hrs**

Drug metabolism; genetic variations revealed by effects of drugs; pharmacogenetics – maturity-onset diabetes of the young (MODY); neonatal diabetes; pharmacogenomics; adverse effects; efficacy

Unit 10: Public health **4 hrs**

Preventive medicine; population screening (cystic fibrosis, sickle cell anaemia, newborn screening); changing behaviour (familial hypercholesterolemia); DNA testing in the workplace – predisposition to disease; detecting exposure to toxins; litigation, identity

Unit 11: Delivering genetics and genomics to consumers **3 hrs**

Definitions and marketplace, types of direct-to-consumer (DTC) DNA tests; Pros and Cons of DTC DNA Tests

BIO-V.E-9: MOLECULAR MEDICINE (PRACTICAL)

COURSE TITLE: MOLECULAR MEDICINE (PRACTICAL)

COURSE CODE: BIO-V.E-9

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Investigation of Genetic Factors in any four common diseases

Study of mitochondrial inheritance, genomic imprinting, mosaicism and chimerism with one example of each

A study on the types of DNA tests for diagnosis of diseases

Investigation of Molecular Mechanisms of any one type of Cancer

Understanding concepts relating to genomics and proteomics

A study on RNA therapies and regenerative medicine

Application of pharmacogenetics in drug metabolism

An investigation into the screening programmes adopted in various countries

Submission of a report on the molecular mechanisms and therapy for any one disease

REFERENCES

- Trent, R.J. (2005). Molecular Medicine – an Introductory Text, Elsevier Academic Press.
- Trent, R.J. (2012). Molecular Medicine – Genomics to Personalized Health Care, Fourth Edition, Elsevier Inc.
- Turnpenny, P.D. &Ellard, S. (2007). Emery's Elements of Medical Genetics, 13th Edition, Churchill Livingstone Elsevier.

BIO-V.E-10: ENVIRONMENTAL BIOTECHNOLOGY

COURSE TITLE: ENVIRONMENTAL BIOTECHNOLOGY (THEORY)
COURSE CODE: BIO-V.E-10
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVES: The main aim of this paper is to introduce the students to the hazards of our environment, the effects of pollution on living systems, solutions to protect the environment for sustainable development.

LEARNING OUTCOME: On completion of this module, students will be able to understand the effects of various types of pollution and gain knowledge in areas like development of biological systems for remediation of contaminated environments and environment-friendly processes such as green manufacturing technologies and sustainable development.

BIO-V.E-10: ENVIRONMENTAL BIOTECHNOLOGY(THEORY)

Unit 1: Introduction **2 hrs**

The scope of environmental biotechnology

Unit 2: Basic ecological concepts and principles **4 hrs**

Structure (biotic and abiotic components); food chain and food webs; ecological pyramids; productivity and eco-energetic (10% law)

Unit 3: Anthropogenic activities, its effects and control **12 hrs**

Air pollution: major air pollutants and their sources, Impacts of air pollution on human health, animals, plants and climate;removal of gaseous contaminants and odour: bioscrubbers, biotrickling filters and biofilters/biobeds;water pollution:principal forms of water pollutants and their sources;wastewater treatment: activated sludge process, rotating biological discs, oxidation ponds, trickling filters;soil pollution: soil pollution and their sources; treatment of solid wastes: hazardous; non hazardous; composting and vermitechnology

Unit 4: Pollution monitoring **10 hrs**

Bio indicators: concept and examples (indicators of water quality; air pollution indictors); choice of criteria: visual rating; genotoxicity; metabolic rating; applications (two each); using plant test systems and animal test systems; tests for assessing Genetic damage: AMES test; cyto-genetic assay; membrane damage; concept and applications of molecular biology in environmental monitoring: reporter gene: concept and applications of biosensors in pollution detection

Unit 5: Pollution abatement: Bioremediation and biodegradation **10 hrs**

Bioremediation: definition, microbial bioremediation, phytoremediation; microbial desulphurization of coal (direct and indirect mechanisms); biodegradation: basis of biodegradation, concepts of use of mixed microbial populations; Biodegradation of two xenobiotics: aromatic hydrocarbons (benzene) and alkanes; Biosorption: principle; use of fungi and algae (2 examples each); genetically engineered microorganisms - super bug (*Pseudomonas*sps.)

Unit 6:Ecofriendly Bio-products **7 hrs**

Biogas (biomethanisation) production; bioethanol production; bio hydrogen production: anaerobic bacteria and photolysis photosynthetic algae; biodiesel production; bioplastics: biopol and biolac; biopesticide

BIO-V.E-10: ENVIRONMENTAL BIOTECHNOLOGY (PRACTICAL)

COURSE TITLE: ENVIRONMENTAL BIOTECHNOLOGY (PRACTICAL)

COURSE CODE: BIO-V.E-10

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Determination of dissolved oxygen concentration of water sample by Winkler's method
Determination of biological oxygen demand (BOD) of the given sample
Determination of chemical oxygen demand (COD) of the given sample ($KMnO_4$/ $K_2Cr_2O_7$ method)
Determination of TS (total solids) of the given water sample
Isolation of xenobiont degrading bacteria by selective enrichment
Determination of nitrates from water sample
Visit to an effluent /sewage treatment plant and preparation of report
Detection of coliforms for determination of the purity of potable water (MPN, Presumptive, confirmatory and confirmed tests)

REFERENCES

- Agarwal S.K. (2009). Environmental Biotechnology, APH Publishing Corporation New Delhi.
- Anjaneyulu Y. (2005). Introduction to environmental Science, BS publications, India.
- Chatterji A.K. (2009). Introduction to Environmental Biotechnology, 2nd ed, Prentice Hall of India Pvt. Ltd. New Delhi.
- Jogdand B.N. (2008). Environmental Biotechnology (Industrial Pollution Management), Himalaya Publishing House, Mumbai.
- Santra S.C. (2001). Environnemental Science, New central book agency (P) Ltd. Calcutta.
- Singh B.D. (2008). Biotechnology, 3rd edition, Kalyani Publishers.
- Thakur I.S. (2006). Environmental Biotechnology: Basic concepts and applications, I.K. International Pvt. Ltd. New Delhi.

BIO-V.E-11: PLANT BIOTECHNOLOGY

COURSE TITLE: PLANT BIOTECHNOLOGY (THEORY)
COURSE CODE: BIO-V.E-11
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVES: This paper aims at introducing the concept of *in vitro* culture of plants including set up of a plant tissue culture laboratory, instruments and sterilization techniques. This paper will help the students to understand that various parts of the plant may be cultured, with each type of culture having specific applications. Plant tissue culture also lends itself for production of transgenic plants which have various applications.

LEARNING OUTCOME: On completion of this module, the student will be able to understand all about plant biotechnology in terms of set up of a laboratory, culture of explants and genetic engineering methods for production of transgenic plants.

BIO-V.E-11: PLANT BIOTECHNOLOGY(THEORY)

Unit 1: History of plant tissue culture **2 hrs**
International and Indian scientists

Unit 2: Laboratory organization **4 hrs**
Washing and drying facility; general laboratory and media preparation area; transfer area; **c**ulture room; growth chambers and green house (ideal conditions for incubation and maintenance of cultures/plants).

Unit 3: Sterilization techniques **2 hrs**
Sterilization techniques used in plant tissue culture – steam, dry, filter, ultra violet, alcohol, flame and chemical (explants)

Unit 4: Plant tissue culture media **4 hrs**
Major and minor inorganic nutrients; vitamins; carbon source; hormones; complex organic additives and their functions**;**composition of some commonly used plant tissue culture media – MS, White’s, Nitsch, Gamborg B5

Unit 5:Totipotency **2 hrs**

Totipotency and its Importance**;** Various parts of the plant serving as Explants

Unit 6: Organ culture and its applications **5 hrs**

Root;shoot tip/meristem; anther and pollen; ovary and ovule embryo

Unit 7: Callus and cell suspension cultures **4 hrs**

Callus culture – principle; characteristics of callus tissue; applications; cell suspension culture – principle; isolation; growth patterns; concept of batch and continuous culture; viability testing

Unit 8: Somaclonal variation **2 hrs**

Concept; isolation of variants; mechanisms of somaclonal variation and applications

Unit 9: Organogenesis **1 hr**

Root and shoot regeneration and applications

Unit 10: Somatic embryogenesis and artificial seeds **2 hrs**

Somatic embryogenesis – principle; procedure and applications**;** artificial seeds – methods of production and applications

Unit 11: Protoplast culture and somatic hybridization **4 hrs**

Protoplast culture – principle; isolation of protoplasts (mechanical and enzymatic); methods of culture; checking viability**;** somatic hybridization - protoplast fusion (spontaneous and induced); selection of hybrid protoplasts; applications of somatic hybridization

Unit 12: Applications of Tissue Culture in Plant Sciences **2 hrs**

Micropropagation; gene conservation banks; forestry

Unit 13: Production of secondary metabolites **2 hrs**

Classification of secondary metabolites with examples**;** production using culture methods - callus culture; cell suspension culture; hairy root culture (*A. rhizogenes*); immobilized cell systems

Unit 14: Gene transfer in plants **4 hrs**

Introduction to *Agrobacterium tumefaciens* and Ti plasmid; *Agrobacterium* based vectors (co-integrate and binary vectors); co-culture method and in plant transformation; direct methods of gene transfer – electroporation, chemical methods, particle gun method and microinjection

Unit 15:Applications of transgenic plants **5 hrs**

Insect resistance (BT toxin); drought and salt tolerance; herbicide resistance; increasing shelf life of fruits; improvement of vitamin content (golden rice) and edible vaccines

BIO-V.E-11: PLANT BIOTECHNOLOGY (PRACTICAL)

COURSE TITLE: PLANT BIOTECHNOLOGY (PRACTICAL)
COURSE CODE: BIO-V.E-11
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Washing, Packing and Sterilization of Glassware

Preparation of Stock solutions for Murashige and Skoog (MS) medium

Preparation, sterilization and pouring of MS medium

Aseptic germination of seedling

Callus induction from hypocotyl and carrot cambial explants and subculturing

Shoot tip culture

Regeneration of shoot/root from callus

Setting up of cell suspension culture and checking viability by Evan's blue method

Setting up an in vitro culture from seed embryo (embryo culture)

Encapsulation of somatic/true embryo (synthetic seeds)

Regeneration of Plants from Synthetic Seeds

REFERENCES

- Chawla, H.S. (2002) Introduction to Plant Biotechnology, Science Publishers Inc. USA.
- De, K.K. (2008) Plant Tissue Culture, New Central Book Agency Pvt. Ltd.
- Jha, T.B. &Ghosh,B. (2005) Plant Tissue Culture, University Press (India) Pvt. Ltd.
- Singh, B.D. (2005) Plant Biotechnology, Kalyani Publishers.

BIO-V.E-12: BIOINFORMATICS

COURSE TITLE: BIOINFORMATICS (THEORY)
COURSE CODE: BIO-V.E-12
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVES: This paper aims at introducing the importance of the basics of computers, concept of Human Genome Project, storage of biological information and tools and techniques of bioinformatics used and their importance in the field of biotechnology.

LEARNING OUTCOME: On completion of this paper the students will be able to understand the importance of computers and networking and the various types of biological databases used for storing genetic information of various organisms and the use of various tools and techniques used for retrieving the same that maybe used in present life and be able to solve interesting and novel scientific problems.

BIO-V.E-12: BIOINFORMATICS(THEORY)

Unit 1: Introduction to Computers in Biology **5 hrs**

Introduction to use of computers, internet and software in biology; medicine and research; historical developments in biology

Unit 2: DNA, RNA and Proteins & HGP **4 hrs**

Background of DNA, RNA and Proteins, ORF**;** review of transcription and translation**;** introduction to HGP; objectives; achievements of HGP; ethical and Social issues

Unit 3: Introduction to bioinformatics **3 hrs**

Definition; scope of bioinformatics; bioinformatics vs computational biology; components of bioinformatics and applications

Unit 4: Information resources **6 hrs**

Introduction; aim and objectives (NCBI, NLM, NIH, EBI and SRS)

Unit 5: Biological databases **6 hrs**

Types of data; types of biological databases; primary databases: Gen Bank and EMBL, DDBJ secondary databases:swiss-PROT, PDB & PIR; composite databases: OWL & PROSITE

Unit 6: Structural databases **5 hrs**

X ray crystallography; PDB; MMDB;CATH & SCOP; Visualization of proteins – Cn3D and rasmol

Unit 7: Literature databases **3 hrs**

Pubmed;MedLINE& OMIM

Unit 8: BLAST & FASTA **4 hrs**

Introduction; BLAST & FASTA and their types

Unit 9: Sequence alignment tools and phylogeny **6 hrs**

Pairwise sequences alignment; multiple sequence alignment using Clustal-W Omega; introduction; definition; construction; structure and types of phylogenetic trees; differences between cladogram and phylogenetic tree

BIO-V.E-12: BIOINFORMATICS (PRACTICAL)

COURSE TITLE: BIOINFORMATICS (PRACTICAL)

COURSE CODE: BIO-V.E-12

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Introduction to Bioinformatics & its Applications

Study of Human Genome Project

Usage of NCBI resources

Biological data search using NCBI – Protein or amino acid sequences

Biological data search using NCBI – DNA or gene sequences

Biological data search using NCBI – Literature & Structure databases

Database search & Pairwise sequence alignment using NCBI BLAST :BLASTp&BLASTn

Multiple sequence alignment using Clustal-W

Construction of phylogenetic tree using Clustal-W

DNA sequence analysis to find restriction enzymes sites using NEBcutter

Visualization of protein structures using Cn3D/ Rasmol

REFERENCES

- Harisha, S. (2007). Fundamentals of Bioinformatics, I.K. International Publishing House, Mumbai.
- Ignacimuthu, S. (2005). Basic Bioinformatics, Narosa Publishing House, New Delhi.
- Mount, D.W. (2004). Bioinformatics – sequence and Genome analysis, CBS Publishers.
- Murthy,C.S.V. (2003). Bioinformatics, Himalaya Publishing House, Mumbai.
- Rastogi, S.C., Mendiratta, N. &Rastogi, P. (2004). Bioinformatics: Concepts, Skills and Applications, CBS Publishers.
- Xiong, J. (2006). Essential Bioinformatics, Cambridge University Press.

BIO-VI.C-8: INDUSTRIAL BIOTECHNOLOGY

COURSE TITLE: INDUSTRIAL BIOTECHNOLOGY (THEORY)
COURSE CODE: BIO-VI.C-8
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45
PRE-REQUISITES: Completion of BIO-II.C-4-Basic Microbiology

COURSE OBJECTIVES: This paper is designed to introduce the students to the basic concepts in Industrial Biotechnology. The paper covers concepts in Industrial Biotechnology, mainly introducing the basics of upstream processes in fermentation technology on an industrial scale.

LEARNING OUTCOME: On completion of this module, students will be able to understand the concept of a bioprocess and its importance in today's world of fast pacing technology. They will be able to apply concepts of fermentation technology to the industrial sector and understand how large scale bioprocesses are carried out. This module will be a pre-requisite to the module Industrial Biotechnology (advanced) of semester VI.

BIO-VI.C-8: INDUSTRIAL BIOTECHNOLOGY(THEORY)

Unit 1: Fermentation equipment and its use **10 hrs**

Definition of fermentor/bioreactors; structure of ideal fermentor**;** definition and uses of impellers and their types; spargers and their types;baffles; headspace**;** controls and sensors (temperature, pH, antifoam, dissolved oxygen and carbon dioxide sensor)**;** types of reactors (definition, description, diagram and uses)-stirred tank reactors; bubble columns; airlift bioreactors (internal and external loop); fluidised bed; packed bed column, photobioreactors; tray bioreactors

Unit 2: Screening and selection of micro-organisms **3 hrs**

Primary screening-definition; techniques; crowded Plate; auxanography; enrichment; indicator dye; secondary screening- definition and features; giant colony technique

Unit 3: Stock cultures **2 hrs**

Cryogenic preservation**;**aims of preservation of cultures; definition of working and primary stock cultures**;** techniques of preservation- serial subculture , sterile soil, water , silica gel; sterile mineral oil; lyophilisation

Unit 4: Types of fermentation processes **3 hrs**

Continuous; submerged; surface/solid state; batch; fed-batch

Unit 5: Fermentation media **5 hrs**

Characteristics of an ideal; production media; media composition – crude, synthetic; media; sterilization -Heat, radiation, chemical methods and filtration; batch and continuous sterilization, inoculum preparation

Unit 6: Detection and assay of fermentation products **5 hrs**

Physical or chemical assay- titration and gravimetric assay; turbidity analysis and cell determination; spectrophotometric assay; chromatographic partition assay; biological assay- concept benefits and drawbacks; diffusion assay;turbidometric and growth assay; end point assay; metabolic response assay; enzymatic assay

Unit 7: Scale up of fermentations and increasing product yields **3 hrs**

Significance of scale up; pilot fermenters**;** increasing product yields by mutagens-physical and chemical mutagens/strain improvement

Unit 8: Downstream processing **4 hrs**

BIOMASS: separation of cells – flocculation; floatation; filter aids and filtration (surface, depth); centrifugation- batch centrifuge eg. tubular bowl centrifuge; continuous centrifuge eg. basket centrifuge; disintegration in brief: mechanical eg: ulltrasonication; homogenisers and use of ballotini; non mechanical eg. thermallysis; chemicaleg.detergent solubilisation, organic solvents; enzymatic methods eg. lysozyme

1. BROTH

   Enrichment: evaporation,membrane filtration, liquid-liquid extraction,precipitation,adsorption

   Purification: chromatography

Formulation - crystallization and drying (convection drying eg. spray dryers, freeze drying)

Unit 9: Industrial production **4 hrs**

Organisms;fermentation media and conditions;downstream processing and uses -alcohol /Wine;
. penicillin,vinegar

BIO-VI.C-8: INDUSTRIAL BIOTECHNOLOGY (PRACTICAL)

COURSE TITLE: INDUSTRIAL BIOTECHNOLOGY (PRACTICAL)

COURSE CODE: BIO-VI.C-8

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

A study on the phases of growth of microorganisms during batch fermentation (equipment: Erlenmeyer flask, medium: nutrient broth, inoculum: *E.coli*).

Parts of a fermentor

Preparation and sterilization of medium for batch fermentation process

Batch fermentation using fermentor

Preparation and sterilization of medium for fed-batch fermentation process

Fed-batch fermentation

Decontamination and sterilization of the fermentor

Primary screening of antibiotic producing bacteria by crowded plate technique

Secondary screening for antibiotic producers by Giant Colony Technique

Production of wine (from pineapple or any other fruit/vegetable) using yeast

Production of vinegar from toddy

Estimation of total reducing sugars and acidity (total and volatile) in wine and vinegar (before and after fermentation)

REFERENCES

- Casida L.E. (2009). Industrial Microbiology, New Age International (P) Ltd. New Delhi.
- Patel A.H. (2012). Industrial Microbiology, MacMillan Publishers India Ltd.
- Prescott & Dunn. (1982). Industrial Microbiology, 4th edition, AVI Publishinhg Co.
- Ratlege C. & Kristiansen B. (2001). Basic Biotechnology, 2nd edition. Cambridge university press.
- Stanbury P. F, Whitaker A. & Hall. (1997). Principles of fermentation technology, 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
- WulfCruger and AnnelieseCruger, A Text book of Industrial Microbiology. 2007. Sinauer associates pub.

- Prave P., Faust U., Sitting W., Sukatsch D.A., Fundamentals of Biotechnology. 2004. VCH publishers.
- Prescott and Dunn, Industrial Microbiology. 4thed, 1982. AVI Pub Co.
- Sivasankar B., Bioseparations: Principles and techniques. 2005. Prentice hall of indiapvt ltd New Delhi.
- Collin Ratlege, Basic Biotechnology. 2006. Cambrige university press.

BIO-VI.E-13: BIOETHICS AND BIOSAFETY

COURSE TITLE: BIOETHICS AND BIOSAFETY (THEORY)
COURSE CODE: BIO-VI.E-13
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVES: This paper aims at introducing the importance of the basic concepts of bioethics and bio-safety and their relationship with several fields such as ecology, agriculture, medicine, chemistry and advances brought about in the field of biology and medicine. The course deals with answers to ethical questions that arise in the relationships among the life sciences and their importance in the field of biotechnology.

LEARNING OUTCOME: On completion of this paper the students will be able to understand the importance of bioethics and biosafety procedures to be followed and describe the basic concepts, its principles, and use in the present life and be able to solve novel scientific problems.

BIO-VI.E-13: BIOETHICS AND BIOSAFETY(THEORY)

Unit 1: Introduction to Bio-safety **6 hrs**

Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels: Physical containment, Biological containment, Biosafety Levels of Specific Microorganisms; Recommended Biosafety levels for infectious agents and infected animals

Unit 2: Safety in Laboratories **4 hrs**

General safety measures, Hazards: Physical, Biological and Chemical, Spillage and waste disposal

Unit 3: International and Indian bio-safety guidelines **5 hrs**

Bio-safety guidelines in India; International bio-safety guidelines: OECD, FAO, WHO, CAC and other organisations

Unit 4: Introduction to bioethics **5 hrs**

Introduction to bioethics; social and ethical issues in biotechnology: issues related to test tube babies; bioethics in plant genetic engineering; bioethics in animal genetic engineering

Unit 5: Introduction to IPR **10 hrs**

Introduction to intellectual property; protection of intellectual property; property rights: trade secret, patent, copyright, plant variety protection; plant breeders' right: history, PPVFR, UPOV, requirements for PBR, need and benefit for PBR, breeders exemption, farmer's privilege, farmer's right; world intellectual property organization (WIPO), GATT & TRIPs ; patent status – international Scenario; patenting of biological materials; significance of patents in India

Unit 6: Case studies **3 hrs**

Patenting Basmati rice; Revocation of patents-turmeric and neem

Unit 7: Protection of biotechnological inventions **6 hrs**

Patenting of genes and DNA sequences; gene patents and genetic resources; farmers rights; plant breeder's rights; patenting of life forms;broad patents in biotechnology

Unit 8: Regulatory affairs **3 hrs**

Good laboratory practices; good manufacturing practices

Unit 9: Biosafety of GMOs and GEMs **3 hrs**

Planned introduction and field trials of: GMOs and GEMs

BIO-VI.E-13: BIOETHICS AND BIOSAFETY (PRACTICAL)

COURSE TITLE: BIOETHICS AND BIOSAFETY (PRACTICAL)

COURSE CODE: BIO-VI.E-13

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

General safety measures and study of safety notices

Study of preventive measures and first aid during laboratory hazards

Case study on handling and disposal of radioactive waste

Case study on handling and disposal of medical/microbial waste

Study of Good Laboratory Practices

Study of Good Manufacturing Practices

Study of components and design of a Biosafety laboratory

A case study on clinical trials in India with emphasis to ethical issues

Planning of establishment of a hypothetical biotechnology industry in India

Study of steps of a patenting process

REFERENCES

- Das H.K. (2008). Text book of Biotechnology, 3rd edition, Wiley India Pvt. Limited, New Delhi.
- Dubey R.C. (1993). A Textbook of Biotechnology, S.Chand and Company, New Delhi.
- Krishna V.S. (2007). Bioethics & Biosafety in Biotechnology, New Age Publishers, Bangalore.
- Plummer D.T. (1988). An Introduction to Practical Biochemistry, 3rd Edition, Tata McGraw, New York.
- Singh B.D. (2003). Biotechnology - Expanding Horizons, 1st edition, Kalyani Publishers, Ludhiana.
- Thomas J.A. &Fush R.L. (2002). Biotechnology & Safety Assessment, 3rd Edition, Academic press.

BIO-VI.E-14 ADVANCED CELL BIOLOGY

COURSE TITLE: ADVANCED CELL BIOLOGY (THEORY)
COURSE CODE: BIO-VI.E-14
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45
PRE-REQUISITES: Completion of BIO-I.C-2- Cell Biology

COURSE OBJECTIVES: The course will give a detailed description of the how eukaryotic cells receive, transmit and respond to environmental signals, cellular regulation of cell cycle progression and cell death. The principal and working of the essential tools used in cell biology will also be covered.

LEARNING OUTCOMES: Students will develop insight into the complexities of cell structure and function, the molecular controls that govern the cells' dynamic properties, and cellular interactions with the organism as a whole.

BIO-VI.E-14 ADVANCED CELL BIOLOGY (THEORY)

Unit 1:Techniques in cell biology **9 hrs**

Review of 2D microscopy; confocal microscopy;transmission electron microscopy; scanning electron and atomic force microscopy; the use of radioisotopes; differential centrifugation; purification of proteins – precipitation;ion-exchange chromatography;gel filtration chromatography;affinity chromatography; polyacrylamide gel electrophoresis; two-dimensional gel electrophoresis; purification of nucleic acids-agarose, gel electrophoresis; ultracentrifugation, blotting techniques

Unit 2: Cell cycle and programmed cell death **12 hrs**

Overview of the cell cycle; regulation of cell cycle;events of mitotic phase; cytokinesis; events of meiosis; regulation of cell division; apoptosis (extrinsic and intrinsic pathway)

Unit 3:Signal transduction **10 hrs**

The basic elements of cell signalling systems-autocrine, paracrine and endocrine types ; an overview of the major signalling pathways; mechanism and signal transduction of G protein-coupled receptors (GPCRs); Receptor protein-tyrosine kinases (RTKs);Lligand-gated channels;

steroid hormone receptors; second messengers- cyclic AMP, phosphatidylinositol derived second messengers;role of calcium and NO as intracellular messengers

Unit 4: Membrane transport **6 hrs**

Review of structure and composition of cell membrane; transport across nuclear envelope - simple diffusion and facilitated diffusion; passive transport - glucose transporter, anion transporter; primary active transporters - P type ATPases, V type ATPases, F type ATPases; secondary active transporters –Na+-glucose symporter; ion channels - voltage-gated ion channels (Na+/K+ voltage-gated channel)

Unit 5: Membrane potentials and nerve impulses **4 hrs**

The resting potential; the action potential; propagation of action potentials; neurotransmission

Unit 6: Cancer biology **4 hrs**

Development and causes of cancer; genetic basis of cancer; oncogenes; tumor viruses

BIO-VI.E-14 ADVANCED CELL BIOLOGY (PRACTICAL)

COURSE TITLE: ADVANCED CELL BIOLOGY (PRACTICLAL)

COURSE CODE: BIO-VI.E-14

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Identification of different stages of mitosis (in garlic root tip) `

Identification of different stages of meiosis (flower buds/ grasshopper testes)

Study of cell viability by trypan blue

Identification and study of cancerous cells using permanent slides/ photomicrographs

Study of plant, animal and human tumour viruses using photomicrographs

Differential centrifugation for separation of cellular components

Preparation of sucrose density gradient and separation of sub cellular organelles

Visualization of nuclear fraction by acetocarmine stain and mitochondria by Janus green stain

Study of electron micrographs of sub-cellular organelles

Separation ofphotosynthetic pigments by TLC

REFERENCES

1. Karp, G. & Harris, D. (2008) Cell and Molecular Biology – Concepts and Experiments, John Wiley & Sons Inc, New York.
2. Krebs, J.E., Goldstein, E.S. & Kilpatrick, S.T. (2014). Lewin's Genes XI, Jones and Bartlett India Pvt. Ltd.
3. Nelson, D. L. & Cox, M.M. (2000). Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
4. Robertis, E.D.P. &Robertis, E.M.F. (1998). Cell Biology and Molecular Biology, 8th edition, Sauder College.
5. Watson, J.D., Hopkins, N.H. et al. (2008). Molecular Biology of the Gene, Garland Publishing (Taylor & Francis Group), New York & London.
6. Verma, P.S. &Agarwal, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Pvt. Ltd.
7. Verma, A.S., Das, S. & Singh, A. (2014). Laboratory Manual for Biotechnology, 1st Edition, S. Chand & Company Pvt. Ltd.

BIO-VI.E-15: FOOD BIOTECHNOLOGY

COURSE TITLE: FOOD BIOTECHNOLOGY (THEORY)
COURSE CODE: BIO-VI.E-15
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

OBJECTIVE: This paper adds information about the role of microorganisms in many food industries both in production and spoilage processes and to understand the importance of the role of microorganisms in food industries both in beneficial and harmful ways.

LEARNING OUTCOME: The students will be able to apply this knowledge in prevention of microbial spoilage and also exploit the microbes for improved food quality. They will also learn the key role and mechanisms of microorganisms, enzymes in biodegradation of hazardous compounds

BIO-VI.E-15: FOOD BIOTECHNOLOGY (THEORY)

Unit 1: History and development of food microbiology **2 hrs**

History of microorganisms in food**;** role and significance of microorganisms in foods

Unit 2: Factors influencing microbial growth in food **4 hrs**

Intrinsic and extrinsic factors responsible for food spoilage

Unit 3: Microorganisms involved in food spoilage **2 hrs**

Microorganisms involved in food spoilage: fruits vegetables, meat, eggs, bread

Unit 4: Food borne diseases **5 hrs**

Food poisoning: (bacterial toxin botulism and Staphylococcal toxin); fungal toxins: aflatoxin; food borne infections: gastroenteritis and Salmonellosis

Unit 5:Milk technology and diseases **5 hrs**

Sources of contamination;different microorganisms implicated in spoilage; milk borne diseases: listeriosis and scarlet fever; grading of milk by dye reduction test – MBRT and resazurin

Unit 6: Detection of food spoilage **6 hrs**

Methods of detection of food spoilage in any 1 type of food (example milk); traditional approaches in detection of spoilage (SCP, breeds smear, identification of specific; organisms by using selective and differential media); new approaches (examples gene probes, bioluminescence)

Unit 7: Microorganisms as source of food **3 hrs**

Nutritive value and use of:Mushroom,SCP eg. Spirullina

Unit 8: Food preservation **8 hrs**

Preservation by drying: solar drying, mechanical drying, salting, smoking)**;** preservation at high temperature: concept of TDP and TDT**;** pasteurization (LTHT, HTST, UHT processes); efficiency of pasteurization – phosphatase test, canning, hurdle technology**;** preservation at low temperature: freezingpreservation by use of additives: acids, salts, sugars, antibiotics, ethylene oxide, antioxidants; preservation by radiation: UV, ionizing radiations,gamma and cathode rays, microwave processing; other methods: hydrostatic pressure cooking,modified atmosphere

Unit 9:Fermentation technology **3 hrs**

Fermented Food: process, microbiology involved and changes during fermentation of fermented food: sauerkraut; milk products: yogurt

Unit 10: Food quality assurance **3 hrs**

Food safety: HACCP system to food protection

Unit 11: GM foods **4 hrs**

Pros and cons of GM foods Eg: Golden rice, FlavrSavr tomato and BtBrinjal

BIO-VI.E-15: FOOD BIOTECHNOLOGY (PRACTICAL)

COURSE TITLE: FOOD BIOTECHNOLOGY (PRACTICAL)

COURSE CODE: BIO-VI.E-15

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Plating ofspoiled food on selective media

MIC of common food preservatives – (sugar/ salt)

MIC of chemical food preservatives – (sodium benzoate/ potassium metabisulphite)

Milk Microbiology

Standard plate count

Grading of quality of milk using dye reduction test (MBDRT / Resazurin)

Pasteurisation of milk

Determination of efficiency of pasteurisation by phosphatase test

Determination of TDP and TDT

REFERENCES

- Das H.K. (2007). Text book of Biotechnology, 3rd Edition, Wiley India (P) Ltd, New Delhi.
- Frazier W.C &Westhoff D.C. (2015). Food Microbiology. 5th edition. McGraw Hill Education (India) Private Limited: New Delhi
- Jay J.M., Loessner, M.J. & Golden D. A. (2005). Modern Food Microbiology, 7th edition. United States: Springer science business media
- Jogdand S. N. (2004). Medical Biotechnology, Himalaya publishing house Pvt. Ltd, India.
- Purohit S.S. (2004). Biotechnology: Fundamentals and applications Agrobios, Jodhpur.
- Ray B. (2004). Fundamental food microbiology, 3rd edition. CRC press: WashingtonD.C
- Satyanarayan U. (2009). Biotechnology, Books and Allied Pvt Ltd, Calcutta.
- Singh B.D. (2004). Biotechnology: Expanding horizons, Kalyani Publishers, New Delhi.
- Tiwari R.P., Hoondal G.S. &Tewari R. (2009). Laboratory Techniques in Microbiology and Biotechnology, Abhishek Publications Chandigarh (India).

BIO-VI.E-16: ANIMAL CELL CULTURE

COURSE TITLE: ANIMAL CELL CULTURE (THEORY)
COURSE CODE: BIO-VI.E-16
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVES: This paper is designed to introduce the students to the basic concepts of Animal Cell Culture. The paper covers topics that explain animal cell culturing and methods involved in basic culturing of animal cells with a few applications to life sciences.

LEARNING OUTCOME: On completion of this module, students will be able to understand the basics in animal cell culture, comprehend methods used in culturing animal cells and the importance of the same. They will be able to apply concepts related to culturing animal cells to the latest developments made in this field. They will also understand the impact it has made to the development of mankind, especially in development of disease diagnostics and therapeutics.

BIO-VI.E-16: ANIMAL CELL CULTURE(THEORY)

Unit 1: Introduction to animal cell culture **3 hrs**

Animal Tissue and Cell Culture (Definition and Concepts in brief)

History and Scope of Animal Tissue Culture

Unit 2: Requirements for animal cell culture **4 hrs**

Basic layout of an animal cell culture laboratory (washing room, media preparation & sterilization room, inoculation and aseptic culture room)**;** equipments; culture vessels for tissue culture

Unit 3: Basics of an animal Cell **3 hrs**

Structure and organization of animal cell; an overview of developmental biology (importance in understanding differentiation of cells in culture)

Unit 4: Media in animal cell culturing **6 hrs**

Physico-chemical properties of culture media (pH, CO_2, O_2& Temperature); growth media – (types, advantages and disadvantages of each type); natural and artificial media; natural media – clots, biological fluid, tissue extracts, complex natural media; artificial media – serum containing, serum- free media, chemically defined and protein- free media; basal salt solutions (BSS) – constituents (vitamins, amino acids, trace elements, inorganic ions); importance; uses and examples; serum as a complex supplement; growth factors in promoting proliferation of cells – uses and examples (EGF, FGF, PDGF)

Unit 5: Basic techniques in animal cell culture 6 hrs

Techniques in mammalian cell culture – source of cells; dissection/isolation of cells; mechanical and enzymatic disaggregation; types of cell cultures (organ culture, whole embryo culture, histotypic cultures, explants cultures)

Unit 6: Cell line cultures 6 hrs

Primary and established cell line cultures; establishment of continuous cell lines – spontaneous transformation; chemical transformation; viral transformation; non- chemical methods; characteristics & maintenance of established / continuous cell lines; characteristics of normal and transformed cells (properties of transformed cells)

Unit 7: Characterization and growth measurement of cultured cells 6 hrs

Characterization – genetic and enzymatic methods (cytogenetics, karyotyping, Isoenzymes and immunological tests); growth measurement – direct method (particle counter, dye exclusion test, cytotoxicity assay); growth measurement – indirect method (MTT assay)

Unit 8: Normal cell growth, phases of growth in culture and synchronization of cells 3 hrs

Eukaryotic cell cycle and basics of cell synchronization; apoptosis in cultured cells – Reasons for cell suicide; phases of cell growth (lag, log, stationary, decline); population doubling level; morphology

Unit 9: Cell separation methods 2 hrs

Physical method of cell separation – separation based on cell size; cell density; cell surface charge; cell affinity; separation by flow cytometry

Unit 10: Applications of animal cell culture 6 hrs

Stem cell culture (applications in Animal Cell Culture); artificial skin; artificial cartilage; special secondary metabolites / products (insulin, growth hormone, interferon, t-plasminogen);

other valuable products obtained using animal cell cultures (emphasis on monoclonal and polyclonal antibodies)

BIO-VI.E-16: ANIMAL CELL CULTURE (PRACTICAL)

COURSE TITLE: ANIMAL CELL CULTURE (PRACTICAL)

COURSE CODE: BIO-VI.E-16

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Washing of glassware and culture wares, preparation of animal cell culture media, sterilization

Introduction to use of instruments and sterile techniques in animal cell culture

Preparation of Basal Salt Solutions (DPBS) and filter sterilization

Preparation of culture media for animal cell culture (DMEM / RPMI 1640) using BSS.

Preparation of serum from goat blood & filter sterilization for animal cell culture

Culturing lymphocytes from blood cells using RPMI 1640

Dissection of chick embryo for culturing fibroblast cells

Estimation of cell viability using MTT& calculations of seeding density for animal cell cultures

Establishing a monolayer culture using warm trypsinization method

Establishing a monolayer culture using cold trypsinization method

Subculture of monolayer culture

REFERENCES

- Das, H.K. (2005). Text book of Biotechnology, Wiley India Pvt. Ltd.
- Freshney, I.R. (2005). Culture of animal cell –A Manual of Basic Techniques, 5th Edition, Wiley- Liss Publications.
- Gangal, S. (2010). Principles and Practice of Animal Tissue Culture, 2nd edition, Universities Press.
- Shivangi, M. (2006). Animal Cell and Tissue Culture, Agrobios, India.
- Singh, B.D (2013). Biotechnology, Expanding horizons, Kalyani Publishers, New Delhi.

Annexure II

INTER-DISCIPLINARY PAPER

MUSHROOM CULTIVATION &VERMICOMPOSTING TECHNOLOGY

SEMESTER: V / VI

COURSE TITLE: MUSHROOM CULTIVATION &VERMICOMPOSTING TECHNOLOGY (THEORY)

COURSE CODE: BIO- INT-1

CREDITS: 4

TOTAL HOURS: 60

COURSE OBJECTIVE: This paper provides an insight to create awareness among students on mushroom cultivation and organic vermicompost production from biodegradable wastes using earthworms.

LEARNING OUTCOME: On completion of this module, students will be able to understand the importance of mushroom cultivation and vermicompost production for sustainable environment management.

MUSHROOM CULTIVATION &VERMICOMPOSTING TECHNOLOGY

MUSHROOM CULTIVATION

Unit 1: Introduction & History **(5 hrs)**

Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms.

Types of edible mushrooms available in India - *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*.

Unit 2: Cultivation Technology **(10 hrs)**

Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray

Culture media preparation; Selection of mushrooms to be cultivated

Production of the starter – Preparation of spawn

Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves

Factors affecting the mushroom bed preparation

Preparation of the compost – Spawning, harvesting, post harvesting technology

Unit 3: Storage and nutrition **(15 hrs)**

Short-term storage (Refrigeration - up to 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions

Nutrition - Proteins - amino acids, minerals, Carbohydrates, Crude fibre content, Vitamins

Types of foods prepared from mushroom

Research Centres - National level and Regional level

Major pests: Insect Pests, Mite Pests, Viral, Bacterial, fungal

Mushroom insect diseases – Prevention and Control measures

VERMICOMPOSTING TECHNOLOGY

Unit 4 Introduction to Vermicomposting **(5hrs)**

Meaning, history, economic importance, value in maintenance of soil structure, role in recycling of organic wastes

Unit 5 Selection of the worms **(10hrs)**

Choosing the right worm; Useful species of earthworms; Local species of earthworms; Exotic species of earthworms; working with worms: bedding; food source; moisture, aeration; protection against predators

Unit 6 Vermicomposting technology **(15hrs)**

Requirements for vermicompost production- site selection, selection of suitable earth worm, selection of food, selection of bedding material

Methods of vermicomposting-Pit or pot method- Heap method, Bin or tray method, Windrow method, Wedge system, Vermi reactor system

Harvesting - Manual methods, Self-Harvesting (migration) methods, Mechanical methods

Nutritive value of vermicompost, Overview of Potential Benefits and Constraints

Vermiwash collection, composition &use

General problems in vermicomposting, Prospects of vermicomposting as self employment venture.

REFERENCES

A. Mushroom cultivation

- Casida L.E. (2009). Industrial Microbiology, New Age International (P) Ltd. New Delhi.
- Prescott & Dunn. (1982). Industrial Microbiology, 4th edition, AVI Publishinhg Co.
- Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms. Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
- Swaminathan, M. (1990) Food and Nutrition. The Bangalore Printing and Publishing Co. Ltd., Bangalore.
- Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation. Mittal Publications, Delhi.
- V.N.Pathak, Nagendra Yadav & Maneesha Gaur, Mushroom Production and Processing Technology. Agrobios (India) Jodhpur.

B. Vermicomposting technology

- R.K. Bhatnagar & R.K. Palta, Earthworm Vermiculture and Vermicomposting. Kalyani Publishers, Chennai.
- P.K. Gupta, Vermi Composting for Sustainable Agriculture. Agrobios (India), Jodhpur.

Parvatibai Chowgule College of Arts and Science

(Autonomous)

<u>DEPARTMENT OF BIOTECHNOLOGY</u>

THREE YEAR B.Sc. DEGREE COURSE IN BIOTECHNOLOGY

B.SC. DEGREE COURSE IN BIOTECHNOLOGY - COURSE STRUCTURE

(To be applicable from the academic year 2018 - 2019)

SEMESTER	CORE		ELECTIVE			
I	**BIO-I.C-1** Biomolecules	**BIO-I.C-2** Cell Biology	--------	--------	--------	--------
II	**BIO-II.C-3** Fundamental Genetics	**BIO-II.C-4** Basic Microbiology	--------	--------	--------	--------
III	**BIO-III.C-5** Molecular Biology		**BIO-III.E-1** Basics of Plant and Animal Sciences	**BIO-III.E-2** Metabolism of Biomolecules	**BIO-III.E-3** Biostatistics	**BIO-III.E-4** Enzymology
IV	**BIO-IV.C-6** Immunology		**BIO-IV.E-5** Plant and Animal Physiology	**BIO-IV.E-6** Tools & Techniques in Biotechnology	**BIO-IV.E-7** Evolution and Anthropology	**BIO-IV.E-8** Molecular genetics
V	**BIO-V.C-7** Concepts in Genetic Engineering		**BIO-V.E-9** Molecular medicine	**BIO-V.E-10** Environmental Biotechnology	**BIO-V.E-11** Plant Biotechnology	**BIO-V.E-12** Bioinformatics
VI	**BIO-VI.C-8** Industrial Biotechnology		**BIO-VI.E-13** Bioethics and Bio-safety	**BIO-VI.E-14** Advanced Cell Biology	**BIO-VI.E-15** Food Biotechnology	**BIO-VI.E-16** Animal Cell Culture

Generic Elective Courses by the Department of Biotechnology:

1. Mushroom Cultivation and Vermicomposting

Skill Enhancement Courses by the Department of Biotechnology:

1. Food and Fermentation Technology

Skill Enhancement Courses for students of Biotechnology:

1. Horticulture, Floriculture and Landscaping
2. Bioentrepreneurship
3. Waste Management Techniques
4. Food and Fermentation Technology

SEMESTER I

CORE COURSE: BIOMOLECULES	
COURSE CODE:	**BIO-I.C-1**
MARKS:	**100** (75 – Theory, 25 – Practical)
CREDITS:	**04** (03 – Theory, 01 – Practical)
CONTACT HOURS:	**Theory:** 45 Hours (3 Lectures per week) **Practical:** 30 Hours (1 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Discuss the structure of atoms, biomolecules and chemical bonds. **CO2:** Understand concepts of enzyme kinetics, bio polymers and metabolic reactions in a living system. **CO3:** Understand and apply general laboratory safety measures as well as calculate for preparation of various chemicals for experiments. **CO4:** Prepare different solutions such as buffers, reagents and stock solutions for experiments independently. **CO5:** Operate various lab instruments such as weighing balance, water bath and spectrophotometer.

BIO-I.C-1: BIOMOLECULES (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL CONTACT HOURS
MODULE 1: **The foundations of Biochemistry, Carbohydrates and Proteins**	**1.1 : The foundations of Biochemistry** Landmarks in the history of Biochemistry (contributions particularly by Louis Pasteur, Carl Neuberg, Wilhelm Kuhne, Eduard Buchner); Urey-Miller's experiment.	**02**	**15**
	1.2 : Carbohydrates Monosaccharides: Structure of aldoses and ketoses, ring structure of sugars; Stereochemistry: mutarotation, anomers, epimers and enantiomers; formation of disaccharides, reducing and non-reducing disaccharides; Polysaccharides: homo and hetero-polysaccharides, structural and storage polysaccharides.	**06**	
	1.3 : Proteins Amino acids**:** Structure and nomenclature, General properties, Zwitter ions, derivatives of amino acids and their biological role; Proteins**:** Peptide bond formation, structural Levels of protein; Polypeptides: Structure and function of Collagen, Elastin, Myoglobin and Haemoglobin; binding of oxygen to Myoglobin and Haemoglobin; Protein folding and misfolding; denaturation of Proteins.	**07**	
MODULE 2: **Lipids and Nucleic Acids**	**2.1 : Lipids** Fatty acids (saturated & unsaturated); Simple Lipids: Fats, oils, waxes; Compound Lipids: Phospholipids & Glycolipids; Derived Lipids: Steroids.	**07**	**15**
	2.2 : Nucleic acids	**08**	

	DNA structures and their importance, different types of RNA, unusual DNA structures, other functions of nucleotides: source of energy, component of coenzymes, second messengers.		
MODULE 3: **Water and Molecular Interactions, Vitamins, Hormones and Enzymology**	**3.1 : Water and Molecular interactions** Structure and unique properties; Covalent bonds, Hydrogen bonds, Ionic bonds, Hydrophobic bonds and Vander waal's interactions. **3.2 : Vitamins** Structure and active forms of water soluble and fat soluble vitamins; deficiency diseases and hypervitaminosis **3.3 : Hormones** Classification and functions **3.4 : Enzymology** Classification of enzymes; Mechanism of enzyme action, Lock & key theory & Induced fit theory; Factors affecting enzymes activity (pH, temperature enzyme concentration, substrate concentration); MM equation, Lineweaver-Burk plot; Enzyme Inhibition and its types; Ribozymes & Isoenzymes.	**03** **05** **02** **05**	**15**

BIO-I.C-1: BIOMOLECULES (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Introduction to safety measures in laboratories	01
2.	Preparation of buffers &solutions (normal, molar, ppm , %)	01
3.	Qualitative tests for carbohydrates, lipids, proteins and nucleic acids	04
4.	Principle and working of a colorimeter and spectrophotometer	01
5.	Determination of λmax and Molar extinction coefficient of a given compound	01
6.	Estimation of reducing sugar - DNSA method	01
7.	Estimation of protein – Folin Lowry's method	01
8.	Titration curve of any one amino acid	01
9.	Determination of peroxide value of oil	01
10.	Effect of pH and temperature on amylase activity	02

REFERENCES

- Nelson, D. L. & Cox, M.M. (2000), Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
- Stryer, L. (1995). Biochemistry, W.H. Freeman and Co., New York, USA.
- Jain, J.L (1999), Fundamentals of Biochemistry, S.Chand and Company, Ltd., New Delhi.
- Murray, R.K, Granner, D.K, Mayes, P.A. & Rodwell, V.W. (2003), Harper's Illustrated Biochemistry, McGraw-Hill Companies.
- Sadasivam, S. And Manickam, A. (1996), Biochemical Methods, New Age International (P) Limited
- Jayaraman, J. (1971), Laboratory Manual in Biochemistry, John Wiley & Sons, Limited.
- Plummer, D.T. (1993). An Introduction to Practical Biochemistry, Sixth Reprint. Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Harvey, R.A. & Ferrier, D.R. (2011). Lippincott's Illustrated Reviews, Biochemistry Fifth Edition, Lippincott Williams and Wilkins.

CORE COURSE: CELL BIOLOGY	
COURSE CODE:	**BIO-I.C-2**
MARKS:	**100** (75 – Theory, 25 – Practical)
CREDITS:	**04** (03 – Theory, 01 – Practical)
CONTACT HOURS:	**Theory:** 45 Hours (3 Lectures per week) **Practical:** 30 Hours (1 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Correlate the function of each cell organelle with proper coordination. **CO2:** Demonstrate an understanding of cell communication.. **CO3:** Prepare various plant and animal specimen for observation of cell structures **CO4:** Identify and analyze different biological cells using a compound microscope.

BIO-I.C-2: CELL BIOLOGY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL CONTACT HOURS
MODULE 1: Introduction to Cell Biology, Cell Wall and Plasma Membrane	**1.1 : Introduction to cell biology** Cell theory; ultra-structure of prokaryotic and eukaryotic cell; cell matrix proteins; components of extracellular matrix. **1.2 : Cell wall & Plasma membrane** Chemical composition; structure and functions of the cell wall and plasma membrane; monolayer; planer bilayer and liposomes as model membrane systems; Fluid mosaic mode; lipid rafts; membrane fluidity; factors affecting membrane fluidity; techniques used to study membrane dynamics – FRAP.	**06** **09**	**15**
MODULE 2: Ultrastructure and Function of Organelles	**2.1 : Ultra-structure and function of organelles** Cilia and Flagella; Endoplasmic reticulum; Golgi apparatus; lysosomes; Microbodies; Mitochondria; Ribosomes; Centrioles and basal bodies; Nucleus; Chloroplasts and Peroxisomes.	**15**	**15**
MODULE 3: Cell Cycle and Cell-cell Interactions	**3.1 : Cell Cycle** Overview of the cell cycle; prokaryotic & eukaryotic cell cycle; events of mitotic & meiotic phases, cytokinesis. **3.2 : Cell-Cell interaction** Interactions of cells with extracellular materials: integrins, focal adhesions and hemidesmosomes; interactions of cells with other cells: selectins, the immunoglobulin superfamily, cadherins, adheren junctions and desmosomes; tight junctions, gap junctions and plasmodesmata.	**05** **10**	**15**

BIO-I.C-2: CELL BIOLOGY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Examination of prokaryotic cell, eukaryotic cell and cell organelles using Photomicrographs	01
2.	Visualization of animal and plant cell using methylene blue	01
3.	Study of cell viability using phenol red / trypan blue	01
4.	Visualization of Permanent slides of: A. Different cell types: Epithelium, Endothelium, Muscle cells, Nerve cell B. Different stages of cell division	02
5.	Identification of different stages of mitosis in onion root tip	01
6.	Identification of different stages of meiosis in onion flower buds	01
7.	Isolation of chloroplast from spinach leaves	02
8.	Prokaryotic cell harvesting & lysis using osmotic (salt) and Chemical (detergent) methods	03

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REFERENCES

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SEMESTER II

CORE COURSE: FUNDAMENTAL GENETICS	
COURSE CODE:	**BIO-II.C-3**
MARKS:	**100** (75 – Theory, 25 – Practical)
CREDITS:	**04** (03 – Theory, 01 – Practical)
CONTACT HOURS:	**Theory:** 45 Hours (3 Lectures per week) **Practical:** 30 Hours (1 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Outline the basic principles of Mendelian genetics and compare and analyze different inheritance patterns as well as solve problems based on genetic principles. **CO2:** Compare and contrast different mutations, their effects on cells and the application of the same to research. **CO3:** Differentiate between the structure and working of a compound and dissection microscope. **CO4**: Construct and interpret a karyotype prepared from a spread of metaphase chromosomes.

BIO-II.C-3: FUNDAMENTAL GENETICS (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL CONTACT HOURS
MODULE 1: Introduction to Genetics, Mendelian Genetics and Chromosomes	**1.1 : Introduction to Genetics** Scope and importance of Genetics; terminology.	**02**	**15**
	1.2 : Mendelian Genetics Mendel's experiments; principle of segregation; monohybrid crosses (dominance, recessiveness, co-dominance, incomplete dominance); principle of independent assortment; multiple alleles – ABO blood type and Rh factor alleles in humans; genotypic interaction – epistasis, pleiotropy and extra-nuclear inheritance.	**09**	
	1.3 : Chromosomes Chromosome number; morphology; chromosome material and chemical composition; giant chromosomes.	**04**	
MODULE 2: Concepts in Breeding, Cell Division, Linkage and Crossing Over, Population Genetics	**2.1 : Introduction to the concepts of:** Inbreeding, heterosis, hybrid vigour.	**02**	**15**
	2.2 : Cell Cycle and cell division Cell cycle - The G1, S and G2 phase; Mitosis and Meiosis, Cell cycle checkpoints.	**04**	
	2.3 : Linkage and Crossing Over Concept of linkage and crossing over, Sutton-Boveri Chromosome theory of inheritance; coupling and repulsion hypothesis; types of linkage (complete and incomplete); types of crossing over; mechanism of meiotic crossing over & significance.	**04**	

	2.4 : Population Genetics Gene pool; theory of allele frequencies (gene and genotypic frequencies); the Hardy-Weinberg principle and its application; exceptions to the Hardy-Weinberg principle -natural selection; random genetic drift; problems on Hardy-Weinberg principle; speciation-definition of species and mode of speciation (allopatric, sympatric).	**05**	
MODULE 3: **Sex Determination, Chromosomal Mutations and Human Genetics**	**3.1 : Sex Determination, Sex Linkage and Pedigree Analysis** Sex determination (pattern and sex chromosomes); sex determination in human beings and flowering plants; dosage compensation; sex-linked inheritance – Haemophilia, Duchenne Muscular Dystrophy, Fragile X Syndrome, Colour blindness; pedigree Analysis – penetrance and expressivity; family tree; dominant inheritance; recessive inheritance. **3.2 : Structural and Numerical Chromosomal Mutations** Types of structural changes (deletion, duplication, inversion, translocation, variation in chromosome morphology); types of numerical changes (euploidy and aneuploidy). **3.3 : Human Genetics** Gene action and related diseases (Alkaptonuria, Phenylketonuria, Sickle Cell Anaemia); autosomal and sex chromosomal anomalies involving numerical and structural aberrations. (Down's, Cri-du-chat, Klinefelter's and Turner's syndromes).	**08** **04** **03**	**15**

BIO-II.C-3: FUNDAMENTAL GENETICS (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Study of a dissection microscope.	01
2.	Study of Barr bodies in sex determination.	01
3.	Study of Polytene chromosomes.	02
4.	Study of Mendelian traits in human population	02
5.	Problem solving on Mendel's Laws & Hardy-Weinberg's Law	02
6.	Karyotype analysis of chromosomal abnormalities.	02
7.	Pedigree analysis and problem solving.	02

REFERENCES

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- Jayaraman, K. &Jayaraman, R. (1979). Laboratory manual in Molecular Genetics, John Wiley and Sons.
- Tamarin, R.H. (2002). Principles of Genetics, 7th Edition, Tata McGraw-Hill Publishing Company Ltd.
- Verma, P.S. &Agarwal, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Pvt. Ltd.

CORE COURSE: BASIC MICROBIOLOGY	
COURSE CODE:	**BIO-II.C-4**
MARKS:	**100** (75 – Theory, 25 – Practical)
CREDITS:	**04** (03 – Theory, 01 – Practical)
CONTACT HOURS:	**Theory:** 45 Hours (3 Lectures per week) **Practical:** 30 Hours (1 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Understand the scope and importance of Microbiology, classification schemes, cultivation, preservation and maintenance of the microbial cultures. **CO2:** Discriminate between various groups of microorganisms and also comprehend the beneficial and harmful effects of each group of microorganisms. **CO3:** Compare, analyze and apply concepts of the principle and working of various types of microscopes. **CO4:** Adhere to strict laboratory safety measures to be followed in a microbiology laboratory. **CO5:** Master skills in aseptic techniques as well comprehend the importance of cleaning and decontamination.

BIO-II.C-4: BASIC MICROBIOLOGY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL CONTACT HOURS
MODULE 1: Scope & historical perspective, basics of microscopy, taxonomy and reproduction in bacteria	**1.1 : History and Scope of Microbiology** Historical account from 16^{th} – 19^{th} century .**1.2 : Basics of Microscopy** Principle of working of light microscope (Bright-field, Dark-field, Phase-contrast, Fluorescence). **1.3 : Bacterial Taxonomy** Introduction to Archaea; taxonomic ranks; classification systems (Phenetic, Numerical, Phylogenetic); Bergey's Manual of Systematic/ Determinative Bacteriology and rDNA sequencing. **1.4 : Reproduction in bacteria – 1** Binary fission; definitions: cell growth, growth rate, generation time	**02** **03** **08** **02**	**15**
MODULE 2: Methods of cultivating and preserving bacteria and an introduction to extremophiles	**2.1 : Cultivation of microorganisms** Sterilisation; disinfection; decontamination: principle and methods; types of culture media: synthetic/defined, complex solid, liquid, enrichment, selective, differential; cultivation of microorganisms: broth culture, agar plate, pour plate; determination of viable count: serial dilution; spread plating; determination of colony forming units (cfu) and calculation of viable count; isolation of pure cultures: streak plate; colony morphology. **2.2 : Maintenance and preservation of microbial cultures** Slant and stab cultures; periodic transfer; storage in	**08** **04**	**15**

	sterile soil; overlaying with mineral oil; glycerol stocks; preservation in liquid nitrogen; lyophilisation. **2.3 : Bacteria in Extreme Environments** Thermophiles, barophiles, halophiles, acidophiles and alkaliphiles.	**03**	
MODULE 3: Ultrastructure of a bacterial cell, growth curve – types, characteristics and an introduction to viruses	**3.1 : Organization and Ultrastructure of a Bacterial cell** Cell wall: structure and chemical composition in Gram positive and Gram negative bacteria; introduction to cell membrane, pili, fimbriae and capsule; flagella structure and function; nucleoid and plasmids: nature and function; endospore: structure, sporulation and germination; reserve materials. **3.2 : Reproduction in bacteria – 2** Bacterial growth curve; characteristics of growth phases; diauxic growth curve, continuous and synchronous growth **3.3 : Viruses** Basic classification and structure of viruses (prokaryotic and eukaryotic); characteristic features of λphage; viral replication (lytic and lysogenic).	**08** **02** **05**	**15**

BIO-II.C-4: BASIC MICROBIOLOGY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Introduction to laminar air flow unit, autoclave, pH meter, incubator, microwave & Introduction to microscope	01
2.	Preparation and sterilization of glassware	01
3.	Preparation of media and autoclaving	02
4.	Preparation of agar plates and open air cultures	01
5.	Serial dilution technique and spread plating	02
6.	Bacterial isolation techniques: streaking methods - simple continuous, T-streak, quadrant, radiant.	01
7.	Preparation and staining of specimen- simple staining, Gram staining, endospore staining	03
8.	Biochemical tests for bacterial identification: sugar fermentation and IMViC tests	02
9.	Isolation and staining of Fungi by lactophenol cotton blue	01
10.	Cleaning and decontamination	01

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- Aneja, K. R. (2007). Experiments in Microbiology, Plant Pathology and Plant Tissue Culture, New Age International.
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SEMESTER III/IV

SKILL ENHANCEMENT COURSE: FOOD AND FERMENTATION TECHNOLOGY	
COURSE CODE:	**SEC**
MARKS:	**100**
CREDITS:	**04** (25% theory, 75% practice)
CONTACT HOURS:	**Theory:** 15 Hours **Practice:** 45 Hours
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Understand the role of microorganisms in the production of fermented foods. **CO2:** Prepare need-based fermented products from cereals, dairy and non-dairy sources. **CO3:** Understand the significance of microorganisms in the preparation of beverages. **CO4**: Enhance the nutritional content of various products through the knowledge and skills obtained in this course.

SEC: FOOD AND FERMENTATION TECHNOLOGY

MODULE	TOPICS	CONTACT HOURS	TOTAL CONTACT HOURS
MODULE 1: Introduction to Fermentation technology and production of foods from cereals	1.1: Introduction to fermentation technology (fermenters, microorganisms) and significance of fermented foods 1.2: Introduction, History, Action of microorganisms/ metabolites/ enzymes, Processing and storage of: (a) Idli/Dosa/sanna (b) Bread (c) Dhokla 1.3: Activities based on the above 2 units	**02** **03** **10**	**15**
MODULE 2: Fermented Beverages	2.1: Introduction, History, Action of microorganisms/ metabolites/ enzymes, Processing and storage of: (a) Beer (b) Fermented juices (eg. apple) (c) Vinegar (d) Wine 2.2: Activities based on the above unit	**04** **11**	**15**
MODULE 3: Non-dairy products	3.1: Introduction, History, Action of microorganisms/ metabolites/ enzymes, Processing and storage of: (a) Tofu (b) Sauerkraut (c) Miso 3.2: Activities based on the above unit	**03** **12**	**15**
MODULE 4: Dairy products	4.1: Introduction, History, Action of microorganisms/ metabolites/ enzymes, Processing and storage of: (a) Yoghurt (b) Cheese (c) Cultured buttermilk	**03**	**15**

	4.2: Activities based on the above unit 4.3 Fermented foods for better gut health	**10** **02**	

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- Casida L.E. (2009). Industrial Microbiology, New Age International (P) Ltd. New Delhi.
- Okafor, n. (2007). Modern industrial microbiology and biotechnology. Science publishers enfield, nh, usa.
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LIST OF COMMON COURSES WITH THE DEPARTMENT OF BIOCHEMISTRY

1. Cell Biology (Semester II)
2. Enzymology (Semester III)
3. Metabolism of Biomolecules (Semester III)
4. Immunology (Semester IV)

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ANNEXURE A

(Summary of changes incorporated in the syllabus)

Semester	Course Title	Existing (Indicate only the unit where the change is proposed)	Changes Proposed	Specify the reason for the change
II	**BIO-II.C-4: Basic Microbiology**	**Module I: 1.1: History and Scope of Microbiology** Historical account from 16^{th} – 18^{th} century	Historical account from 16^{th} – 19^{th} century	Recent advancements in the field of Microbiology were not included in the previous syllabus.
II	**BIO-II.C-4: Basic Microbiology**	**Practical 8:** Biochemical tests for bacterial identification: IMViC test **Practical 9:** Biochemical tests for bacterial identification: carbohydrate test.	**Practical 8 & 9:** Biochemical tests for bacterial identification: sugar fermentation and IMViC tests.	Practicals were merged as both are included under Biochemical tests.

Reorganised courses into Module System

SYBSc BIOTECHNOLOGY

SYLLABUS (Sem III & IV)

for

ACADEMIC YEAR

2020 - 2021

COURSE STRUCTURE

SEMESTER	CORE		ELECTIVE			
I	**BIO-I.C-1** Biomolecules	**BIO-I.C-2** Cell Biology	--------	--------	--------	--------
II	**BIO-II.C-3** Fundamental Genetics	**BIO-II.C-4** Basic Microbiology	--------	--------	--------	--------
III	**BIO-III.C-5** Molecular Biology		**BIO-III.E-1** Basics of Plant and Animal Sciences	**BIO-III.E-2** Metabolism of Biomolecules	**BIO-III.E-3** Biostatistics	**BIO-III.E-4** Enzymology
IV	**BIO-IV.C-6** Immunology		**BIO-IV.E-5** Plant and Animal Physiology	**BIO-IV.E-6** Tools & Techniques in Biotechnology	**BIO-IV.E-7** Evolution and Anthropology	**BIO-IV.E-8** Molecular genetics
V	**BIO-V.C-7** Concepts in Genetic Engineering		**BIO-V.E-9** Molecular medicine	**BIO-V.E-10** Environmental Biotechnology	**BIO-V.E-11** Plant Biotechnology	**BIO-V.E-12** Bioinformatics
VI	**BIO-VI.C-8** Industrial Biotechnology		**BIO-VI.E-13** Bioethics and Biosafety	**BIO-VI.E-14** Advanced Cell Biology	**BIO-VI.E-15** Food Biotechnology	**BIO-VI.E-16** Animal Cell Culture

BIO-III.C-5: MOLECULAR BIOLOGY

COURSE TITLE: MOLECULAR BIOLOGY (THEORY)
COURSE CODE: BIO-III.C-5
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

Course objective

This course provides insights on replication, transcription and translation process in prokaryotes and eukaryotes, various mutations and their repair mechanisms, regulation of gene expression and mechanism of gene transfer.

Course Outcomes

On the successful completion of the course, students will be able to:

CO1: Study the structure of DNA and RNA.

CO2: Understand basic concepts in molecular biology.

CO3: Compare differences between replication, transcription and translation processes in prokaryotes and eukaryotes.

CO4: Describe the mechanism of gene transfer and regulation.

CO5: Isolate and purify genomic DNA.

BIO-III.C-5: MOLECULAR BIOLOGY (THEORY)

Module I **15 hrs**

Basic Concepts in Molecular Biology **7 hrs**

Experiments proving DNA as genetic material: S. F. Griffith's transforming principle; Avery and Hershey and Chase Experiment; evidence for RNA as the genetic material of some viruses; Chargaff's experiments and law; Watson - Crick Model.

DNA Replication **8 hrs**

Experimental evidence for semi-conservative DNA replication in *E.coli*- Meselson and Stahl's experiment; the basic requirements of DNA replication: template, DNA polymerases: structure and function, ancillary proteins associated with replication; mechanism of replication in prokaryotes: initiation, elongation and termination; mechanism of DNA replication in eukaryotes; replication of circular DNA (rolling circle model).

Module II **15 hrs**

DNA Damage and its Repair **6 hrs**

Mutations and types of mutations: spontaneous and induced mutation, missense, silent, frameshift, reversion; physical and chemical mutagens (ethidium bromide, alkylating agents, base analogs); DNA Repair Mechanisms: Mismatch, photo-reactivation repair, Excision repair.

Transcription **9 hrs**

Mechanism of prokaryotic transcription - transcription factors and machinery; formation of initiation complex; RNA polymerase enzyme; initiation, elongation and termination; transcription in eukaryotes- eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription; RNA processing: capping, splicing, polyadenylation.

Module III **15 hrs**

Protein Synthesis **9 hrs**

Central dogma and genetic code; mechanism of protein synthesis in prokaryotes - initiation, elongation and termination; mechanism of protein synthesis in eukaryotes- activation of amino acids, initiation, elongation and termination; post-translational modifications- phosphorylation, acylation, glycosylation & disulphide linkage.

Regulation of Gene Expression **3 hrs**

Lactose operon; Tryptophan operon

Mechanism of Gene transfer **3 hrs**

Conjugation; transformation; transduction

BIO-III.C-5: MOLECULAR BIOLOGY (PRACTICAL)

COURSE TITLE: MOLECULAR BIOLOGY (PRACTICAL)
COURSE CODE: BIO-III.C-5
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Isolation of genomic DNA from prokaryotes
2. Isolation of genomic DNA from eukaryotes
3. Isolation of genomic RNA
4. Agarose gel electrophoresis
5. Determination of molecular size of DNA by agarose gel electrophoresis
6. Mutagenesis in *E. coli* cells - UV survival or chemical mutagens
7. Purity of DNA by spectrophotometric method

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6. Verma, P.S. &AgarwaL, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Pvt. Ltd.

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BIO-III.E-1: BASICS OF PLANT AND ANIMAL SCIENCES

COURSE TITLE: BASICS OF PLANT AND ANIMAL SCIENCES (THEORY)
COURSE CODE: BIO-III.E-1
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

Course Objective

This course provides insights on the Plant and Animal Kingdoms and their classification into different phyla. They will understand the variety of habitats that support the growth and reproduction of different plants and animals and will also look into the general characteristics and adaptations exhibited by these organisms.

Course Outcome

On the successful completion of the course, students will be able to:

CO1: Explain classification of plant and animal kingdom.

CO2: Distinguish between various phyla of the plant and animal kingdoms based on their characteristics.

CO3: Compare and contrast the differences in morphology and anatomy in Angiosperms.

CO4: Explain features of the non-chordates and chordates.

CO5: Sketch the morphology and anatomy of selected plant and animal specimens.

BIO-III.E-1: BASICS OF PLANT AND ANIMAL SCIENCES (THEORY)

Module I **15 hrs**

Introduction **1 hr**

Introduction to the plant and animal kingdom; introduction to classification systems

Plant Kingdom **7 hrs**

Study of the general characteristics of Algae, Fungi, Lichens, Bryophytes, Pteridophytes, Gymnosperms

Morphology and Anatomy in Angiosperms **7 hrs**

Vegetative morphology of roots; stem and leaf reproductive morphology of flower; inflorescence, fruits; comparative anatomy of roots, stem and leaves in monocots and dicots; secondary growth in angiosperms

Module II **15 hrs**

Animal Kingdom - Non chordates **10 hrs**

Study of habitat and general characteristics of Protozoa, Porifera, Cnidaria, Platyhelminthes Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata

Animal Kingdom-Chordates **5 hrs**

Study of habitat and general characteristics of: superclass Pisces; class Amphibia; class Reptilia; class Aves; class Mammalia

Module III **15 hrs**

Salient features of non-chordates **8 hrs**

Study of salient features of non-chordates: disease-causing Protozoa, Platyhelminthes and nematodes (Aschelminthes); circulation in Porifera -water vascular system in Echinoderms; Excretion in Aschelminthes and Annelida; torsion in Gastropods (Mollusca); metamorphosis in insects and economic importance (Arthropoda); corals and coral reefs (Cnidaria)

Salient features of Chordates **7 hrs**

Study of salient features of chordates: economic importance of fishes; parental care in amphibians; venomous and non-venomous reptiles; migration in birds; dentition in mammals

BIO-III.E-1: BASICS OF PLANT AND ANIMAL SCIENCES (PRACTICAL)

COURSE TITLE: BASICS OF PLANT AND ANIMAL SCIENCES (PRACTICAL)
COURSE CODE: BIO-III.E-1
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Study of algal types through temporary mounting: (*Chlorella* and *Anabaena*)
2. Microscopy study of thallus structures in Riccia and Cycas
3. Preparation of mycorrhizal slides by trypan blue method

4. T.S of monocot and dicot root
5. T.S of monocot and dicot stem
6. T.S of monocot and dicot leaf
7. Observation of permanent slides: Anther, ovules, embryo sac, embryo
8. Study of specimens with reference to habit, habitat, characteristic features: two examples from each Invertebrate major phyla

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1. Barnes, R.D. (2000). Invertebrate Zoology, Hall Saunders International Editions.
2. Jordan, E.L. & Verma,P.S. (2000). Invertebrate Zoology, S. Chand & Co. Pvt. Ltd. New Delhi.
3. Jordan, E.L. & Verma, P.S. (2006). Chordate Zoology, New Edition, S. Chand & Co. Pvt. Ltd. New Delhi.
4. Pandey, S.N., Misra, S.P. & P S Trivedi. (2015). A Textbook of Botany, Volume I, Vikas Publishing House Pvt. Ltd.
5. Pandey, S.N., Misra, S.P. & P S Trivedi. (2016). A Textbook of Botany, Volume II, Vikas Publishing House Pvt. Ltd.
6. Verma, V. (2010). Botany, Ane Books, Pvt. Ltd.

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3. https://academic.oup.com/mbe/article/23/3/541/1110188 (Chordates)
4. https://www.sciencedirect.com/science/article/pii/S0960982211008311 (Metamorphosis)
5. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/echinodermata (Echinodermata)

BIO-III.E-2: METABOLISM OF BIOMOLECULES

COURSE TITLE: METABOLISM OF BIOMOLECULES (THEORY)
COURSE CODE: BIO-III.E-2
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45
PRE-REQUISITES: Completion of BIO-I.C-1- Biomolecules

Course objectives

While the core course in Biomolecules explored the different biomolecules, their structure and function, this elective aims to provide clarity to those basics by integrating the processes of metabolism and observing their function under different conditions.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Understand and explain the metabolic processes.
CO2: Explain the interconnections of metabolic pathways.
CO3: Explain the effect of diet on metabolism and implications of improper diet and metabolism.
CO4: Estimate various biomolecules using spectrophotometry, Thin layer chromatography & centrifugation techniques.
CO5: Understand and describe the causes and treatment of various metabolic disorders through case studies.

BIO-III.E-2: METABOLISM OF BIOMOLECULES (THEORY)

Module I

Basic concepts and design of metabolism **2 hrs**

Definition of metabolism; catabolism; anabolism; ATP as energy currency; energy relationship between catabolic and anabolic pathways

Carbohydrate metabolism **9 hrs**

Glycolysis; gluconeogenesis; pentose-phosphate pathway; glycogen synthesis and breakdown and its regulation; tricarboxylic acid cycle; glyoxylate pathway

Amino acid catabolism and anabolism **4 hrs**

Overview of biosynthesis and catabolism of amino acids; Urea cycle

Module II

Fatty acid synthesis and degradation **7 hrs**

Digestion; mobilization and transport of cholesterol and triacylglycerols; oxidation of fatty acids; ketone bodies; biosynthesis of fatty acids - elongation and unsaturation of fatty acids.

Oxidative phosphorylation **4 hrs**

The respiratory chain in mitochondria; proton gradient powering ATP synthesis; Transfer of cytosolic reducing equivalents to mitochondria: glycerol-3- phosphate and malate-aspartate shuttle

Nucleotide metabolism **4 hrs**

Biosynthesis - *de novo* and salvage pathways; degradation.

Module III

Integration of Metabolism **8 hrs**

The Feed-Fast Cycle: overview; enzymatic changes; activity in the liver; adipose tissue; resting skeletal muscle and brain during absorptive state; overview; activity in liver, adipose tissue, resting skeletal muscle, brain and kidney during fasting.

Metabolic Disorders **7 hrs**

Clinical characteristics; diagnosis and management of: Ehlers Danlos syndrome (Classic type), Lesch-Nyhan syndrome, Alzheimer’s disease; Diabetes; Crutzfeldt-Jakob disease; Gout,

BIO-III.E-2: METABOLISM OF BIOMOLECULES (PRACTICAL)

COURSE TITLE: METABOLISM OF BIOMOLECULES (PRACTICAL)
COURSE CODE: BIO-III.E-2
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Estimation of protein - Biuret method
2. Estimation of DNA by Diphenylamine method
3. Estimation of Urea (serum/urine)
4. Estimation of Uric acid (serum/urine)
5. Estimation of blood glucose
6. Isolation of lecithin from egg yolk
7. Isolation of cholesterol from egg yolk
8. Separation of fatty acids by TLC
9. Estimation of blood cholesterol
10. Case studies: Clinical Characteristics, Diagnosis and Management of: Alzheimer's Disease, Diabetes, Ehlers Danlos syndrome, Crutzfeldt-Jakob disease.

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6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3243375/ (Nucleotide Metabolism)
7. https://www.ncbi.nlm.nih.gov/books/NBK22459/ (Amino Acid Metabolism)

BIO-III.E-3: BIOSTATISTICS

COURSE TITLE: BIOSTATISTICS (THEORY)
COURSE CODE: BIO-III.E-3
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

Course Objective

The objective of this course is to introduce students to statistical methods and to understand the underlying principles (summarizing data and drawing valid inferences based on limited information). The purpose of the course is to give students an introduction to the discipline, an appreciation of a statistical perspective on information from biology and basic critical skills to assess the quality of research evidence.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Explain the importance of Biostatistics in biology.
CO2: Understand the concepts of Sampling.
CO3: Represent and interpret the data using graphical method and MS Excel/
CO4: Solve problems on measures of central tendency, dispersion and hypothesis testing.
CO5: Apply appropriate statistical tools in their project work.

BIO-III.E-3: BIOSTATISTICS (THEORY)

Module I **15 hrs**

Scope & importance of Biostatistics **2hrs**

Definition; importance and applications of Biostatistics

Introduction to Sampling **3 hrs**

Concepts of: statistical population, sample; advantages and disadvantages of sampling; types of data; collection of data: primary & secondary data; types of sampling - simple; random sampling; stratified random sampling; systematic sampling; cluster sampling.

Graphical & Diagrammatic representation of data **3 hrs**

Tabulation of data; graphical and diagrammatic representation of data; construction of graphs using MS Excel

Measures of central tendency **7 hrs**

Characteristics of ideal measure; arithmetic mean - simple, weighted, combined, and corrected mean; limitations of arithmetic mean; median - calculation for raw data, for grouped data, for continuous series, limitations of median; mode -computation of mode for individual series, by grouping method in a continuous frequency distribution, limitations of modes; relationship between mean, median and mode; geometric mean; harmonic mean

Module II **15 hrs**

Measures of dispersion **8 hrs**

Quartiles; deciles; percentiles Range, mean deviation, coefficient of mean deviation, standard deviation (individual observations, grouped data, continuous series), variance, coefficient of variance, limitation; Skewness - definition; positive; negative; Karl pearson's coefficient, Bowley's Coefficient

Correlation analysis **7 hrs**

Correlation; covariance; correlation coefficient for ungrouped data; Spearson's rank correlation coefficient; scatter and dot diagram (graphical method

Module III **15 hrs**

Regression analysis **5 hrs**

Regression equation, regression coefficient, examples from biological sciences

Hypothesis testing **10 hrs**

Parameter and statistics; sampling theory;sampling and non-sampling error; confidence limits testing of hypothesis; test of significance; students' t-test: unpaired & paired; F test; Chi-square test and ANOVA

BIO-III.E-3: BIOSTATISTICS (PRACTICAL)

COURSE TITLE: BIOSTATISTICS (PRACTICAL)
COURSE CODE: BIO-III.E-3
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Problem solving on arithmetic mean, median, mode (measures of central tendency) with reference to biological data.
2. Problem solving on measures of central tendency with reference to biological data using MS Excel.
3. Problem solving on measures of dispersion with reference to biological data.
4. Graphical presentation of data - Construction of various types of graphs and charts based on the given data (Manually and using MS Excel
5. Problem solving on hypothesis testing

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4. https://statisticsbyjim.com/basics/measures-central-tendency-mean-median-mode/ (Measures of central tendency)
5. http://onlinestatbook.com/2/summarizing_distributions/measures.html (Measures of central tendency)
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8. http://sphweb.bumc.bu.edu/otlt/MPHModules/BS/BS704_Multivariable/BS704_Multivariable5.html (Correlation & regression analysis)

BIO-III.E-4: ENZYMOLOGY

COURSE TITLE: ENZYMOLOGY (THEORY)
COURSE CODE: BIO-III.E-4
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

Course Objective

This course will provide a comprehensive view of enzyme chemistry and kinetics, methods and strategies for enzyme purification and characterization. One section also deals with the applications of enzymes in diagnostics.

Course Outcomes

On the successful completion of the course, students will be able to:

CO1: Explain the structure of an enzyme and kinetics of enzyme catalysed reactions.

CO2: Understand different types of enzyme inhibitions.

CO3: Understand the wide applications of enzymes and future potential.

CO4: Isolate and purify crude forms of enzyme extract and apply appropriate method for determination of activity of enzyme.

CO5: Discuss factors that affect enzymatic activity.

BIO-III.E-4: ENZYMOLOGY (THEORY)

Module I **15 hrs**

Introduction to enzymes **8 hrs**

Nature of enzymes - protein and non-protein (ribozyme); coenzymes, cofactors & prosthetic group; apoenzyme; holoenzyme; ribozymes & isoenzymes; specificity of enzymes; classification of enzymes

Features of enzyme catalysis **7 hrs**

Fischer's lock and key hypothesis; Koshland's induced fit hypothesis; factors affecting the rate of reactions (time, enzyme concentration, substrate concentration, pH and temperature)

Module II **15 hrs**

Enzyme kinetics **8 hrs**

Principles of reaction rates; order of reactions and equilibrium constants; derivation of Michaelis-Menten equation and Lineweaver- Burk plot; significance of K_m and V_{max}, K_{cat} and turnover number

Enzyme inhibition **7 hrs**

Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and suicide, end product); mechanism-based inhibitors - antibiotics as inhibitors; types of irreversible inhibition; allosteric inhibition

Module III **15 hrs**

Mechanisms of enzyme action and regulation **4 hrs**

Mechanism of action of chymotrypsin; regulation of enzyme activity and its importance - aspartate transcarbamoylase

Enzyme purification **6 hrs**

Purification of enzymes: salt precipitation; dialysis; molecular exclusion chromatography; PAGE; Molecular weight determination by SDS-PAGE

Applications of enzymes **5 hrs**

Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases); enzyme immunoassay (HRPO); applications of enzymes in industry - detergents, leather, food

BIO-III.E-4: ENZYMOLOGY (PRACTICAL)

COURSE TITLE: ENZYMOLOGY (PRACTICAL)
COURSE CODE: BIO-III.E-4
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Effect of pH on enzyme activity
2. Effect of temperature on enzyme activity
3. Effect of substrate concentration and determination of K_m and V_{max}
4. Partial purification of any one enzyme from suitable source- ammonium sulphate precipitation, dialysis
5. Assay of enzyme activity and specific activity
6. SDS-PAGE

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2. Jain, J.L (2005), Fundamentals of Biochemistry, S.Chand and Company Ltd., New Delhi.
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BIO-IV.C-6: IMMUNOLOGY

COURSE TITLE: IMMUNOLOGY (THEORY)
COURSE CODE: BIO-IV.C-6
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

Course Objectives

This course aims at introducing the basic concepts of the immune system and its defense mechanisms. This will help them understand and reason out concepts related to diseases. A section on vaccination, monoclonal and polyclonal antibodies stresses on the importance of these for treatment of lethal diseases.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Compare and contrast primary and secondary immune response.
CO2: Gain knowledge of the structure and function of the cells and organs of immune systems.
CO3: Describe the mechanisms of Ag-Ab reaction, hypersensitivity reactions and importance of Complement system.
CO4: Understand the importance of Monoclonal Ab and various immunodeficiency diseases.
CO5: Familiarize with various techniques involved in Immunology.

BIO-IV.C-6: IMMUNOLOGY (THEORY)

Module I **15 hrs**

Immune system **8 hrs**

Introduction to the immune system - historical perspective; types of immunity (innate and acquired); barriers of innate immunity - anatomic, physiologic, phagocytic, inflammatory; collaboration between innate and adaptive immunity; introduction to humoral and cell mediated immunity

Cells and organs of the immune system **7 hrs**

Cells (myeloid and lymphoid lineage); immune-reactive cells (macrophages, granulocytes, NK Cells); primary lymphoid organs (bone marrow and thymus); secondary lymphoid organs; (spleen, lymph nodes, GALT and MALT).

Module II **15 hrs**

B cells and T cells **4 hrs**

B-cells & T-cells - structure; function and significance; maturation, activation of B-cells and T-cells

Antigen-antibody interactions **8 hrs**

Introduction to antigens and antibodies; structure, types, classes, properties and variants (e.g. immunogens, antigens, haptens, adjuvants); paratope and epitope; antigen - antibody interaction;

forces involved in antigen-antibody reaction; concept of affinity, avidity, precipitation, agglutination reactions; applications in diagnostics

Complement system **3 hrs**

The complement system; functions, components and activation pathways (classical, alternate & lectin)

Module III **15 hrs**

MHC and Hypersensitivity **5 hrs**

Major histocompatibility complex (MHC); introduction and discovery of human histocompatibility complex; structure of MHC I and II; presence of MHC I and II on different cells and their significance; hypersensitivity - Introduction

Vaccines & monoclonal antibodies **5 hrs**

Introduction to vaccines and types of vaccines; Polyclonal & Monoclonal antibodies (hybridoma technology)

Autoimmunity and immunodeficiency **5 hrs**

Introduction to autoimmunity with examples; introduction to immunodeficiency types with examples

BIO-IV.C-6: IMMUNOLOGY (PRACTICAL)

COURSE TITLE: IMMUNOLOGY (PRACTICAL)
COURSE CODE: BIO-IV.C-6
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Study of lymphoid organs and cells of the Immune System
2. Total count of WBC & RBCs using haemocytometer
3. Differential count of WBC
4. Blood grouping & Rh factor
5. Preparation of serum
6. Single Radial Immuno-diffusion
7. Ouchterolony's double diffusion method and antibody titre calculation
8. Immuno-electrophoresis
9. ELISA (Demonstration)
10. Serological tests involving precipitations (Pregnancy & Widal)

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3. Rao, C.V. (2011). Immunology, Narosa Book Distributors Pvt. Ltd.
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BIO-IV.E-5: PLANT AND ANIMAL PHYSIOLOGY

COURSE TITLE: PLANT AND ANIMAL PHYSIOLOGY (THEORY)
COURSE CODE: BIO-IV.E-5
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45
PRE-REQUISITES: Completion of BIO-III.E-1- Basics of Plant and Animal Sciences

Course Objectives

The main aim of this course is to introduce the students to the physiology of plant and animal systems with special emphasis on humans, thereby allowing them to understand how plant and animal systems function.

Course Outcomes

On the successful completion of the course, students will be able to:

CO1: Understand the physiological aspects of plants and animals.

CO2: Explain the parts/organs and processes involved.

CO3: Comprehend and distinguish between the organs and organs systems while understanding the biological functions associated with every system.

CO4: Perform basic experiments like blood counts and checking pressure.

CO5: Understand the effect of hormones on plant growth and assess the metabolites in the plant.

BIO-IV.E-5: PLANT AND ANIMAL PHYSIOLOGY (THEORY)

Module I **15 hrs**

Plant Physiology

Plant - Water Relations **3 hrs**

Absorption (passive and active); ascent of sap and transpiration

Photosynthesis & photorespiration **8 hrs**

Chloroplast pigments; photosystem I and II; electron flow through cyclic and non-cyclic; photophosphorylation; CO_2 fixation in C3 and C4 plants; CAM and glycolate pathways

Physiology of flowering in angiosperms **4 hrs**

Photoperiodism; vernalization and dormancy; molecular models of flowering: ABC model

Module II **15 hrs**

Plant Physiology

Plant hormones and regulation of plant growth **4 hrs**

Hormonal; (auxin, cytokinin, gibberellins, ethylene and abscisic acid); regulation of plant growth and development)

Secondary metabolites in plant **3 hrs**

Classification of secondary metabolites and sources of: phenolics, porphyrins, terpenoids, alkaloids

Animal Physiology

Digestive system **3 hrs**

The digestive system and associated glands in mammals

Muscular system **2 hrs**

Introduction to the muscular system; types of muscles, muscle movement

Excretory system **3 hrs**

The excretory system and associated functions

Module III **15 hrs**

Animal Physiology

Respiration and circulation **5 hrs**

The respiratory system - organs and their function; the circulatory system - components and their function

Nervous system **4 hrs**

The nervous system and associated functions

Gametogenesis and reproductive physiology **6 hrs**

Spermatogenesis and oogenesis; mammalian reproductive physiology - male and female reproductive system; an overview of developmental biology and regulatory mechanisms

BIO-IV.E-5: PLANT AND ANIMAL PHYSIOLOGY (PRACTICAL)

COURSE TITLE: PLANT AND ANIMAL PHYSIOLOGY (PRACTICAL)
COURSE CODE: BIO-IV.E-5
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Study of the physiology of plants using charts
2. Study of the rate of photorespiration in plants
3. Study of osmosis: endosmosis and exosmosis in plants
4. Osmolarity of RBCs (Effect of different salt solutions of RBCs)
5. Isolation of Rhizobium from root nodules and Gram's staining
6. Qualitative phytochemical analysis in medicinal plants
7. Analysis of the animal physiology systems in man using charts - the reproductive, digestive, respiratory, circulatory, excretory, nervous and muscular systems.
8. Observation of permanent slides - Transverse section of mammalian gonads
9. Developmental stages in Frog (cleavage, blastula, gastrula)
10. Analysis of components of blood
11. Analysis of human blood pressure and pulse rate in man

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1. Galston, A.W. (1989). Life Processes in Plants, Scientific American Library, Springer-Verlag., New York, USA.
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Animal Physiology

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BIO-IV.E-6: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY

COURSE TITLE: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (THEORY)
COURSE CODE: BIO-IV.E-6
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

Course Objective

This course aims at introducing the importance of the basic concepts of instruments and their applications in the field of biotechnology.

Course Outcomes

On the successful completion of the course, students will be able to:

CO1: Explain the principle, types of centrifugation and their functions in biological sciences.
CO2: Understand the basic differences between agarose electrophoresis, SDS and native PAGE.
CO3: Explain the principle and applications of various spectroscopic and chromatographic techniques.
CO4: Discuss radioactivity, radioactivity techniques used in biomedical research.
CO5: Perform purification and separation of proteins.

BIO-IV.E-6: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (THEORY)

Module I **15 hrs**

Basics of biochemical studies **5 hrs**

Units of measurement; weak electrolytes - the biochemical importance of weak electrolytes; ionisation of weak acids and bases; calculation of pH; ionisation of a weak electrolyte; buffer solutions; buffer capacity; buffer action; measurement of pH

Centrifugation **5 hrs**

Principle of centrifugation; centrifugal force and sedimentation rate; preparative and analytical ultracentrifuges; differential and density gradient centrifugation

Spectroscopy **5 hrs**

Principle and technique of UV, Fluorescence, Infrared, Raman and AAS

Module II **15 hrs**

Chromatography **7 hrs**

Principle and technique of: paper chromatography, TLC, gel filtration chromatography, ion exchange chromatography, affinity chromatography, HPLC, GLC

Electrophoresis **8 hrs**

Gel electrophoresis- agarose and PAGE (SDS and native); isoelectric focusing and 2D PAGE

Module III **15 hrs**

Probes and hybridization **8 hrs**

Introduction to hybridization probes; radioactive and non-radioactive probes; FISH; southern; northern; western blotting and hybridization

Radioisotopes techniques **7 hrs**

Radiation - sources; types and applications of isotopes; radioactive decay - alpha, beta, gamma and x-rays; rate of radioactive decay and radioactive units; Geiger Muller counter and scintillation

BIO-IV.E-6: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (PRACTICAL)

COURSE TITLE: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (PRACTICAL)
COURSE CODE: BIO-IV.E-6
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Comparison of absorption curves of any two coloured compounds
2. Isolation of plant chloroplasts by density gradient centrifugation
3. Preparation of TLC plates & separation of plant pigments
4. Gel filtration chromatography- Demonstration
5. Review of HPLC technique
6. Study of Atomic Absorption Spectroscopy
7. Dialysis of protein and SDS-PAGE
8. Southern blotting technique- Demonstration

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BIO-IV.E-7: EVOLUTION AND ANTHROPOLOGY

COURSE TITLE: EVOLUTION AND ANTHROPOLOGY (THEORY)
COURSE CODE: BIO-IV.E-7
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

Course Objective

This course aims at introducing the importance of the basic concepts of Evolution and anthropology and its importance in the field of biotechnology which will increase the awareness of the principles of human evolution and the biological adaptations that humans have made through time to various biotic and abiotic factors.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Understand basic concepts of evolution and anthropology and importance in biotechnology.
CO2: Explain the evolutionary history and describe the historical development of anthropology.
CO3: Explain past and present cultures including ecological adaptations with scientific approach.
CO4: Describe quantitative and qualitative methods in the analysis of anthropological data.
CO5: Critically evaluate the logic of anthropological research and apply anthropological research to contemporary environmental, social, or health issues worldwide.

BIO-IV.E-7: EVOLUTION AND ANTHROPOLOGY (THEORY)

Module I **15 hrs**

Evolution of Life **5 hrs**

Organic evolution; evidence; mechanism & theories; chemical evolution; biological evolution; types of Organic evolution

Evolution of Species **5 hrs**

Lamarckism; Darwinism; modern synthetic theory; mutational theory; introduction to molecular clock

Evolution above the species level **5 hrs**

Adaptive radiations with examples macroevolutions; microevolution; Simpson's adaptive grid; macroevolution

Module II **15 hrs**

Speciation **5 hrs**

Nature of Speciation; modes of speciation (instantaneous and gradual); types of barriers and isolation

Selection **4 hrs**

Types - selection; natural selection (directional, disruptive, stabilizing) and artificial

Fossils **6 hrs**

Formation; conditions; nature and types of fossils; determination of age of rocks and fossils (carbon dating); evidence of evolution from fossils

Module III **15 hrs**

Geographical and Geological Time Scale **2 hrs**

An overview of the geographical and geological time scale

Introduction to anthropology **2 hrs**

Definition; areas and applications; relationship of biological anthropology with other sciences

Evolution of Man **6 hrs**

Phylogenetic status; characteristics and geographical distribution of the following: Homo erectus, Neanderthal man, Rhodesian man, Homo sapiens

The role of biotechnology in anthropology **5 hrs**

Phylogenetic trees; mitochondrial DNA; Y chromosome analysis

BIO-IV.E-7: EVOLUTION AND ANTHROPOLOGY (PRACTICAL)

COURSE TITLE: EVOLUTION AND ANTHROPOLOGY (PRACTICAL)
COURSE CODE: BIO-IV.E-7
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Study of the various theories of evolution
2. Evidence for Evolution - Study of Darwin's theory of evolution with examples
3. Evidence for Evolution - Study of L.S.B. Leakey's work in establishing human evolutionary development in Africa
4. Problems based on Selection
5. Study of genetic evolution across species
6. Construction of phylogenetic trees
7. Study of types of fossils
8. Study of dentition of different types of mammals - (Herbivores, Carnivores and Omnivores)
9. Visit to museum in Old Goa for anthropological studies
10. Comparative studies of pre-hominids and hominids
11. Comparative studies of haemoglobins

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2. https://www.mcqslearn.com/anthropology/basics/quiz/quiz-questions-and-answers.php? (Anthropological Studies and their applications)
3. https://www.dk.com/us/book/9781465462558-dk-eyewitness-books-fossil/ (Examples on fossils and preservation methods)
4. https://www.cambridge.org/core/books/genetics-paleontology-and-macroevolution/E1806891821199EF032AB6EA3A8FD03D (Organic Evolution)
5. https://www.mnn.com/earth-matters/animals/blogs/facts-about-lucy-australopithecine (Fossils of *Australopithecus afarensis*)

<u>**BIO-IV.E-8: MOLECULAR GENETICS**</u>

COURSE TITLE: MOLECULAR GENETICS (THEORY)
COURSE CODE: BIO-IV.E-8
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45
PRE-REQUISITES: Completion of BIO-II.C-3 and BIO-III.C-5

<u>**Course Objective**</u>

Having completed the two prerequisite courses - Fundamental Genetics and Molecular Biology, students will be able to apply their knowledge and skills to this course. It focuses on various aspects of human genetics and explores the techniques and tools at the molecular level that can be used to identify them.

<u>**Course Outcomes**</u>

On the successful completion of the course, students will be able to:

CO1: Understand the concepts of chromosomes, cell division and it's associated disorders.

CO2: Understand the various molecular aspects of human genetics including DNA variation and mutations.

CO3: Explain concepts in diagnosis of inherited diseases and forensics genetics.

CO4: Discuss case studies on application of various molecular biology techniques for the diagnosis of genetic disorders.

CO5: Calculate the risk factors in genetic counseling for individuals with a family history of genetic disorders through case studies.

BIO-IV.E-8: MOLECULAR GENETICS (THEORY)

<u>***Module I***</u> **15 hrs**

Introduction **2 hrs**

Introduction to molecular genetics - organization of a eukaryotic genome (human genome)

Chromosomes and cell division **9 hrs**

Classification and nomenclature of chromosomes; methods of chromosome analysis (chromosome banding techniques - G, R, Q, C and high resolution banding); brief account of cell cycle; mitosis and meiosis; mechanisms of aneuploidy - nondisjunction; non-conjugation; anaphase lag; premature division of centromere; syndromes caused by aneuploidy - prevalence, causes and clinical features of Down's syndrome, Edward's syndrome and Patau syndrome; causes of polyploidy; structural abnormalities - reciprocal and Robertsonian translocations; Brief account of mosaicism and Chimerism

Review of central dogma of molecular biology **1 hr**

Brief review of the structure of DNA and replication, transcription and translation processes

DNA Variation **3 hrs**

Variation in DNA: genetic polymorphism; restriction Fragment Length Polymorphism (RFLP); short tandem repeat polymorphism (STR); variable number tandem repeat (VNTR)

<u>Module II</u> **15 hrs**

Techniques and tools in molecular biology **8 hrs**

Techniques and Tools in Molecular Biology used in Genetic Diagnoses: genetic material studied for diagnosis- DNA, RNA and cDNA;DNA fragmentation and separation by electrophoresis and membrane transfer; selective amplification of a nucleotide sequence using PCR; molecular hybridization techniques and applications:Labeled probes,fluorescence in situ hybridization (FISH),southern blot hybridization, dot blot and reverse dot blot, ARMS and OLA techniques, DNA microarrays.

Genetic counseling **7 hrs**

Screening (pre and post-natal) for genetic abnormalities; establishing the diagnosis (family history and pedigree chart); calculation, presentation and quantification of risk (Bayesian determination of recurrent risks for genetic disorders within families); placing risks in context and discussion of options; patient support groups; directive and non-directive genetic counseling; special problems in genetic counseling

<u>Module III</u> **15 hrs**

The Diagnosis of Inherited Diseases **6 hrs**

Clinical description; molecular basis and genotype-phenotype correlation of:cystic fibrosis, α-thalassemia and β-thalassemia, duchenne Muscular dystrophy, Huntington's disease

Gene Therapy **3 hrs**

An overview of gene therapy and its applications in treating genetic disorders e.g. SCID

Forensic genetics **6 hrs**

Brief History; biological evidence - sources, collection, identification, characterization; DNA fingerprinting using PCR-based and non-PCR-based techniques

BIO-IV.E-8: MOLECULAR GENETICS (PRACTICAL)

COURSE TITLE: MOLECULAR GENETICS (PRACTICAL)
COURSE CODE: BIO-IV.E-8
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Extraction of DNA from human blood and saliva
2. Visualization of extracted DNA on agarose gels
3. Principle of Southern blot
4. Study of diagnostic tools based on DNA polymorphisms
5. Principle of preparation of human metaphase chromosomes

6. Steps in molecular diagnosis of and further genetic counseling for:
    a) Cystic fibrosis
    b) α-thalassemia and β-thalassemia
    c) Duchenne muscular dystrophy
    d) Huntington's disease
7. Risk calculation: using Bayes method for any two clinical case studies
8. Clinical features of Down's syndrome, Edward's syndrome and Patau syndrome and mechanisms leading to aneuploidy
9. Research: Current status of gene therapy for any two genetic disorders

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1. Goodwin, W., Linacre, A. &Hadi, S. (2007). An Introduction to Forensic Genetics, John Wiley & Sons, Ltd.
2. Pasternak, J.J. (2005). An Introduction to Human Molecular Genetics, Mechanisms of Inherited Diseases, Second Edition, John Wiley % Sons, Inc.
3. Serre, J.L. (2006). Diagnostic Techniques in Genetics, John Wiley & Sons, Ltd.
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2. https://journals.plos.org/plosgenetics/article?id=10.1371/journal.pgen.1006960 (Forensic Genetics)
3. https://www.annualreviews.org/doi/10.1146/annurev-med-012017-043332 (Gene Therapies)
4. https://www.intechopen.com/books/genetic-diversity-and-disease-susceptibility/dna-polymorphisms-dna-based-molecular-markers-and-their-application-in-medicine (Genetic Diversity)
5. https://www.jove.com/science-education-library/2/basic-methods-in-cellular-and-molecular-biology (Basic Methods in cellular and Molecular Biology)
6. https://academic.oup.com/bmb/article/126/1/27/4958384 (Genetic Counselling)

Reorganised courses into Module System

TYBSc BIOTECHNOLOGY SYLLABUS (Sem V & VI)

for

ACADEMIC YEAR

2020 - 2021

BIO-V.C-7: CONCEPTS IN GENETIC ENGINEERING

COURSE TITLE: CONCEPTS IN GENETIC ENGINEERING (THEORY)
COURSE CODE: BIO-V.C-7
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45
PRE-REQUISITES: Completion of BIO-III.C-5- Molecular Biology

Course Objective

The course aims to introduce the students to the principles and techniques involved in Genetic Engineering through the use of genetic material and clonning vehicles for suitable manipulation of genes.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Understand the functions of several enzymes and vectors used in genetic engineering.
CO2: Acquaint to the versatile tools and techniques employed in recombinant DNA technology.
CO3: Explain the construction of DNA & c DNA library.
CO4: Acquire skills on techniques of plasmid isolation.
CO5: Develop skills for transformation and selection of recombinants.

BIO-V.C-7: CONCEPTS IN GENETIC ENGINEERING (THEORY)

Module I **15 hrs**

Introduction to genetic engineering **2 hrs**

Aims; principles; applications; ethical issues involving recombinant DNA technology and genetic engineering

DNA modifying enzymes **3 hrs**

Nucleases- endonucleases (restriction enzymes recognition sequences, cleavage pattern); exonucleases;DNA ligases;reverse transcriptases;polynucleotide kinases;alkaline phosphatases;nucleotidyltransferases

Vehicles for gene cloning **10 hrs**

Vectors - properties of ideal cloning vectors; plasmids - properties, classification; Vector for Prokaryotes - pBR322, pUC 18; bacteriophages as cloning vectors - lambda bacteriophages; features-insertional vectors and replacement vectors & M13 Bacteriophage; cosmids, phagemids and phasmids- definition, features with examples; vectors for cloning in *Saccharomyces cerevisiae* (examples and features); shuttle vectors - any one example; vectors for plant - Ti plasmid

Module II **15 hrs**

DNA insertion into vector **3 hrs**

Ligation; linkers; adaptors, homopolymer tailing

Transformation methods **8 hrs**

Methods, advantages and disadvantages: competence (transformation in bacteria); microinjection; lipofection; electroporation; macroinjection; sonication; silicon carbide fibre vortex; DNA co-precipitation; ultrasonication; laser induced; *Agrobacterium* mediated transfers

Identification of recombinants **4 hrs**

Principle and importance of identification of recombinants; antibiotic resistance (amp, tet resistance); lacZ selection; colony hybridization; *cI*selection

Module III **15 hrs**

DNA isolation methods and analysis **5 hrs**

Isolation of genomic DNA & plasmid DNA; principle of plasmid isolation; spectrophotometric analysis of DNA; agarose gel electrophoresis; purification of DNA

Amplification of nucleotide sequences **3 hrs**

Polymerase chain reaction (principles, components & method of PCR)

DNA sequencing **5 hrs**

Significance and importance of DNA sequencing**;** Maxam Gilbert's method**,** Sanger's method**,** Automatic DNA sequencer

Genomic / cDNA libraries **2 hrs**

Preparation of genomic library; cDNA library**;** Screening of libraries

BIO-V.C-7: CONCEPTS IN GENETIC ENGINEERING (PRACTICAL)

COURSE TITLE: CONCEPTS IN GENETIC ENGINEERING (PRACTICAL)
COURSE CODE: BIO-V.C-7
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Plasmid DNA isolation by alkaline lysis method
2. Plasmid DNA isolation by boiling method
3. Plasmid DNA separation on agarose gel
4. Molecular size determination of the plasmid
5. Preparation of competent cells in bacteria
6. Transformation in bacteria using suitable plasmid (pUC 18)
7. Selection of transformed colonies
8. Deciphering the DNA sequence from a sequencing gel photograph by Maxam and Gilbert's method and Sanger's method
9. Demonstration of Polymerase Chain Reaction (PCR)

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1. Brown, T.A. (2006) Manipulation of purified DNA. In:Gene cloning & DNA analysis An Introduction, 5th Ed. Blackwell publishing, Ltd, UK
2. Jogdand, S.N. (2008). Gene Biotechnology, 2nd edition, Himalaya Publishing House, Mumbai.
3. Primrose, S.B. & Twyman, R.M. (2009). Principles of Gene Manipulation and Genomics, Blackwell Publishing.
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5. Singh, B.D. (2008). Biotechnology: Expanding Horizons, Kalyani publishers.
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2. https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics/hs-biotechnology/v/the-polymerase-chain-reaction-pcr (PCR)
3. https://www.khanacademy.org/science/biology/biotech-dna-technology/dna-cloning-tutorial/a/bacterial-transformation-selection (Transformation in bacteria using pUC 18)

BIO-V.E-9 MOLECULAR MEDICINE

COURSE TITLE: MOLECULAR MEDICINE (THEORY)
COURSE CODE: BIO-V.E-9
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45
PRE-REQUISITES: Completion of BIO-IV.E-8 -Molecular Genetics

Course Objective

Molecular medicine is the application of molecular biology and molecular genetics to the understanding of human health and disease. It aims to understand the underlying origins and mechanisms of human diseases and to find novel ways of preventing, diagnosing and treating diseases

Course Outcomes

On the successful completion of the course, students will be able to:

CO1: Understand the historical aspects of molecular medicine.

CO2: Understand the underlying genetic factors of common diseases.

CO3: Describe molecular and cellular therapies for the same.

CO4: Gain a basic knowledge on cancer genetics and pharmaco-genetics.
CO5: Understand the importance of maintaining public health.

BIO-V.E-9 MOLECULAR MEDICINE (THEORY)

Module I **15 hrs**

Historical aspects **2 hrs**

History of molecular medicine - foundations (1869 - 1980s); the modern era (1980s - 2000s); The Human Genome project (1990 - 2000)

Gene structure and expression **3 hrs**

Exons, introns, alternative splicing, epigenetic changes

Genetic factors in common diseases **6 hrs**

Hypertension; coronary heart disease; autism; alzheimer disease; haemochromatosis; age-related macular degeneration

Complex genetic traits **4 hrs**

Multifactorial disorders - diabetes, dementia, schizophrenia; novel mechanisms for DNA and disease - mitochondrial inheritance, genomic imprinting, mosaicism, chimerism

Module II **15 hrs**

Cancer genetics **5 hrs**

Differentiation between genetic and environmental factors in cancer; oncogenes - types and function; tumour-suppressor genes - "two hit hypothesis"; genetics of common cancers - breast, ovarian and prostate cancer

Introduction to Omics **3 hrs**

Genomics, Proteomics, Metabolomics, Phenomics, Metagenomics

DNA Tests **4 hrs**

Direct Detection; indirect detection - DNA scanning; linkage analysis; classes of DNA tests and function of each type; validity of DNA tests

Delivering genetics and genomics to consumers **3 hrs**

Definitions and marketplace, types of direct-to-consumer (DTC) DNA tests; Pros and Cons of DTC DNA Tests

Module III **15 hrs**

Molecular and cellular therapies **8 hrs**

Recombinant DNA products - Factor VIII (Haemophilia); vaccines; somatic cell gene therapy; examples of gene therapy trials - ADA, haemophilia, cancer, eye disease, HIV; RNA therapies - RNA interference (RNAi), ribozymes; regenerative medicine - cloning, stem cells.

Pharmacogenetics **3 hrs**

Drug metabolism; genetic variations revealed by effects of drugs; pharmacogenetics- maturity -onset diabetes of the young (MODY); neonatal diabetes; pharmacogenomics; adverse effects; efficacy

Public health **4 hrs**

Preventive medicine; population screening (cystic fibrosis, sickle cell anaemia, newborn screening); changing behaviour (familial hypercholesterolemia); DNA testing in the workplace - predisposition to disease; detecting exposure to toxins; litigation, identity

BIO-V.E-9: MOLECULAR MEDICINE (PRACTICAL)

COURSE TITLE: MOLECULAR MEDICINE (PRACTICAL)
COURSE CODE: BIO-V.E-9
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Investigation of Genetic Factors in any four common diseases
2. Study of mitochondrial inheritance, genomic imprinting, mosaicism and chimerism with one example of each
3. A study on the types of DNA tests for diagnosis of diseases
4. Investigation of Molecular Mechanisms of any one type of Cancer
5. Understanding concepts relating to genomics and proteomics
6. A study on RNA therapies and regenerative medicine
7. Application of pharmacogenetics in drug metabolism
8. An investigation into the screening programmes adopted in various countries
9. Submission of a report on the molecular mechanisms and therapy for any one disease

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1. Trent, R.J. (2005). Molecular Medicine - an Introductory Text, Elsevier Academic Press.
2. Trent, R.J. (2012). Molecular Medicine - Genomics to Personalized Health Care, Fourth Edition, Elsevier Inc.
3. Turnpenny, P.D. & Ellard, S. (2007). Emery's Elements of Medical Genetics, 13th Edition, Churchill Livingstone Elsevier.

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2. https://onlinelibrary.wiley.com/doi/abs/10.1002/bies.201400138 (Eukaroytic gene expression)
3. https://onlinelibrary.wiley.com/doi/full/10.1002/wrna.1276 (Alternative splicing)
4. http://journals.tubitak.gov.tr/medical/issues/sag-15-45-5/sag-45-5-3-1406-146.pdf (genetic factors in Alzheimer's disease and age related macular degeneration)
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7. https://link.springer.com/article/10.1007/s10815-017-0895-5 (Genomic imprinting)
8. https://www.sciencedirect.com/science/article/abs/pii/S0168952515000669 (Mosaicism review)
9. https://www.sciencedirect.com/science/article/abs/pii/S0090825817300744 (Cancer genetics)
10. https://www.nature.com/articles/nrg.2018.4 (Omics)
11. https://www.nature.com/articles/nrg3908 (DNA testing Linkage analysis)
12. https://onlinelibrary.wiley.com/doi/abs/10.1002/ajmg.c.31390 (Pharmacogenetics)

BIO-V.E-10: ENVIRONMENTAL BIOTECHNOLOGY

COURSE TITLE: ENVIRONMENTAL BIOTECHNOLOGY (THEORY)
COURSE CODE: BIO-V.E-10
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

Course Objective

The main aim of this course is to introduce the students to the hazards of our environment, the effects of pollution on living systems, solutions to protect the environment for sustainable development.

Course Outcomes

On the successful completion of the course, students will be able to:

CO1: Explain the scope of Environmental Biotechnology.

CO2: Understand the basic ecological concepts, various types of pollution, its measurements & remediation.

CO3: Describe the various eco-friendly bio-products.

CO4: Assess the quality of the water sample through various parameters like MPN test, dissolved oxygen concentration, biological oxygen demand, chemical oxygen demand and nitrates of water sample.

CO5: Understand the working of sewage treatment plants.

BIO-V.E-10: ENVIRONMENTAL BIOTECHNOLOGY (THEORY)

Module I **15 hrs**

Basic ecological concepts and principles **3 hrs**

Structure (biotic and abiotic components); food chains and food webs; ecological pyramids; productivity and eco-energetic (10% law)

Anthropogenic activities, its effects and control **12 hrs**

Air pollution: Major air pollutants and their sources, Impacts of air pollution on human health, animals, plants and climate; removal of gaseous contaminants and odour: bioscrubbers, biotrickling filters and biofilters/biobeds

Water pollution: Principal forms of water pollutants and their sources;wastewater treatment: activated sludge process, rotating biological discs, oxidation ponds, trickling filters

Soil pollution: Soil pollution and their sources; treatment of solid wastes: hazardous; non hazardous; composting and vermi-technology

Module II **15 hrs**

Pollution monitoring **10 hrs**

Bio indicators: concept and examples (indicators of water quality; air pollution indicators); choice of criteria: visual rating; genotoxicity; metabolic rating; applications (two each); using plant test systems and animal test systems; tests for assessing Genetic damage: AMES test; cyto-genetic assay; membrane damage; concept and applications of molecular biology in environmental monitoring: reporter gene: concept and applications of biosensors in pollution detection

Pollution abatement: Bioremediation **5 hrs**

Bioremediation: definition, microbial bioremediation, phytoremediation; microbial desulphurization of coal (direct and indirect mechanisms)

Module III **15 hrs**

Pollution abatement: biodegradation **6 hrs**

Biodegradation: basis of biodegradation, concepts of use of mixed microbial populations; Biodegradation of two xenobiotics: aromatic hydrocarbons (benzene) and alkanes

Biosorption: principle; use of fungi and algae (2 examples each); genetically engineered microorganisms - superbug (*Pseudomonas* sps.)

Eco-friendly Bio-products **7 hrs**

Biogas (biomethanisation) production; bioethanol production; bio hydrogen production: anaerobic bacteria and photolysis photosynthetic algae; biodiesel production; bioplastics: biopol and biolac; biopesticide

Scope of environmental biotechnology **2 hrs**

Scope of environmental biotechnology

BIO-V.E-10: ENVIRONMENTAL BIOTECHNOLOGY (PRACTICAL)

COURSE TITLE: ENVIRONMENTAL BIOTECHNOLOGY (PRACTICAL)
COURSE CODE: BIO-V.E-10
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Determination of dissolved oxygen concentration of water sample by Winkler’s method
2. Determination of biological oxygen demand (BOD) of the given sample

3. Determination of chemical oxygen demand (COD) of the given sample ($KMnO_4$/ $K_2Cr_2O_7$ method)
4. Determination of TS (total solids) of the given water sample
5. Isolation of xenobiont degrading bacteria by selective enrichment
6. Determination of nitrates from water sample
7. Visit to an effluent /sewage treatment plant and preparation of report
8. Detection of coliforms for determination of the purity of potable water (MPN, Presumptive, confirmatory and confirmed tests)

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7. Thakur I.S. (2006). Environmental Biotechnology: Basic concepts and applications, I.K. International Pvt. Ltd. New Delhi.

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3. https://www.sciencedirect.com/book/9780128000212/microbial-biodegradation-and-bioremediation (Anthropogenic activities and its effects)
4. https://www.intechopen.com/books/biodegradation-life-of-science/biodegradation-involved-microorganisms-and-genetically-engineered-microorganisms (Bioremediation & biodegradation)
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4463667/ (Bioremediation & biodegradation)
6. https://www.intechopen.com/books/biofuels-state-of-development/prospective-biodegradable-plastics-from-biomass-conversion-processes (Eco-friendly Bio-products)
7. https://www.epa.gov/ingredients-used-pesticide-products/what-are-biopesticides (Eco-friendly Bio-products)
8. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/biopesticide (Eco-friendly Bio-products)

BIO-V.E-11: PLANT BIOTECHNOLOGY

COURSE TITLE: PLANT BIOTECHNOLOGY (THEORY)
COURSE CODE: BIO-V.E-11
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

Course Objective

This course aims at introducing the concept of in vitro culture of plants including set up of a plant tissue culture laboratory, instruments and sterilization techniques. This course will help the students to understand that various parts of the plant may be cultured, with each type of culture having specific applications. Plant tissue culture also lends itself for production of transgenic plants which have various applications.

Course outcomes

On the successful completion of the course, students will be able to:
CO1: Understand that various parts of the plant that can be cultured, with each type of culture having specific applications.
CO2: Comprehend concepts of protoplast culture, somatic hybridization and production of secondary metabolites.
CO3: Describe genetic engineering methods for production of transgenic plants.
CO4: Understand all the aspects of plant biotechnology in terms of set up of a laboratory, culture of explants.
CO5: Perform techniques of root/shoot callus production and cell suspension culture.

BIO-V.E-11: PLANT BIOTECHNOLOGY (THEORY)

Module I **15 hrs**

History of plant tissue culture **2 hrs**

International and Indian scientists

Laboratory organization **4 hrs**

Washing and drying facility; general laboratory and media preparation area; transfer area; culture room; growth chambers and green house (ideal conditions for incubation and maintenance of cultures/plants).

Sterilization techniques **2 hrs**

Sterilization techniques used in plant tissue culture - steam, dry, filter, ultra violet, alcohol, flame and chemical (explants)

Plant tissue culture media **4 hrs**

Major and minor inorganic nutrients; vitamins; carbon source; hormones; complex organic additives and their functions;composition of some commonly used plant tissue culture media - MS, White's, Nitsch, Gamborg B5

Totipotency **2 hrs**

Totipotency and its Importance; Various parts of the plant serving as Explants

Organogenesis **1 hr**

Root and shoot regeneration and applications

Module II **15 hrs**

Organ culture and its applications **5 hrs**

Root; shoot tip/meristem; anther and pollen; ovary and ovule embryo

Callus and cell suspension cultures **4 hrs**

Callus culture - principle; characteristics of callus tissue; applications; cell suspension culture - principle; isolation; growth patterns; concept of batch and continuous culture; viability testing

Somaclonal variation **2 hrs**

Concept; isolation of variants; mechanisms of somaclonal variation and applications

Somatic embryogenesis and artificial seeds **2 hrs**

Somatic embryogenesis - principle; procedure and applications; artificial seeds - methods of production and applications

Applications of Tissue Culture in Plant Sciences **2 hrs**

Micropropagation; gene conservation banks; forestry

Module III **15 hrs**

Protoplast culture and somatic hybridization **4 hrs**

Protoplast culture - principle; isolation of protoplasts (mechanical and enzymatic); methods of culture; checking viability; somatic hybridization - protoplast fusion (spontaneous and induced); selection of hybrid protoplasts; applications of somatic hybridization

Production of secondary metabolites **2 hrs**

Classification of secondary metabolites with examples; production using culture methods - callus culture; cell suspension culture; hairy root culture (A. rhizogenes); immobilized cell systems

Gene transfer in plants **4 hrs**

Introduction to Agrobacterium tumefaciens and Ti plasmid; Agrobacterium based vectors (cointegrate and binary vectors); co-culture method and in plant transformation; direct methods of gene transfer - electroporation, chemical methods, particle gun method and microinjection

Applications of transgenic plants **5 hrs**

Insect resistance (BT toxin); drought and salt tolerance; herbicide resistance; increasing shelf life of fruits; improvement of vitamin content (golden rice) and edible vaccines

BIO-V.E-11: PLANT BIOTECHNOLOGY (PRACTICAL)

COURSE TITLE: PLANT BIOTECHNOLOGY (PRACTICAL)
COURSE CODE: BIO-V.E-11
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Washing, Packing and Sterilization of Glassware
2. Preparation of Stock solutions for Murashige and Skoog (MS) medium
3. Preparation, sterilization and pouring of MS medium
4. Aseptic germination of seedling
5. Callus induction from hypocotyl and carrot cambial explants and subculturing
6. Shoot tip culture
7. Regeneration of shoot/root from callus
8. Setting up of cell suspension culture and checking viability by Evan's blue method
9. Setting up an in vitro culture from seed embryo (embryo culture)
10. Encapsulation of somatic/true embryo (synthetic seeds) and Regeneration of Plants from Synthetic Seeds

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2. https://www.researchgate.net/publication/272493719_Plant_Cell_Tissue_and_Organ_Culture_Biotechnology_and_Its_Application_in_Medicinal_and_Aromatic_Plants (organ culture)
3. https://link.springer.com/article/10.1007/BF02632054 (transgenic plants)
4. https://www.nature.com/articles/nbt0188-56 (protoplast culture)
5. https://link.springer.com/chapter/10.1007/978-981-10-2961-5_2 (applications)

BIO-V.E-12: BIOINFORMATICS

COURSE TITLE: BIOINFORMATICS (THEORY)
COURSE CODE: BIO-V.E-12
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

Course Objective

This course aims at introducing the importance of the basics of computers, concept of Human Genome Project, storage of biological information, tools and techniques of bioinformatics used and their importance in the field of biotechnology.

Course Outcomes

On the successful completion of the course, students will be able to:

CO1: Explain the scope of Bioinformatics.

CO2: Understand the basic concept of biological databases, various types and applications of biological databases.

CO3: Describe the various applications of BLAST and FASTA in understanding differences in evolutionary patterns.

CO4: Assess the mutations and genetic disorders and understand the importance of drug design in silico.

CO5: Will be able to construct evolution tree, cladogram, retrieve biological information accessed through various information resources.

BIO-V.E-12: BIOINFORMATICS (THEORY)

Module I **15 hrs**

Introduction to Computers in Biology **3 hrs**

Introduction to use of computers, internet and software in biology; Role of computers in medicine and research

DNA, RNA and Proteins and HGP **5 hrs**

Background of DNA, RNA and Proteins, ORF; Review of transcription and translation; Introduction to HGP; objectives; achievements of HGP; Ethical and Social issues

Introduction to bioinformatics **3 hrs**

Definition; scope of bioinformatics; bioinformatics vs computational biology; components of bioinformatics and applications

Information resources **4 hrs**

Introduction and objectives of NCBI, NLM, NIH, EBI and SRS

Module II **15 hrs**

Biological databases **7 hrs**

Types of data and biological databases; Primary databases: GenBank, EMBL, DDBJ; Secondary databases: Swiss-PROT, PDB & PIR; Composite databases: OWL & PROSITE

Structural databases **5 hrs**

X-ray crystallography, PDB, MMDB, CATH and SCOP; Visualization of proteins - Cn3D and Rasmol

Literature databases **3 hrs**

Pubmed; MedLINE and OMIM

Module III **15 hrs**

BLAST and FASTA **4 hrs**

Introduction to BLAST and FASTA and their types

Sequence alignment tools **6 hrs**

Sequence alignment - Pairwise and Multiple; Clustal-W Omega; T-coffee

Phylogeny **5 hrs**

Introduction to phylogeny and cladistics; Cladogram and Phylogenetic tree construction; structure and types of phylogenetic trees; differences between cladogram and phylogenetic tree; Applications of phylogeny.

BIO-V.E-12: BIOINFORMATICS (PRACTICAL)

COURSE TITLE: BIOINFORMATICS (PRACTICAL)
COURSE CODE: BIO-V.E-12
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Introduction to Bioinformatics & its Applications
2. Study of Human Genome Project
3. Usage of NCBI resources
4. Biological data search using NCBI - Protein or amino acid sequences
5. Biological data search using NCBI - DNA or gene sequences
6. Biological data search using NCBI - Literature & Structure databases
7. Database search & Pairwise sequence alignment using NCBI BLAST :BLASTp&BLASTn
8. Multiple sequence alignment using Clustal-W
9. Construction of phylogenetic tree using Clustal-W
10. DNA sequence analysis to find restriction enzymes sites using NEBcutter
11. Visualization of protein structures using Cn3D/ Rasmol

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3. https://vlab.amrita.edu/?sub=3&brch=273&sim=1432&cnt=1 (Phylogenetic tree construction)
4. https://www.ck12.org/biology/phylogeny-and-cladistics/lesson/Cladistics-Advanced-BIO-ADV/ (Phylogeny and Cladistics)
5. https://science.jrank.org/pages/5210/Phylogeny/ (Phylogeny and Cladistics)
6. https://pediaa.com/difference-between-cladogram-and-phylogenetic-tree/ (Phylogeny and Cladistics)
7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1186895/ (X-ray crystallography and protein structure determination)

BIO-VI.C-8: INDUSTRIAL BIOTECHNOLOGY

COURSE TITLE: INDUSTRIAL BIOTECHNOLOGY (THEORY)
COURSE CODE: BIO-VI.C-8
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45
PRE-REQUISITES: Completion of BIO-II.C-4-Basic Microbiology

Course Objective

This course is designed to introduce the students to the basic concepts in Industrial Biotechnology. The course covers concepts in Industrial Biotechnology, mainly introducing the basics of upstream processes in fermentation technology on an industrial scale.

Course Outcomes

On the successful completion of the course, students will be able to:

CO1: Understand and explain various parts of a fermentor.

CO2: Comprehend various concepts of Upstream and Downstream processes.

CO3: Describe the production processes of fermentation products like wine or vinegar at the industrial level.

CO4: Design small scale experiments to produce common enzymes like amylase.

CO5: Prepare basic fermentation products like wine, vinegar, etc.

BIO-VI.C-8: INDUSTRIAL BIOTECHNOLOGY (THEORY)

Module I **15 hrs**

Fermentation equipment and its use **10 hrs**

Definition of fermentor/bioreactors; structure of ideal fermentor; definition and uses of impellers and their types; spargers and their types;baffles; headspace; controls and sensors (temperature, pH, antifoam, dissolved oxygen and carbon dioxide sensor); types of reactors (definition, description, diagram and uses)-stirred tank reactors; bubble columns; airlift bioreactors (internal and external loop); fluidised bed; packed bed column, photobioreactors; tray bioreactors

Screening and selection of microorganisms **3 hrs**

Primary screening-definition; techniques; crowded Plate; auxanography; enrichment; indicator dye; secondary screening- definition and features; giant colony technique

Stock cultures **2 hrs**

Cryogenic preservation;aims of preservation of cultures; definition of working and primary stock cultures; techniques of preservation- serial subculture , sterile soil, water , silica gel; sterile mineral oil; lyophilisation

Module II **15 hrs**

Types of fermentation processes **3 hrs**

Continuous; submerged; surface/solid state; batch; fed-batch

Fermentation media **5 hrs**

Characteristics of an ideal; production media; media composition - crude, synthetic; media; sterilization -Heat, radiation, chemical methods and filtration; batch and continuous sterilization, inoculum preparation

Detection and assay of fermentation products **5 hrs**

Physical or chemical assay- titration and gravimetric assay; turbidity analysis and cell determination; spectrophotometric assay; chromatographic partition assay; biological assay-concept benefits and drawbacks; diffusion assay;turbidimetric and growth assay; end point assay; metabolic response assay; enzymatic assay

Scale up of fermentations and increasing product yields **2 hrs**

Significance of scale up; pilot fermenters; increasing product yields by mutagens-physical and chemical mutagens/strain improvement

Module III **15 hrs**

Downstream processing **10 hrs**

Biomass: separation of cells - flocculation; floatation; filter aids and filtration (surface, depth); centrifugation- batch centrifuge eg. tubular bowl centrifuge; continuous centrifuge eg. basket centrifuge; disintegration in brief: mechanical eg: ultrasonication; homogenisers and use of ballotini; non mechanical eg. thermallysis; chemical detergent solubilisation, organic solvents; enzymatic methods eg. lysozyme

Broth: Enrichment: evaporation, membrane filtration, liquid-liquid extraction, precipitation, adsorption

Purification: chromatography

Formulation - crystallization and drying (convection drying eg. spray dryers, freeze drying)

Industrial production **5 hrs**

Organisms; fermentation media and conditions;downstream processing and uses -alcohol /Wine; penicillin,vinegar

BIO-VI.C-8: INDUSTRIAL BIOTECHNOLOGY (PRACTICAL)

COURSE TITLE: INDUSTRIAL BIOTECHNOLOGY (PRACTICAL)
COURSE CODE: BIO-VI.C-8
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. A study on the phases of growth of microorganisms during batch fermentation (equipment: Erlenmeyer flask, medium: nutrient broth, inoculum: *E.coli*).
2. Parts of a fermentor
3. Preparation and sterilization of medium for batch fermentation process
4. Batch fermentation using fermentor
5. Preparation and sterilization of medium for fed-batch fermentation process
6. Fed-batch fermentation
7. Decontamination and sterilization of the fermentor
8. Primary screening of antibiotic producing bacteria by crowded plate technique
9. Secondary screening for antibiotic producers by Giant Colony Technique
10. Production of wine (from pineapple or any other fruit/vegetable) using yeast
11. Production of vinegar from toddy
12. Estimation of total reducing sugars and acidity (total and volatile) in wine and vinegar (before and after fermentation)

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3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4027325/ (Isolation and Screening)
4. https://www.youtube.com/watch?v=3pL2X-8-eVk (Fractional Distillation)
5. https://www.sciencedirect.com/science/article/pii/S2095809917304241 (Photobioreactors)

BIO-VI.E-13: BIOETHICS AND BIOSAFETY

COURSE TITLE: BIOETHICS AND BIOSAFETY (THEORY)
COURSE CODE: BIO-VI.E-13
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

Course Objective

This course aims at introducing the importance of the basic concepts of bioethics and biosafety and their relationship with several fields such as ecology, agriculture, medicine, chemistry and advances brought about in the field of biology and medicine. The course deals with answers to ethical questions that arise in the relationships among life sciences and their importance in the field of biotechnology.

Course Outcomes

On the successful completion of the course, students will be able to:

CO1: Understand the importance of general safety measures in laboratories and biosafety guidelines.

CO2: Justify the design of confinement facilities at different Biosafety levels.

CO3: Implement good laboratory practices.

CO4: Discuss the relevance of intellectual property rights to biotechnological innovations.
CO5: Describe the standard operating procedures for disposal of various types of wastes from the Biotechnology laboratory.

BIO-VI.E-13: BIOETHICS AND BIOSAFETY (THEORY)

Module I **15 hrs**

Introduction to Bio-safety **6 hrs**

Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels: Physical containment, Biological containment, Biosafety Levels of Specific Microorganisms; Recommended Biosafety levels for infectious agents and infected animals

Safety in Laboratories **4 hrs**

General safety measures, Hazards: Physical, Biological and Chemical, Spillage and waste disposal

International and Indian biosafety guidelines **5 hrs**

Biosafety guidelines in India; International biosafety guidelines: OECD, FAO, WHO, CAC and other organisations

Module II **15 hrs**

Introduction to bioethics **5 hrs**

Introduction to bioethics; social and ethical issues in biotechnology: issues related to test tube babies; bioethics in plant genetic engineering; bioethics in animal genetic engineering

Introduction to IPR **10 hrs**

Introduction to intellectual property; protection of intellectual property; property rights: trade secret, patent, copyright, plant variety protection; plant breeders' right: history, PPVFR, UPOV, requirements for PBR, need and benefit for PBR, breeders exemption, farmer's privilege, farmer's right; world intellectual property organization (WIPO), GATT & TRIPs ; patent status - international Scenario; patenting of biological materials; significance of patents in India

Module III **15 hrs**

Case studies **3 hrs**

Patenting Basmati rice; Revocation of patents-turmeric and neem

Protection of biotechnological inventions **6 hrs**

Patenting of genes and DNA sequences; gene patents and genetic resources; farmers rights; plant breeder's rights; patenting of life forms;broad patents in biotechnology

Regulatory affairs **3 hrs**

Good laboratory practices; good manufacturing practices

Biosafety of GMOs and GEMs **3 hrs**

Planned introduction and field trials of: GMOs and GEMs

BIO-VI.E-13: BIOETHICS AND BIOSAFETY (PRACTICAL)

COURSE TITLE: BIOETHICS AND BIOSAFETY (PRACTICAL)
COURSE CODE: BIO-VI.E-13
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. General safety measures and study of safety notices
2. Study of preventive measures and first aid during laboratory hazards
3. Case study on handling and disposal of radioactive waste
4. Case study on handling and disposal of medical/microbial waste
5. Study of Good Laboratory Practices
6. Study of Good Manufacturing Practices
7. Study of components and design of a Biosafety laboratory
8. A case study on clinical trials in India with emphasis to ethical issues
9. Planning of establishment of a hypothetical biotechnology industry in India
10. Study of steps of a patenting process

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4. https://www.wipo.int/export/sites/www/about-ip/en/iprm/pdf/ch1.pdf (Introduction to IPR)
5. http://www.fao.org/fileadmin/user_upload/gmfp/docs/Biosafety%20Brochure.pdf (Biosafety of GMOs)
6. https://www.hindawi.com/journals/isrn/2011/369573/ (Biosafety of GMOs)

BIO-VI.E-14 ADVANCED CELL BIOLOGY

COURSE TITLE: ADVANCED CELL BIOLOGY (THEORY)
COURSE CODE: BIO-VI.E-14
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45
PRE-REQUISITES: Completion of BIO-I.C-2- Cell Biology

Course Objective

The course will give a detailed description of how eukaryotic cells receive, transmit and respond to environmental signals, cellular regulation of cell cycle progression and cell death. The principal and working of the essential tools used in cell biology will also be covered.

Course Outcomes

On the successful completion of the course, students will be able to:

CO1: Understand the theory behind the working of various techniques in cell biology.
CO2: Explain the processes of membrane transport and signal transduction.
CO3: Describe cell cycle events and their regulation.
CO4: Isolate and visualize the subcellular organelles.
CO5: Prepare slides and identify various stages of Mitosis and Meiosis.

BIO-VI.E-14 ADVANCED CELL BIOLOGY (THEORY)

Module I **15 hrs**

Techniques in cell biology **10 hrs**

Review of 2D microscopy; confocal microscopy;transmission electron microscopy; scanning electron and atomic force microscopy; the use of radioisotopes; differential centrifugation; purification of proteins - precipitation;ion-exchange chromatography;gel filtration chromatography;affinity chromatography; polyacrylamide gel electrophoresis; two-dimensional gel electrophoresis; purification of nucleic acids-agarose, gel electrophoresis; ultracentrifugation, blotting techniques

Membrane potentials and nerve impulses **5 hrs**

The resting potential; the action potential; propagation of action potentials; neurotransmission

Module II **15 hrs**

Cell cycle and programmed cell death **10 hrs**

Overview of the cell cycle; regulation of cell cycle;events of mitotic phase; cytokinesis; events of meiosis; regulation of cell division; apoptosis (extrinsic and intrinsic pathway)

Membrane transport **5 hrs**

Review of structure and composition of cell membrane; transport across the nuclear envelope - simple diffusion and facilitated diffusion; passive transport - glucose transporter, anion transporter; primary active transporters - P type ATPases, V type ATPases, F type ATPases; secondary active transporters -Na+-glucose symporter; ion channels - voltage-gated ion channels (Na+/K+ voltage-gated channel)

Module III **15 hrs**

Signal transduction **11 hrs**

The basic elements of cell signalling systems-autocrine, paracrine and endocrine types ; an overview of the major signalling pathways; mechanism and signal transduction of G protein-coupled receptors (GPCRs); Receptor protein-tyrosine kinases (RTKs); Ligand-gated channels; steroid hormone receptors; second messengers- cyclic AMP, phosphatidylinositol derived second messengers;role of calcium and NO as intracellular messengers

Cancer biology **4 hrs**

Development and causes of cancer; genetic basis of cancer; oncogenes; tumor viruses

BIO-VI.E-14 ADVANCED CELL BIOLOGY (PRACTICAL)

COURSE TITLE: ADVANCED CELL BIOLOGY (PRACTICAL)
COURSE CODE: BIO-VI.E-14
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Identification of different stages of mitosis (in garlic root tip) `
2. Identification of different stages of meiosis (flower buds/ grasshopper testes)
3. Study of cell viability by trypan blue
4. Identification and study of cancerous cells using permanent slides/ photomicrographs
5. Study of plant, animal and human tumour viruses using photomicrographs
6. Differential centrifugation for separation of cellular components
7. Preparation of sucrose density gradient and separation of subcellular organelles
8. Visualization of nuclear fraction by acetocarmine stain and mitochondria by Janus green stain
9. Study of electron micrographs of subcellular organelles
10. Separation of photosynthetic pigments by TLC

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3. https://www.ncbi.nlm.nih.gov/books/NBK12959/ (Genetic Basis of Cancer)
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BIO-VI.E-15: FOOD BIOTECHNOLOGY

COURSE TITLE: FOOD BIOTECHNOLOGY (THEORY)
COURSE CODE: BIO-VI.E-15
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

Course Objective

This course adds information about the role of microorganisms in many food industries both in production and spoilage processes and to understand the importance of the role of microorganisms in food industries in both beneficial and harmful ways.

Course Outcomes

On the successful completion of the course, students will be able to:

CO1: Understand the important spoilage microorganisms in foods and food borne diseases.

CO2: Explain the principles of various food preservation techniques and the importance of food quality assurance.

CO3: Debate on the Pros and cons of GM foods.

CO4: EvaluateMIC of food preservatives.

CO5: Assess the quality of milk through various tests.

BIO-VI.E-15: FOOD BIOTECHNOLOGY (THEORY)

Module I **15 hrs**

History and development of food microbiology **2 hrs**

History of microorganisms in food; role and significance of microorganisms in foods

Factors influencing microbial growth in food **4 hrs**

Intrinsic and extrinsic factors responsible for food spoilage

Microorganisms involved in food spoilage **2 hrs**

Microorganisms involved in food spoilage: fruits vegetables, meat, eggs, bread

Food borne diseases **4 hrs**

Food poisoning: (bacterial toxin botulism and Staphylococcal toxin); fungal toxins: aflatoxin; food borne infections: gastroenteritis and Salmonellosis

Microorganisms as source of food **3 hrs**

Nutritive value and use of:Mushroom,SCP eg. Spirullina

Module II **15 hrs**

Milk Microbiology **6 hrs**

Sources of contamination; different microorganisms implicated in spoilage; milk borne diseases: listeriosis and scarlet fever; grading of milk by dye reduction test - MBRT and resazurin

Detection of food spoilage **6 hrs**

Methods of detection of food spoilage in any 1 type of food (example milk); traditional approaches in detection of spoilage (SCP, breeds smear, identification of specific; organisms by using selective and differential media); new approaches (examples gene probes, bioluminescence)

Food quality assurance **3 hrs**

Food safety: HACCP system to food protection

Module III **15 hrs**

Food preservation **8 hrs**

Preservation by drying: solar drying, mechanical drying, salting, smoking); preservation at high temperature: concept of TDP and TDT; pasteurization (LTHT, HTST, UHT processes); efficiency of pasteurization - phosphatase test, canning, hurdle technology; preservation at low temperature: freezing preservation by use of additives: acids, salts, sugars, antibiotics, ethylene oxide, antioxidants; preservation by radiation: UV, ionizing radiations,gamma and cathode rays, microwave processing; other methods: hydrostatic pressure cooking,modified atmosphere

Fermentation technology **3 hrs**

Fermented Food: process, microbiology involved and changes during fermentation of fermented food: sauerkraut; milk products: yogurt

GM foods **4 hrs**

Pros and cons of GM foods Eg: Golden rice, FlavrSavr tomato and BtBrinjal

BIO-VI.E-15: FOOD BIOTECHNOLOGY (PRACTICAL)

COURSE TITLE: FOOD BIOTECHNOLOGY (PRACTICAL)
COURSE CODE: BIO-VI.E-15
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Plating of spoiled food on selective media
2. MIC of common food preservatives - (sugar/ salt)
3. MIC of chemical food preservatives - (sodium benzoate/ potassium metabisulphite)
   Milk Microbiology
4. Standard plate count
5. Grading of quality of milk using dye reduction test (MBDRT / Resazurin)
6. Pasteurisation of milk
7. Determination of efficiency of pasteurisation by phosphatase test
8. Determination of TDP and TDT

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BIO-VI.E-16: ANIMAL CELL CULTURE

COURSE TITLE: ANIMAL CELL CULTURE (THEORY)
COURSE CODE: BIO-VI.E-16
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

Course Objective

This course is designed to introduce the students to the basic concepts of Animal Cell Culture. The course covers topics that explain animal cell culturing and methods involved in basic culturing of animal cells with a few applications to life sciences.

Course Outcomes

On the successful completion of the course, students will be able to:

CO1: Understand the basic concepts of animal cell culture.

CO2: Comprehend the various requirements and techniques for animal cell culture and importance of the same.

CO3: Understand the importance of primary and established cell lines for biotechnological applications.

CO4: Describe the various methods of characterization and growth assessment techniques in culturing animal cells.

CO5: Understand the applications of animal cells in the development of disease diagnostics and therapeutics.

BIO-VI.E-16: ANIMAL CELL CULTURE (THEORY)

Module I **15 hrs**

Introduction to animal cell culture **2 hrs**

Animal Tissue and Cell Culture (Definition and Concepts in brief)
History and Scope of Animal Tissue Culture

Requirements for animal cell culture **4 hrs**

Basic layout of an animal cell culture laboratory (washing room, media preparation & sterilization room, inoculation and aseptic culture room); equipment; culture vessels for tissue culture

Basics of an animal Cell **3 hrs**

Structure and organization of animal cell; an overview of developmental biology (importance in understanding differentiation of cells in culture)

Media in animal cell culturing **6 hrs**

Physico-chemical properties of culture media (pH, CO_2, O_2& Temperature); growth media - (types, advantages and disadvantages of each type); natural and artificial media; natural media - clots, biological fluid, tissue extracts, complex natural media; artificial media - serum containing, serum- free media, chemically defined and protein- free media; basal salt solutions (BSS) - constituents (vitamins, amino acids, trace elements, inorganic ions); importance; uses and examples; serum as a complex supplement; growth factors in promoting proliferation of cells - uses and examples (EGF, FGF, PDGF)

Module II **15 hrs**

Basic techniques in animal cell culture **6 hrs**

Techniques in mammalian cell culture - source of cells; dissection/isolation of cells; mechanical and enzymatic disaggregation; types of cell cultures (organ culture, whole embryo culture, histotypic cultures, explants cultures)

Cell line cultures **6 hrs**

Primary and established cell line cultures; establishment of continuous cell lines - spontaneous transformation; chemical transformation; viral transformation; non- chemical methods; characteristics & maintenance of established / continuous cell lines; characteristics of normal and transformed cells (properties of transformed cells)

Normal cell growth, phases of growth in culture and synchronization of cells **3 hrs**

Eukaryotic cell cycle and basics of cell synchronization; apoptosis in cultured cells - Reasons for cell suicide; phases of cell growth (lag, log, stationary, decline); population doubling level; morphology

Module III **15 hrs**

Characterization and growth measurement of cultured cells **6 hrs**

Characterization - genetic and enzymatic methods (cytogenetics, karyotyping, Isoenzymes and immunological tests); growth measurement - direct method (particle counter, dye exclusion test, cytotoxicity assay); growth measurement - indirect method (MTT assay)

Cell separation methods **3 hrs**

Physical method of cell separation - separation based on cell size; cell density; cell surface charge; cell affinity; separation by flow cytometry

Applications of animal cell culture **6 hrs**

Stem cell culture (applications in Animal Cell Culture); artificial skin; artificial cartilage; special secondary metabolites / products (insulin, growth hormone, interferon, t-plasminogen); other valuable products obtained using animal cell cultures (emphasis on monoclonal and polyclonal antibodies)

BIO-VI.E-16: ANIMAL CELL CULTURE (PRACTICAL)

COURSE TITLE: ANIMAL CELL CULTURE (PRACTICAL)
COURSE CODE: BIO-VI.E-16
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Washing of glassware and culture wares, preparation of animal cell culture media, sterilization
2. Introduction to use of instruments and sterile techniques in animal cell culture
3. Preparation of Basal Salt Solutions (DPBS) and filter sterilization
4. Preparation of culture media for animal cell culture (DMEM / RPMI 1640) using BSS.
5. Preparation of serum from goat blood & filter sterilization for animal cell culture
6. Culturing lymphocytes from blood cells using RPMI 1640
7. Dissection of chick embryo for culturing fibroblast cells
8. Estimation of cell viability using trypan blue & calculations of seeding density for animal cell cultures
9. Establishing a monolayer culture using warm trypsinization method
10. Establishing a monolayer culture using cold trypsinization method
11. Subculture of monolayer culture

REFERENCES

1. Das, H.K. (2005). Textbook of Biotechnology, Wiley India Pvt. Ltd.
2. Freshney, I.R. (2005). Culture of animal cell -A Manual of Basic Techniques, 5th Edition, Wiley- Liss Publications.
3. Gangal, S. (2010). Principles and Practice of Animal Tissue Culture, 2nd edition, Universities Press.
4. Shivangi, M. (2006). Animal Cell and Tissue Culture, Agrobios, India.
5. Singh, B.D (2013). Biotechnology, Expanding horizons, Kalyani Publishers, New Delhi.

WEB REFERENCES

1. https://onlinelibrary.wiley.com/doi/full/10.1002/rmb2.12024 (Requirements and media for animal cell culture)
2. https://books.google.com/books?hl=en&lr=&id=GyfLBAAAQBAJ&oi=fnd&pg=PP1&dq=requirements+of+animal+cell+culture&ots=G6-CoDHnJW&sig=Zyukoy1RdMEmHDDwriHhMLATOlY (Techniques in animal cell culture)
3. https://link.springer.com/book/10.1007%2F978-3-319-10320-4 (Techniques in animal cell culture)
4. https://link.springer.com/protocol/10.1007/978-1-62703-733-4_7 (Media for animal cell culture)

5.https://books.google.co.in/books?hl=en&lr=&id=GyfLBAAAQBAJ&oi=fnd&pg=PP1&dq=requirements+of+animal+cell+culture&ots=G6-CoDHnJW&sig=Zyukoy1RdMEmHDDwriHhMLATOlY&redir_esc=y (Methods in animal cell culture)
6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3931621/ (Characterisation of animal cells)
7. https://link.springer.com/article/10.1007/s11051-015-2958-9 (Growth assessment of animal cells)
8.https://link.springer.com/protocol/10.1007/978-1-4939-2074-7_26 (Viability assays for animal cell culture)
9. https://www.hindawi.com/journals/bmri/2015/285869/ (Applications of animal cell culture)
10.https://www.liebertpub.com/doi/abs/10.1089/ten.TEB.2014.0086 (Application of animal cell culture in tissue engineering)
11.https://www.tandfonline.com/doi/full/10.3109/21691401.2016.1146731(General applications of animal cell culture)

Certificate course in Food Product and Business Development

Course Title: Certificate course in Food Technology and Business Development (theory)

Total hours: 30 hours

Number of modules: 4

Credits: 2

Eligibility: Completed HSSC Science

Course Objectives:

-To enable students to have fundamental skills in the field of food- technology.

-To broaden the understanding of students in the aspects of Research and Development, Manufacturing Process, Quality Assurance and Quality Control and Entrepreneurship.

Course Outcomes:

On successful completion of the course, students will be able to

CO1: Understand the process of designing a new product

CO2: Comprehend the manufacturing process.

CO2: Analyze and control the quality of the product through various stages of production.

CO4: Understand the various stages of quality assurance

CO3: Gain a basic understanding of entrepreneurial skills.

Module I **8 hours**

Research and Development

Physical, chemical and microbiological characteristics of food products

(fruits/vegetables/dairy- value added food products)

Product formulation

Designing a product- exercise and case study (fruits/vegetables/dairy- value added food products)

Sensory evaluation/ analysis

Module II **8 hours**

Production

Food Manufacturing Process

5 M's- ishikawa

Production management and packaging

Module III **7 hours**

Quality Control and Quality Assurance

Food safety and Quality assurance

HACCP, ISO 22000- international standard that defines the requirements of a food safety management system, focusing on hazard control and continuous improvement.

Audits Methodology

Industrial risk management

Quality control

Microbiological tests, physio- chemical tests and sensory tests (practicals)

Module IV **7 hours**

Business development

Preparation of Business Plan

SWOT, 4 Ps, PESTLE, fund generation, lean canvas model

Course Title: Certificate course in Food Technology and Business Development (Practical)

1. Product designing
2. Sensory evaluation
3. Lab scale production of the new product
4. Implementation of HACCP
5. Food microbiological testing- yeast and molds, coliform, bacteria
6. Audit methodologies- exercise
7. Preparation of Business Plan

REFERENCES:

- Das H.K. (2007). Text book of Biotechnology, 3rd Edition, Wiley India (P) Ltd, New Delhi.
- Frazier W.C &Westhoff D.C. (2015). Food Microbiology. 5th edition. McGraw Hill Education (India) Private Limited: New Delhi

LIST OF COMMON COURSES WITH THE DEPARTMENT OF BIOCHEMISTRY

1. BIO-III.E-4: Enzymology
2. BIO-IV.C-6: Immunology

BOTANY

Parvatibai Chowgule College of Arts and Science
(Autonomous)

DEPARTMENT OF BOTANY
COURSE STRUCTURE
THREE YEAR B.SC. DEGREE COURSE IN BOTANY

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	BOT-I.C-1 Plant Diversity	BOT-I.C-2 Cell Biology & Biomolecules	-------------	-----------	-----------	-------
II	BOT-II.C-3 Plant Anatomy & Embryology	BOT-II.C-4 Microbiology	------------	------------	-----------	-------
III	BOT-III.C-5 Physiology of Plants		BOT-III.E-1 Ecology & Conservation	BOT-III.E-2 Biological Techniques & Instrumentation	BOT-III.E-3 Enzyme and metabolic pathways	
IV	BOT-IV.C-6 Cytogenetics		BOT-IV.E-4 Plant Breeding and Biostatistics	BOT-IV.E-5 Systematics of Flowering plants and Phylogeny	BOT-IV.E-6 Plant pathology	
V	BOT-V.C-7 Plant Molecular Biology		BOT-V.E-7 Bioinformatics	BOT-V.E - 8 Seed Technology	BOT-V.E-9 Pharmacognosy	
VI	BOT-VI.C-8 Plant Biotechnology & Genetic Engineering		BOT-VI.E-10 Plant tissue culture	BOT-VI.E-11 Agricultural Biotechnology	BOT-VI.E-12 Plant Drug Technology	

LIST OF PAPERS UNDER AUTONOMOUS DEGREE COURSE IN BOTANY

Sr. No.	NAME OF THE CORE PAPERS	SEMESTER
1	Plant diversity	Semester-I
2	Cell Biology & Biomolecules	Semester-I
3	Plant Anatomy and Embryology	Semester-II
4	Microbiology	Semester-II
5	Physiology of Plants	Semester-III
6	Cytogenetics	Semester-IV
7	Plant Molecular Biology	Semester-V
8	Plant Biotechnology and Genetic Engineering	Semester-VI
	NAME OF THE ELECTIVE PAPERS	
1	Ecology & Conservation	Semester- III
2	Biological techniques and Instrumentation	Semester- III
3	Enzyme and metabolic pathways	Semester- III
4	Plant Breeding and Biostatistics	Semester-IV
5	Systematics of Flowering plants and Phylogeny	Semester-IV
6	Plant pathology	Semester-IV
7	Bioinformatics	Semester-V
8	Seed technology	Semester-V
9	Pharmacognosy	Semester-V
10	Plant tissue culture	Semester-VI
11	Agricultural biotechnology	Semester-VI
12	Plant Drug Technology	Semester-VI

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BOTANY

PAPER TITLE: PLANT DIVERSITY (THEORY)

PAPER CODE: BOT-I.C1

NAME OF THE FACULTY: Ms. Amisha Shirodker, Ms.Anisha Fernandes & Dr. Sangeeta Sankhalkar

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

This paper provides knowledge on morphology, structure and importance of the lower group of organisms. Education and awareness about plant diversity, its role in sustainable livelihoods.

LEARNING OUTCOMES:

On completion of the course: The students will be able to differentiate between various groups of algae, fungi, lichens, bryophytes and pteridophytes. Students will gain knowledge about the economic and ecological importance of the lower group of plants and also to effectively conserve the plant biodiversity.

BOT.I.C-1 PLANT DIVERSITY THEORY -75 MARKS

Sr.No.	UNITS, TOPICS AND SUB-TOPICS		Hours
UNIT I: ALGAE		15 Marks	09
1.1	Five kingdom classification:		1
1.2	Classification of algae (Cyanophyta, Chlorophyta, Phaeophyta and Rhodophyta) following Lee (1999) upto groups with general characters and examples		2
1.3	Endosymbiotic theory: origin of plastids		1
1.4	Cyanophyceae: Ecology, importance, evolutionary significance: Distribution, systematic position and life cycle of *Nostoc* and *Chara*		4

1.5	Economic importance of algae: as Medicine, food, phycocolloids & Algal toxins		1
UNIT II: FUNGI		12 Marks	08
2.1 2.2	General characteristics, Classification, economic importance. systematic position, life history of *Puccinia* and *Penicillium* Plant diseases in rice, wheat, coconut, arecanut General account of plant diseases caused by fungi and their control		6 2
UNIT III: LICHENS		06 Marks	02
3.1	Structure and reproduction: Ecological and economic importance		2
UNIT IV: BRYOPHYTES		12 Marks	08
4.1 4.2	General characters, classification and alternation of generation Structure, reproduction, life history and systematic position of *Anthoceros* and *Marchantia* Evolution of sporophyte in bryophytes.		2 6
UNIT V: PTERIDOPHYTES		12 Marks	08
5.1 5.2	General characters, classification, alternation of generation. Structure, reproduction, life history and systematic position of *Lycopodium* and *Marsilea*. Evolution of sporophyte.		2 6
UNIT VI: GYMNOSPERMS		12 Marks	08
6.1 6.2	General characters, classification, alternation of generation. Systematic position, life history of *Pinus* and *Gnetum*		2 6
UNIT VII: PALEOBOTANY		06 Marks	02
7.1	Introduction, fossils and fossilization, geological time scale, importance of fossils		2
	TOTAL	**75 Marks**	45

PAPER TITLE: PLANT DIVERSITY (PRACTICAL)

PAPER CODE: BOT-I.C-1

NAME OF THE FACULTY: Ms. Amisha Shirodker, Ms.Anisha Fernandes & Dr. Sangeeta Sankhalkar

MARKS: 25

CREDITS: 1

Sr. No	Experiments	Practical
1	Morphological study of algal forms: *Anabena, Nostoc, Chara, Sargassum* and *Polysiphonia*	3
2	Morphological study of fungal forms: *Puccinia, Penicillium Albugo* and *Rhizopus*	3
3	Morphological study of bryophytes: *Anthoceros* and *Marcantia*	1
4	Culture of algal forms: *Nostoc spirulina*	2
5	Pure culture of Fungi using PDA medium	1
6	Field visit: study of habitats of lower forms of plants	1
7	Comparative anatomical study in *Pinus* and *Gnetum*	1
8	Study of fossils: (Permanent slide/ specimen)	1
9	Study of locally available forms of Pteridophyte and Gymnosperms	1
10	Study of lichens (Permanent slide/ specimen)	1
	TOTAL	**15**

REFERNCES:

1. Alexopoulos, Constantine J.;Mims, Charles W. (1983). Introductory Mycology; 3rd edition; New Delhi: Wiley Eastern Limited.

2. Kar, Ashok Kumar;Gangulee, Hirendra Chandra (2006). College Botany: Volume II; 2nd Edition; Kolkata: New Central Book Agency (P) Ltd.

3. Smith, Gilbert M. (1955).Cryptogamic Botany Algae & Fungi Volume 1; 2nd Edition; McGraw-Hill Book Comp. Tokyo.

4. Smith, Gilbert M. (1955). Cryptogamic Botany Bryophyta & Pteridophyta Volume 2; 2nd Edition; McGraw-Hill book Comp. Tokyo.

5. Vasishtha B.R. And Sinha A. K. (2005). Botany for degree students Part 1 Algae; 1st Edition S. Chand & Company Ltd.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BOTANY

PAPER TITLE: CELL BIOLOGY AND BIOMOLECULES (THEORY)

PAPER CODE: BOT.I.C-2

NAME OF THE FACULTY: Dr. (Mrs). UMA MASUR & Dr. SANGEETA G. SANKHALKAR

MARKS: 75 MARKS

CREDITS: 3

COURSE OBJECTIVES:

This course will provide a detailed discussion on a wide range of topics in Cell biology & Bio-molecules emphasizing experimental approaches and key experiments that have provided important insights. The course is aimed at conveying an understanding of how cellular structure and function arise as a result of the properties of cellular macromolecules. Emphasis will be on the dynamic nature of cellular organization, structure and function.

LEARNING OUTCOME:

Students will understand the structures and purpose of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, organelles and importance of cells as basic units of living organisms & the role of cell membrane in movement of substances into and out of cells. It will also help to understand the chemical structure of water, carbohydrates, lipids and proteins and their role in living organisms.

BOT.I.C-2: CELL BIOLOGY AND BIOMOLECULES THEORY: 75 Marks

Sr. No	Units, Topics and Sub- Topics		Hours
Unit-I: Overview of cells		**02 Marks**	**03**
1.1	Discovery of cells, Basic properties of cells		1
1.2	Prokaryotic and Eukaryotic cell; Cell theory		1
1.3	Cell evolution and biogenesis		1
Unit-II: The Ultra-structure and Function of Cell wall		**07 Marks**	**04**

2.1	Structure and function of cell wall		1
2.2	Chemical composition of cell wall		1
2.3	Extracellular matrix and cell interactions		1
2.4	Gap -Junctions & plasmodesmata		1
Unit-III: The Ultrastructure and Function of Plasma membrane		**13 Marks**	**07**
3.1	Structure and function of plasma membrane		1
3.2	Transport of water and solute		2
3.3	Active and Passive transport of solute (channels & pumps).		2
3.4	Cell signaling- molecules and receptors, signaling network		2
Unit-IV: The Cell Organel studies-Chloroplast, Mitochondria and Nucleus		**17 Marks**	**09**
4.1	Structural organization and functions		1
4.2	Origin and biogenesis Semiautonomy and gene control		2 1
4.3	Structure & functions of peroxisome, glyoxysome & lysosomes		1
4.4	Nucleus and its Organization		3
4.5	Nuclear envelope, nuclear pore complex Nuclear matrix, Chromosomes and chromatin structure		1`
Unit-V: Ribosome and membrane systems		**06 Marks**	**04**
5.1	Structure and function of ribosome		2
5.2	Endomembrane systems- Endoplasmic reticulum and Golgi complex		2
Unit-VI: Cytoskeleton and its role in motility		**05 Marks**	**04**
6.1	Structure and functions of cytoskeleton		1
6.2	Structure and function of Microtubule, Intermediate filaments, Microfilaments		3

BIOMOLECULES

Sr. No	**UNITS, TOPICS AND SUB-TOPICS**		**Hours**
UNIT- I: BIOCHEMISTRY OF BIOMOLECULES		**04 Marks**	**02**

1.1 **1.2** **1.3** **1.4**	Defination & importance in the functional organization of the cell Types of bonds in bio-molecules PH and buffers Water as a biological solvent		1 1
UNIT-II: CARBOHYDRATES		**08 Marks**	**04**
2.1 **2.2** **2.3**	Classification of carbohydrates Structural and biological functions Sugar derivatives, proteoglycans, glycoproteins & glycolipids		1 1 2
UNIT III : LIPIDS		**04 Marks**	**02**
3.1	Classification, Structure & function of lipids		2
UNIT IV: AMINO ACIDS AND PROTEINS		**09 Marks**	**06**
 4.1 **4.2** **4.3** **4.4** **4.5**	**Amino Acids**: Classification of amino acids, chemical reactions & properties Synthesis of peptides Purification **Proteins:** Classification & Physico-chemical properties Structures of proteins Biological functions of proteins Torsion angle and Ramachandran plot		1 1 1 1 1 1
Total		**75 Marks**	**45**

PAPER TITLE: CELL BIOLOGY & BIOMOLECULES (PRACTICAL)

PAPER CODE: BOT.I.C-2

NAME OF FACULTY: Dr. (Mrs). UMA MASUR & Dr. SANGEETA G. SANKHALKAR

MARKS: 25

CREDITS: 1

Sr.No	Topics	Practical
1.	**General instructions**: Laboratory Safety Study of cell structure in *Hydrilla* and *Tradescantia* staminal hairs	1
2.	Examination of prokaryotic cell, eukaryotic cell and cell organelles by EM graphs	1
3.	Isolation of Mitochondria from plant material	2
4.	Effect of solution on plant cell membrane	1
5.	Preparation of temporary slides to observe different types of cells	1
6.	Staining and Preparation of slides	5
	I. Cytochemical staining of DNA- Feulgen II. Cytochemical staining of DNA and RNA- Methyl Green Pyronin (MGP) III. Cytochemical staining of polysaccharides- Periodic Acid Schiff's (PAS) IV. Cytochemical staining of Total proteins –Bromophenol blue V. Cytochemical staining of Histones – Fast Green	
7.	Determination of PH using PH meter	1
8.	Quantitative determination of carbohydrates (Anthrone reagent)	1
9.	Estimation of oil in fatty seeds	1
10.	Estimation of proteins by Bardford method	1
	Total	**15**

Suggested Reference Books:

1. David L. Nelson. & Michael M. Cox. (2013). Lehninger Principles of Biochemistry, 4th ed. W.H. Freeman & Co,New York.
2. Donald Voet., Judith G. Voet and Charlotte W. Pratt. (2002). Fundamentals of Biochemistry, 2nd edition, John Wiley and Sons (Asia) Pvt Ltd.
3. Gupta, P.K. (1999). A Text-book of Cell and Molecular Biology. Rastogi Publications, Meerut, India.
4. H.Robert Horton. (2006).Principals of biochemistry.4th ed. Pearson Prentice Hall.
5. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer.(2002). Biochemistry 5$_{th}$ edition, W.H.Freeman & Company, New York
6. Karp, G. (1999). Cell and molecular Biology, Concepts and experiments (John Wiley and Sons Inc) 2nd edition. USA.
7. Paul Flinch (1999). Carbohydrates structure, Synthesis & Dynamics. Kluwer Academic Pub.The Netherlands.
8. U. Satyanarayana and U. Chakrapani. (2000).Biochemistry, 4th edition., Elsvier Pub. Kolkata.
9. Verma P.S. and Agarwal V. K. (1998).Cell Biology, Genetics, Molecular Biology, Evolution and ecology. Edn.14

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BOTANY

PAPER TITLE: PLANT ANATOMY AND EMBRYOLOGY (THEORY)

PAPER CODE: BOT-II. C-3

NAME OF THE FACULTY: Dr. (Mrs). UMA MASUR & DR. R.V. GAONKAR

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

This paper deals to understand the plant anatomy and embryology of angiospermic plant. Importance of studying this paper is highlighted reflecting on the current changing needs of the students by providing latest information. Practical component will provide an ample understanding of anatomical and embryological features.

LEARNING OUTCOME:

Student will understand the basic concepts with ability to identify and distinguish various features related to anatomy and embryology.

BOT.II.C-3: PLANT ANATOMY AND EMBRYOLOGY MARKS: 75

Sr.No.	UNITS, TOPICS AND SUB-TOPICS		Hours
UNIT I: Shoot Development		05 Marks	04
1.1	Organization of Shoot apical meristem		2
1.2	Apical cell theory, Histogen theory, Tunica-Corpus theory, Cyto-histological zonation.		2
UNIT II: Root Development		06 Marks	04
2.1	Organization of root apical meristem		2
2.2	Apical cell theory, Histogen theory, Korper-Kappe theory, Quiescent centre		2
UNIT III: Leaf Development and Phyllotaxy		10 Marks	06
3.1	Initiation of leaf primordia`		2
3.2	Differentiation of epidermis, mesophyll and vascular		2

3.3 3.4	tissue Stomata and its diversity Leaf phyllotaxy, leaf abscission		1 1
UNIT IV: Wood Structure		12 Marks	07
4.1 4.2 4.3 4.4 4.5	Vascular cambium Secondary xylem, wood anatomy Secondary phloem and Periderm Conifer wood Dicotyledon wood, Identification of wood		1 2 1 1 2
UNIT V: Transition of Flowering		10 Marks	05
5.1 5.2 5.3	Floral development: Induction of flowering, Floral meristems Origin and development of floral parts and floral development in *Arabidopsi*s and *Antirrhinum* ABC model of flowering		2 2 1
UNIT VI: Reproductive biology		12 Marks	06
6.1 6.2 6.3 6.4	Structure and development of male gametophyte- microsporangium Microsporogenesis & Pollen grains Structure and development female gametophyte – Megasporangium Megasporogenesis, Forms of ovule-Monosporic, bisporic and Tetrasporic		2 2 2
UNIT VII: Pollination and fertilization		20 Marks	13
7.1 7.2 7.3 7.4	Mechanism of pollination and fertilization- types of pollination, germination of pollen grain, pollen pistil interaction, self- incompatibility Double fertilization and endosperm formation Apomixis: Types, causes, consequences and Significances of apomixis Polyembryony: Classification, causes, experimental induction and importance		4 2 3 2 2
	TOTAL	**75**	45

PAPER TITLE: PLANT ANATOMY AND EMBRYOLOGY (PRACTICAL)

PAPER CODE: BOT-II.C-3

NAME OF FACULTY: Dr. (Mrs). UMA MASUR & Dr. R. V. GAONKAR

MARKS: 25

CREDITS: 1

Sr.No.	TOPICS	PRACTICAL
1.	Study of simple and complex tissues by using permanent slides/ EM graphs.	1
2.	Microscopic study of wood tissues in T.S, T.L.S. and R.L.S. and maceration (Any one species)	2
3.	Study of meristems through permanent slides	1
4.	Study of leaf anatomy, stomata and appendages	2
5.	Histochemical tests for identification of lignin, Pectin, Starch, Suberin, cutin and silica bodies in suitable leaf material.	2
6.	Stages in Microsporogenesis and Megasporogenesis (Permanent slides)	1
7.	Embryo and Endosperm with haustoria mounting (*Tridax/ Cucurbit*).	2
8.	In vitro growth of pollen tube and pollen viability test in *Portulaca/ Vinca.*	2
9.	Study of diversity in female gametophyte exhibiting self incompatibility.	1
10	Pollen studies: Chitaley's method for analysis in *Ipomoea, Ocimum, Hibiscus*, *Acacia auriculiformis* and Grass.	1
	TOTAL	**15**

REFERENCES: -

1. Bhojwani, S. S and Bhatnagar, S.P. The Embryology of Angiosperms, Vikas Publishing House Pvt. Ltd., New Delhi.
2. Dwivedi. J.N. (1988). Embryology of Angiosperms. Rastogi and Co. Meerut.
3. Esau, K. (1977). Plant Anatomy, 2nd Edition. Wiley Eastern Private Limited. New Delhi.
4. Fahn, A. (1982). Plant Anatomy (3rd edition).Pergoman Press, Oxford.
5. John Jothi Prakash, E. (1987). A Text Book of Plant Anatomy.
6. Mauselth, J.D. (1988). Plant Anatomy. The Benjamin Cummings Publishing Co. Inc., Mehlo Park, California, USA.
7. Maheswari, P. (1971). An Introduction to the Embryology of Angiosperms. Tata McGra
8. Pandey, B.P. (1981). A textbook of Botany Angiosperms. S. Chand and Co., New Delhi.
9. Pandey, B.P. (1978). Plant Anatomy, S. Chand and Co., New Delhi.
10. Vashista, P.C. (1968). A text Book of plant Anatomy.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BOTANY

PAPER TITLE: MICROBIOLOGY (THEORY)

PAPER CODE: BOT.II.C-4

NAME OF THE FACULTY: Dr. SANGEETA G. SANKHALKAR

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

The objective of this course is to familiarize the student with basic concepts that help in understanding of microbial world. The course is aimed to understand microbial survival and distribution, it's relation and interaction with environment and human beings. The laboratory exercises are designed so that students acquire basic and bacteriological skills and are able to successfully use them.

LEARNING OUTCOME:

On completion of this course, students will be able to understand the scope and importance of Microbiology, classification schemes, cultivation, preservation and maintenance of the microbial cultures. They will also be able to understand pathogenecity of microorganisms, precautions and measures to control the same.

BOT.II.C-4: MICROBIOLOGY THEORY: 75 MARKS

Sr. No	UNITS, TOPICS AND SUB-TOPICS		Hours
UNIT-I: OVERVIEW OF MICROBIAL WORLD & DEVELOPMENT		**16 Marks**	**09**
1.1	Developments of microbiology in the twentieth century		1
1.2	Microbial taxonomy & phylogeny (archea, bacteria, fungi, algae, protozoa)		3
1.3	Structure & General characteristics of viruses, viroids, Prions, Bacteriophages, PPLO & Mycoplasma		4

1.4	Scope of microbiology		1
UNIT-II: ISOLATION, CHARACTERIZATION & GROWTH OF MICROORGANISMS		**14 Marks**	**08**
2.1 **2.2** **2.3** **2.4** **2.5** **2.6**	Control of microbial growth Biochemical characterization & nutritional types Preparation of pure cultures Growth factors & growth curve Sterilization techniques Staining techniques		1 2 1 1 1 2
UNIT III: MICROBIAL GENETICS		**05 Marks**	**02**
3.1 **3.2**	Transformation, Transduction and Conjugation Transposons		1 1
UNIT IV: ENVIRONMENTAL MICROBIOLOGY		**08 Marks**	**05**
4.1 **4.2** **4.3** **4.4** **4.5**	Major environmental conditions influencing micro-flora Distribution of microorganisms (terrestrial & aquatic) Applications of microbes in environment sustenance Bioremediation Biofuels		1 1 1 1 1
UNIT V: AGRICULTURAL MICROBIOLOGY		**08 Marks**	**06**
5.1 **5.1.1** **5.2** **5.3**	Applications of microbes in agriculture Beneficial association between plant and microorganisms (association of plants with cyanobacteria, actinomycetes & fungus) Microbial degradation of cellulose, hemicelluloses, lignin, xylans, starch and pectin. Biodegradation of hydrocarbons, pesticides, herbicides and xenobiotics		1 1 1 3
UNIT VI: MEDICAL MICROBIOLOGY		**10 Marks**	**07**
6.1 **6.1.1** **6.3** **6.4**	Koch's postulates Normal micro-flora in human body Microbial diseases Water borne diseases		1 1 1

6.5 **6.6** **6.7**	Air borne diseases Food borne diseases Microbial antibiotics		1 1 2
	UNIT VII: MICROBIAL FOOD TECHNOLOGY	**14 Marks**	**08**
7.1 **7.1.1** **7.2** **7.3** **7.4** **7.5** **7.6**	**Fermentation Technology**: Baker's yeast & bread making, Microorganisms & proteolytic enzymes in cheese making Dairy industry Sweeteners Organic acids Production of ethanol, beer, wine and fruit juices		1 1 1 1 1 3
	TOTAL	**75 Marks**	**45**

PAPER TITLE: MICROBIOLOGY (PRACTICAL)

PAPER CODE: BOT.II.C-4

NAME OF FACULTY: Dr. SANGEETA G. SANKHALKAR

MARKS: 25

CREDITS: 1

	BOT.II.C-4: MICROBIOLOGY PACTICAL (25 marks)	
Sr. No	**Topics**	**Practicals**
1	**General instructions**: Laboratory Safety Preparation of culture media for bacteria	1
2	Pure culture of bacteria and aseptic transfer of pure cultures.	2
3	Staining of microorganisms	1
4	Measurement of cell number in a culture (serial dilution technique)	1
5	Cell count in a culture by Haemocytometer	1
6	Distribution of microorganisms in our environment (Skin, air, water and soil sample)	1
7	Fermentation of simple carbohydrates	1
8	Measurements of growth of microorganisms (turbidity method)	1
9	Microbiological examination of water	1
10	Bacteriological testing of milk	1
11	Preparation of cheese	2
12	Preparation of wine using microorganisms	1
13	Visit to industry (Wine and cheese)	1
	Total	**15**

Suggested Reference books:

1. Aneja, K. R. (2007) Experiments in Microbiology Plant Pathology & Biotechnology. 5th ed., New Age International Publishers.
2. Atlas, RM., Principles of Microbiology, 2nd ed.,(1997), McGraw-Hill
3. Dubey, R.C & Maheshwari, D.K. (2002). Practical Microbiology. S. Chand & Comapany Ltd., New Delhi.
4. Frazier, W.C. and Westhoff, D.C.(2008), Food Microbiology 4th ed., the McGraw Hill.
5. Pelczar. M.,(2000). Microbiology, 5th ed., Tata-McGraw Hill.
6. Powar, C.B & Daginawala, H.F.(1982). General Microbiology–Volume II. Himalaya Publishing house: Bombay.
7. Prescott, Harley(2008). Microbiology. McGraw-Hill Higher Education, Boston
8. Prescott, LM. (2005), Microbiology. 6th ed. 2005., McGraw-Hill.
9. Salle, AJ., Fundamental Principles of Bacteriology, 7th ed.,(1999). Tata- McGraw Hill.

10. Shivkumar PK., MM Joe & Sukesh K.(2010).An Introduction to Industrial Microbiology. 1st ed., S.Chand & Company PVt. Ltd.
11. Stanier R.Y. General Microbiology (1993).Cambridge University press.

COURSE STRUCTURE – DEPARTMENT OF BOTANY
Three year B.Sc Degree Course in BOTANY

Sem	Core		Elective			
I	**BOT-I.C-1** Plant diversity	**BOT-I.C-2** Cell Biology & Biomolecules	--------	--------	--------	--------
II	**BOT-II.C-3** Plant Anatomy and Embryology	**BOT-II.C-4** Microbiology	--------	--------	--------	--------
III	**BOT-III.C-5** Physiology of Plants		**BOT-III.E-1** Ecology & Conservation	**BOT-III.E-2** Techniques and Instrumentation in Botany	**BOT-III.E-3** Enzymes and It's metabolic pathways	**BOT-III.E-4** Herbal Cosmetolog y
IV	**BOT-IV.C-6** Cytogenetics		**BOT-IV.E-5** Plant Breeding and Biostatistics	**BOT-IV.E-6** Systematics of Flowering plants and Phylogeny	**BOT-IV.E-7** Plant pathology	**BOT-IV.E-8** Horticulture
V	**BOT-V.C-7** Plant Molecular Biology		**BOT-V.E-9** Bioinformatics	**BOT-V.E-10** Seed Technology	**BOT-V.E-11** Pharmacognosy	**BOT-V.E-12** Organic Farming
VI	**BOT-VI.C-8** Plant Biotechnology and Genetic Engineering		**BOT-VI.E-13** Plant tissue culture	**BOT-VI.E-14** Agricultural Biotechnology	**BOT-VI.E-15** Plant Drug Technology	**BOT-VI.E-16** Field Ecology

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BOTANY

SEMESTER -III

PAPER TITLE: PHYSIOLOGY OF PLANTS (THEORY)

PAPER CODE: BOT.III.C-5

NAME OF THE FACULTY: Dr. SANGEETA G. SANKHALKAR

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

Objective of this introductory course is to provide understanding of how plants function. The course explain principle of plant functions covering physiological processes in plants, such as biochemical metabolism, secondary products, water & solute (organic & inorganic) uptake and growth & development.

Learning Outcomes: Upon completing this course, students will be familiar with contemporary concepts in Plant Physiology and the physiological mechanisms controlling plant growth and development. Students will have an understanding of movement of water and solutes in plant, know the importance of the photosynthesis as related to harvesting solar energy and plant productivity, hormone and its relation with plant growth and development.

BOT.III.C-5: PHYSIOLOGY OF PLANTS THEORY: 75 MARKS

Sr. No	UNITS, TOPICS AND SUB-TOPICS	Hours
UNIT-I: PLANT WATER RELATIONS		**06**
1.1	Water and its significance to plants	1
1.2	Osmotic & water potential of cell	2
1.3	Transpiration, anti-transpirants, stomatal regulation and its role in plant productivity (agriculture, horticulture & floriculture)	3

UNIT-II: SOLUTE TRANSPORT		**07**
2.1	Uptake, transport and translocation of water	2
2.2	Essentiality of mineral nutrition and its uptake (active, passive and its role on membranes)	3
2.3	Transport of organic solutes (source sink relationship)	2
UNIT III: PHOTOSYNTHESIS		**07**
3.1	Chloroplast and Light harvesting complexes	1
3.2	Z scheme of photosynthesis & Mechanisms of electron transport	2
3.3	Photoprotective mechanisms (photorespiration)	1
3.4	CO_2 fixation (C3, C4 and CAM pathways)	2
3.5	Environmental change and its impact on photosynthesis	1
UNIT IV: RESPIRATION		**05**
4.1	Respiratory substrate	1
4.2	Glycolysis (aerobic & anaerobic) & Citric acid cycle	2
4.3	Mitochondrial electron transport (alternate oxidase pathway)	2
UNIT V: NITROGEN METABOLISM		**05**
5.1	Biological nitrogen fixtation	2
5.2	Assimilation of ammonia (Reductive amination & transamination reactions)	3
UNIT VI: PLANT GROWTH AND DEVELOPMENT		**10**
6.1	Role of phytochromes & Cryptochromes and its functions	2
6.2	Plant hormones , biosynthesis, transport and physiological functions	4
6.3	Photoperiodism and & vernalization	2
6.4	Senescence, seed dormancy & germination	2
UNIT VII: SECONDARY METABOLITES AND STRESS PHYSIOLOGY		**05**
7.1	Responses of plants to abiotic (water, temperature and salt) stresses	3
7.2	Biosynthetic pathway of terpenes, phenols and alkaloids and their functions	2
	TOTAL	**45**

PAPER TITLE: PHYSIOLOGY OF PLANTS

PAPER CODE: BOT.III.C-5 (PRACTICAL)

NAME OF FACULTY: Dr. SANGEETA G. SANKHALKAR

MARKS: 25

CREDITS: 1 (Any 10 to be conducted)

Sr. No	TOPICS	Practicals
1	Determination of osmotic potential of plant cell sap by plasmolytic method.	1
2	Determine water potential of given tissue by falling drop method	1
3	Testing of seed viability (2,3,5-triphenyl tetrazolium chloride test)	1
4.	Separation, identification and quantitation of plant pigments	2
5	Separation of sugars by paper chromatography	1
6	Effect of light intensity on production of starch during photosynthesis	1
7	Effect of GA & Kinetin on inter-nodal elongation and leaf senescence	2
8	Measurement of chlorophyll fluorescence in plant leaves	1
9	To demonstrate that oxygen is consumed during respiration	1
10	Study of mineral deficiency symptoms in plants (demonstration)	1
11	Quantitation of total free amino acids	1
12	Estimation of phenols from different plant materials	1
13	Demonstration of chemotropism in pollen tubes	1
	Total	**15**

REFERENCES

1. William G. Hopkins (1999). Introduction to Plant Physiology, 2nd edition, John Wiley A Sons, Inc.

2. Taiz, L. and Zeiger, E. (2006). Plant Physiology, 4th edition, Sinauer Associates Inc .MA, USA

3. Frank B. Salisbury and Cleon W. Ross (2002). Plant Physiology 3rd edition. CBS publishers and distributers.

4. G. Ray Noggle and George J.Fritz (2010) Introductory Plant Physiology Prentice Hall.

5. Goodwin Y.W., and Mercer E.I. (2003) Introduction to Plant Biochemistry. 2nd edition CBS Publishers and distributors.

6. Galstone A.W. (1989). Life processes in Plants. Scientific American Library, Springer Verlag, New York,

7. Moore T.C. (1989). Biochemistry and Physiology of Plant Hormones Springer –Verlag, New York,USA.

8.Singhal G.S.,Renger G., Sopory, S.K. Irrgang K.D and Govindjee (1999). Concept in Photobiology; Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi

9. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.

10. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

11. David I. Nelson and Michael M. Cox (2000). Lehninger. Principles of biochemistry, 3rdedition, Macmillan U.K.

12. David T Plummer (1985).An introduction to Practical Biochemistry 2nd edition. Tata Mcgraw Hill Publishing company Ltd.

13. D. Bajracharya (1999).Experiments in Plant Physiology. Narosa Publishing House new Delhi.

CURRENT LITERATURE (JOURNAL ARTICLES):

Plant Physiology, The Plant Cell, Journal of Plant Physiology, Physiologia Plantarum, Plant Physiology and Biochemistry, Postharvest Biology and Technology, Journal of the American Society for Horticultural Science, Science, Nature, Scientific American.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BOTANY

SEMESTER-III

PAPER TITLE: ECOLOGY & CONSERVATION (THEORY)

PAPER CODE: BOT-III.E-1

NAME OF THE FACULTY: MS. AMISHA SHIRODKER

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

Objective of this paper is to provide introductory knowledge on biotic and abiotic environmental factors, pollution and phytogeography with regards to Govt regulations towards environmental management with respect to agriculture and food security.

LEARNING OUTCOMES:

The Students will be able to understand the role and importance of biotic and abiotic environment factors in the sustenance of plant life and causes, consequences, prevention, remediation of pollution and efforts taken in reducing or controlling the pollution causing factor. The course will impart importance of phytogeography and forestry to teach managing regional flora.

BOT-III.E-1 ECOLOGY & CONSERVATION THEORY-75 MARKS

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	HOURS
	UNIT I: CONCEPT OF ECOSYSTEM	**05**
1.1 1.2 1.3	Concept of Ecosystem: Components and their interactions, food chains and food web Ecological pyramids Ecological adaptations of plants belonging to following ecological groups: Hydrophytes, Xerophytes and Halophytes	**02** **01** **02**
	UNIT II: ECOLOGICAL FACTORS (Biotic & Abiotic)	**16**
2.1	Light - quality, duration, absorption, intensity & effects on plants	**03**

2.2 2.3 2.4 2.5 2.6	Temperature-variation due to altitude effects on plants, thermal constant and stratification Water- precipitation, moisture & measurement of rainfall Wind - speed, advantages and damage caused to plants Soil- soil profile, texture, classification and organic matter Biotic-community relationships- mutualism, mycorrhizae, commensalisms, protocooperation, competition, amensalism and saprophytes	**02** **02** **02** **02** **05**
UNIT III: POLLUTION , CAUSES AND CONSEQUENCES		**11**
3.1 3.2 3.3 3.4	Air pollution- polluting gases; ozone depletion, greenhouse effect, global warming, acid rain and smog Water pollution-eutrophication, sewage, industrial waste, heavy metals & oil in sea Soil pollution – chemical pollutants , bioagents and toxins Phytoremediation	**03** **04** **03** **01**
UNIT IV: PHYTOGEOGRAPHY AND FORESTRY		**13**
4.1 4.2 4.3 4.4	Phytogeography- plant distribution, theories on plant distribution & static phytogeography Endemism, major biomes of the world, minor biomes, and phytogeographical regions of India Forestry- destruction of forest, deforestation, aforestation, reforestation, forest research, education and training institutes, biosphere reserves Forest conservation act, Indian forest act, Indian wildlife act, biodiversity act, western Ghat protection act, Kasthurirangan Act, Gadgil committee report, Mining committee reports, wild life act (**recent acts to be studied**)	**03** **02** **03** **05**
	TOTAL	**45**

SEMESTER-III

PAPER TITLE: ECOLOGY & CONSERVATION (PRACTICAL)

PAPER CODE: BOT-III.E-1

NAME OF THE FACULTY: MS. AMISHA SHIRODKER

MARKS: 25

CREDITS: 1 (ANY 10 to be conducted)

Sr. No	EXPERIMENTS	PRACTICAL
1.	Study of ecological instruments i.e. lux meter, rain guage, hygrometer, wet and dry bulb thermometer, maximum and minimum thermometer	**02**
2.	To study the physical and chemical characters (moisture, texture and pH) of different types of soils.	**02**
3.	Analysis of different water samples for oxygen content	**01**
4.	Analysis of different water samples for carbon-dioxide content	**01**
5.	Estimation of total carbonates from soil sample	**01**
6.	To determine minimum area of sampling unit (quadrat) for the study of local community.	**01**
7.	Species diversity indices (Simpson's & Shannon-Weiner) of herbaceous vegetation	**02**
8.	Study of polluted soil (presence of xenobiotics).	**01**
9.	Study of polluted water (total suspended solids, turbidity, grease and oil content)	**01**
10.	Visual interpretation of remotely sensed image for vegetation types	**01**
11.	Study of community relationships- Mutualism (mycorrhizae) and Saprophytes	**02**
	TOTAL	**15 P**

Reference Books:

1. Ambasht, R.S. A Text Book of Plant Ecology. Students Friends Co., Varanasi. 1988
2. Ecology and environment; P. D. Sharma, Rastogi publications, Meerut. 7th ed – 2004.
3. Ecology- N.S. Subrahmanyam and A.V.S.S. Sambamurty, Narosa Publishing House, 2000.

4. Environmental Biotechnology. Jogdand, SN 1995. Himalaya Publishing House, Mumbai.
5. Environmental chemistry by B. K. Sharma, Goel publication house, Meerut, Sixth revised edition – 2001.
6. Environmental Chemistry, A. K. Day, Fourth Edition, New Age International Publishers-2002
7. Environmental Science; by-Santra SC; Central Publ. New Delhi.
8. Fundamental of Ecology: EP Odum; WB Saunders Company. 1971
9. Moore, P.W.and Chapman, S.B. 1986. Methods in Plant Ecology. Blackwell Scientific Publications.
10. Piper, C.S. 1950. Soil and Plant Analysis. University of Adelaide, Australia.
11. Sharma, P.D. Ecology and Environment; 7th edition; Meerut :Rastogi Publishers , 1998.
12. Subrahmanyam, N.S.;Sambamurty, A.V.S.S.; Ecology; 1st edition; New Delhi : Narosa Publishing House , 2000.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BOTANY

SEMESTER III

PAPER TITLE: TECHNIQUES & INSTRUMENTATION IN BOTANY

PAPER CODE: BOT-III.E-2

NAME OF FACULTY: Dr. (MRS). UMA MASUR

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

Objective of the course is to impart knowledge of principle, methodology and application of various techniques & instrumentation.

LEARNING OUTCOMES:

Students will learn the principle and working of various instruments essential to study different facets of Botany.

BOT-III.E-2: TECHNIQUES & INSTRUMENTATION IN BOTANY

MARKS: 75

Sr.No	UNITS, TOPICS AND SUB-TOPICS	Hours
UNIT I: SOLUTIONS, BUFFERS AND pH: PRINCIPLE & APPLICATIONS		**03**
1.1	Solutions (molar, molal, ppm & percent solutions), buffer and pH	03
UNIT II: MICROSCOPY: PRINCIPLE, METHODOLOGY & APPLICATIONS		**09**
2.1	Light microscopy (compound microscopy and Phase contrast microscopy)	2
2.2	Fluorescence microscopy	1
2.3	Transmission and Scanning electron microscopy (sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze-etching)	4
2.4	Microscopic measurements and photography (Micrometry & cytometry)	2
UNIT-III : CENTRIFUGATION: PRINCIPLE, METHODOLOGY AND APPLICATIONS		**05**

3.1 3.2 3.3	Centrifugation: Low speed, high speed, cooling centrifuges and ultracentrifugation Analytical, preparatory and gradient centrifugation Various types of rotor heads and their maintenance	2 2 1
UNIT – IV: SPECTROPHOTOMETRY: PRINCIPLE, METHODOLOGY AND APPLICATIONS		**08**
4.1 4.2 4.3 4.4 4.5 4.6 4.7	UV visual spectrophotometry Fluorescence spectrophotometry Flame spectrophotometry Atomic absorption spectrophotometry Mass spectrophotometry IR, NMR and EPR X-ray diffraction	1 1 1 1 1 2 1
UNIT –V: CHROMATOGRAPHY: PRINCIPLE, METHODOLOGY AND APPLICATIONS		**09**
5.1 5.2 5.3 5.4	Adsorption and partition chromatography (Paper, column and TLC) Column chromatography (size, shape and theoretical plate concept) and development (isocratic and gradient) Ion-exchange chromatography, Affinity chromatography and Molecular sieve chromatography HPLC & GC	2 2 3 2
UNIT- VI: ELECTROPHORESIS & MOLECULAR TECHNIQUES: PRINCIPLE, METHODOLOGY AND APPLICATIONS		**08**
6.1 6.2	Electrophoresis: AGE,SDS- PAGE , IEF and 2D Electrophoresis PCR, RT PCR, MALDI TOFF	05 03
UNIT – VII: RADIOISOTOPES: PRINCIPLE, METHODOLOGY AND APPLICATIONS		**03**
7.2	Radioactivity and its measurements (Geiger Muller and Scintillation counter and autoradiography)	03
	TOTAL	**45**

PAPER TITLE: TECHNIQUES & INSTRUMENTATION IN BOTANY

PAPER CODE: BOT-III.E-2

NAME OF FACULTY: Dr. (MRS). UMA MASUR

MARKS: 25

CREDITS: 1 (Any 10 to be conducted**)**

BOT-III.E-2: TECHNIQUES & INSTRUMENTATION IN BOTANY (PRACTICAL)
MARKS: 25

SR.NO	TOPICS	PRACTICAL
1	Use of pH meter to set pH of a given solution	1
2	Determination of Lambda (λ) max of a given solution	1
3	Verification of Beer's Law	1
4	Micrometric dimensions (cytometry and micrometry)	2
5	Demonstration of SDS- PAGE	1
6	Demonstration of Agarose gel Electrophoresis	1
7	Preparation of TLC and separation of biomolecule?	1
8	Preparation of column and separation of pigments	2
9	Centrifugation of particles and precipitation	1
10.	Visit to Instrumentation Lab (College/NIO/ Goa University)	1
11.	Microscopy and photography	1
12	Flame photometry	1
13	One practical to be developed on microscope	1
	Total	**15**

Suggested Reference Books:

1. Karp, G. (1999). Cell and molecular Biology, Concepts and experiments (John Wiley and Sons Inc) 2nd edition. USA.
2. Bajpai P. K. (2006). Biological instrumentation and methodology (S. Chand and Company. Ltd. Mumbai.
3. Plummer D.T. (2009). An Introduction to Practical Biochemistry. 3rd edition. Tata Mc Graw Hill Education Private ltd. New Delhi.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BOTANY

SEMESTER- III

PAPER TITLE: ENZYMES AND ITS METABOLIC PATHWAYS (THEORY)

PAPER CODE: BOT. III.E-3

NAME OF FACULTY: Dr. SANGEETA G. SANKHALKAR & Ms. PRABHA TIWARI

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

The objective of this course is to understand the importance and mechanisms of enzyme action. The course also discusses about enzymatic regulation & metabolic control of biochemical reactions.

LEARNING OUTCOME:

On completion of this course students will be able to relate the relationship between structure and function of enzymes, importance of enzymes in regulation of metabolic processes.

BOT.III.E-3 ENZYMES AND ITS METABOLIC PATHWAYS

THEORY: 75 MARKS

Sr.No	UNITS, TOPICS AND SUB-TOPICS	Hours
UNIT I: NOMENCLATURE AND CLASSIFICATION OF ENZYMES		**09**
1.1	Classifications & nomenclature (IUB system)	2
1.2	Biological role of enzymes	2
1.3	Concept of holoenzyme & apoenzymes, prosthetic group, iso-enzymes and allosteric enzymes	5
UNIT II: CHARACTERISTICS AND STRUCTURE OF ENZYMES		**09**

2.1	Chemical nature of enzymes	1
2.2	Characteristics **(**Physico-chemical and biological properties)	3
2.3	Specificity of enzyme action (thermolability, reversibility and pH sensitivity)	3
2.4	Three dimensional structure of enzymes (Lyzozymes)	2
UNIT III: MECHANISM OF ENZYME ACTION		**11**
3.1	Michalis Menten equation and its applications	3
3.2	Active sites, Fisher's lock and key module and Koschland (induced fit theory)	3
3.4	Enzyme action (competitive, noncompetitive and reversible)	5
UNIT IV: METABOLIC CONCEPTS		**07**
4.1	Catabolic and anabolic pathway of proteins	3
4.2	Regulation of metabolic pathway and their role (carbohydrate/lipids/protein)	4
MODULE V: AMINO ACID METABOLISM		**09**
5.1	Nitrogen cycle	1
5.2	Pathway of amino acid catabolism	2
5.3	Nitrogenase enzyme complex	1
5.4	Metabolism of purine and pyrimidines (synthesis and catabolism)	5
	TOTAL	**45**

PAPER TITLE: ENZYMES AND ITS METABOLIC PATHWAYS (PRACTICAL)

PAPER CODE: BOT. III.E-3

NAME OF FACULTY: Dr. SANGEETA SANKHALKAR & Ms. PRABHA TIWARI

MARKS: 25 MARKS

CREDITS: 1 (Any 10 to be conducted)

BOT.III.E-3 ENZYMES AND ITS METABOLIC PATHWAYS (PACTICAL)

Sr. No	TOPICS	Practicals
1	Qualitative determination for Amylase and Invertase enzyme in given plant samples.	2
2	Study of enzyme kinetics for determination of Km value	1
3	Effect of enzyme concentration on the hydrolysis of starch with amylase	1
4	Effect of temperature and pH on the activity a)α-amylases b) pH	2
5	Effect of substrate on rate of enzyme reaction	1
6	Effect of inhibitors on α-amylase enzyme	2
7	Qualitative determination of a) catalase and b) lipase enzymes in the given plant samples	2
8	To demonstrate anaerobic respiration in germinating seeds	1
9	To extract and study the activity of enzymes catalase	1
10	To extract and study the activity of enzymes pectinase	1
11	To study the activity of peroxidase enzyme	1
	TOTAL	**15**

Suggested Reference books:

1. Bennett, T. P., and Frieden, (1969) E.: Modern Topics in Biochemistry, pg. 43-45, Macmillan, London
2. Breaker, Ronald R. "Making Catalytic DNAs." *Science* 290 (2000): 2095–2096.
3. Campbell, Neil A., Jane B. Reece, and Lawrence G. Mitchell (1999) *Biology,* 5th ed. Menlo Park, CA: Benjamin/Cummings.
4. Deeth, Robert J. (1997)"Chemical Choreography." *New Scientist* 155: 24–27.
5. Harrow, B., and Mazur, A.(1958): Textbook of Biochemistry, 109, Saunders, Philadelphia.
6. Holum, J (1968): Elements of General and Biological Chemistry, 2nd ed., 377, Wiley, NY.
7. Koshland, Daniel E.,(1973). Jr. "Protein Shape and Biological Control." *Scientific American* 229: 52–64.

8. Madigan, Michael R., and Barry L. Marrs. (1997) "Extremophiles." *Scientific American* 276: 82–87.
9. Martinek, R.: Practical Clinical Enzymology(1969). *J. Am. Med. Tech., 31,* 162.
10. Pfeiffer, J. (1954). Enzymes, the Physics and Chemistry of Life, pg 171-173, Simon and Schuster, NY.
11. Price C. Nicholas, Stevens Lewis: Fundamentals of Enzymology (1999) Oxford University Press.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BOTANY

SEMESTER-III

PAPER TITLE: HERBAL COSMETOLOGY (THEORY)

PAPER CODE: BOT-III.E-4

NAME OF THE FACULTY: Ms. AMISHA SHIRODKER

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

Objective of this course is to impart knowledge about the different plants that play a very important role in enriching inner health and skin quality.

LEARNING OUTCOMES:

The student by the end of this course will gain knowledge of most of the herbs that are useful in the cosmetic industry.

BOT-III.E-4 HERBAL COSMETOLOGY (THEORY) MARKS-75

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	HOURS
	UNIT I - INTRODUCTION TO HERBAL COSMETICS	**05**
1.1	Definition, Collection and processing of herbal material, Natural and artificial drying of herbal material	02
1.2	Herbal remedies for holistic health	02
1.3	Current status of Herbal Cosmetic Industry in India	01
UNIT II- Identification (botanical name and family), description and utilization of following plants with Cosmetic benefits & their cosmetic uses		**13**
	i) *Curcuma longa*	01
	ii) *Aloe vera*	01
	iii)*Azadirachta indica*	01
	iv) *Ocimum sp.*	01
	v) Moringa sp.	

	vi) Cymbopogon flexuosus *vii) Murraya koenigii* *viii) Citrus limon* ix) Mentha sp. x) *Tagetes sp.* *xi) Musa paradisica* *xii) Rosa sp.* xiii) Manjistha	01 01 01 01 01 01 01 01 01
UNIT III - STANDARDIZATION OF RAW MATERIAL		**05**
3.1	Importance of standardization	01
3.2	Physical and chemical methods of standardization	02
3.3	Quantitative and qualitative estimation of phytoconstitutes	02
UNIT IV- COMMONLY USED HERBS IN THE FOLLOWING HERBAL COSMETICS		**07**
4.1	Herbal Shampoo	01
4.2	Herbal Conditioner	01
4.3	Herbal Hair Dye/ Herbal Hair Oil/Hair Cream/Hair Gel,	02
4.4	Herbal Face Mask	02
4.5	Herbal Bath Oil.	01
UNIT V- PROTOCOLS FOR PREPARATION		**05**
5.1	Different types of Herbal face masks- for dry skin, oily skin, pigmented skin & wrinkled skin	03
5.2	Special Herbal masks for sensitive skin	01
5.3	Herbal Shampoo	01
UNIT VI -HERBAL EDIBLE CHURNAS BENEFICIAL FOR SKIN TO HAIR		**04**
UNIT VII - HERBS USED IN WEIGHT LOSS AND WEIGHT GAIN		**04**
7.1	Herbs for weight gain	02

7.2	Herbs for weight loss **(**For e.g. Ginseng, Cinnamon, Black Pepper, Dandelion, Yashtimadhu, Ashwagandha)	02
UNIT VIII -HERBS THAT HELP IN DEPRESSION AND ANXIETY		**01**
UNIT IX -FUTURE PROSPECTS OF HERBAL COSMETIC INDUSTRY		**01**
	TOTAL	**45**

BOT-III.E-4

PAPER TITLE: HERBAL COSMETOLOGY (PRACTICAL)

PAPER CODE: BOT-III.E-4

NAME OF THE FACULTY: Ms. AMISHA SHIRODKER

MARKS: 25

CREDITS: 1 (Any 10 to be conducted)

BOT-III.E-4 HERBAL COSMETOLOGY (PRACTICAL)

Sr. No	TOPICS	PRACTICAL
1	Herbal face masks for dry skin, oily skin, pigmented skin, wrinkled skin	02
2	Study of plants valued in the cosmetic industry- skin and hair	02
3	Preparation of Herbal Shampoo	02
4	Local Survey to know about awareness about home remedies for cosmetic purposes	01
5	Study of various skin and hair care herbal products available in the market	01
6	Comparision of Herbal products to non-herbal products	01
7	Visit to Ayurvedic institute and a local clinic.	02
8	Demostration of Churna preparation	01

9	Study of herbal products for weight loss and weight gain	01
10	Extraction of plant pigments- *Lawsonia inermis* (mehndi) and *Curcuma longa* (turmeric),	01
11	Study of locally available herbal Churnas.	01
	TOTAL	**15**

Reference Books:

1. Fuller, K.W. and Gallon, J.A. Plant Products and New Technology. Clarendon Press, Oxford, New York. 1985
2. Kocchar, S.L. Economic Botany in Tropics, 'i.'d edition. Macmillan India Ltd., New Delhi. 1998.
3. Simpson, B.B. and Conner-Ogorzaly, M. Economic Botany- Plants in Our World. McGraw Hill, New York. 1986.
4. Sachs, M. Ayurvedic Beauty Care: Ageless Techniques to Invoke Natural Beauty. ISBN: 9788120818804. 2014
5. Sharma, O.P. Hill's Economic Botany. Tata McGraw Hill Publishing Company Ltd., New Delhi. 1996.

Framework of Question paper

	Q1	Q2	Q3	Q4	Max marks	Total marks
C	Any 3 OF 4 (3 marks each)	Any 2 OF 3 (6 marks each)	Any 2 OF 3 (6 marks each)	Any 1 OF 2 (12 marks each)	45	72

Note: Teachers are requested to take a note that Q4 in their respective question paper should preferably be set involving a higher order thinking. You are requested to submit answer key to the respective question paper.

COURSE STRUCTURE – DEPARTMENT OF BOTANY

Three year B.Sc Degree Course in BOTANY

Semester	Core		Elective			
I	**BOT-I.C-1** Plant diversity	**BOT-I.C-2** Cell Biology & Biomolecules	--------	--------	--------	--------
II	**BOT-II.C-3** Plant Anatomy and Embryology	**BOT-II.C-4** Microbiology	--------	--------	--------	--------
III	**BOT-III.C-5** Physiology of Plants		**BOT-III.E-1** Ecology & Conservation	**BOT-III.E-2** Techniques and Instrumentation in Botany	**BOT-III.E-3** Enzymes and It's metabolic pathways	**BOT-III.E-4** Herbal Cosmetology
IV	**BOT-IV.C-6** Cytogenetics		**BOT-IV.E-5** Plant Breeding and Biostatistics	**BOT-IV.E-6** Systematics of Flowering plants and Phylogeny	**BOT-IV.E-7** Plant pathology	**BOT-IV.E-8** Horticulture, Floriculture & Landscaping
V	**BOT-V.C-7** Plant Molecular Biology		**BOT-V.E-9** Bioinformatics	**BOT-V.E-10** Seed Technology	**BOT-V.E-11** Pharmacognosy	**BOT-V.E-12** Organic Farming
VI	**BOT-VI.C-8** Plant Biotechnology and Genetic Engineering		**BOT-VI.E-13** Plant tissue culture	**BOT-VI.E-14** Agricultural Biotechnology	**BOT-VI.E-15** Plant Drug Technology	**BOT-VI.E-16** Field Ecology

C- CORE **E- ELECTIVE**

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)

SEMESTER-IV

COURSE TITLE: CYTOGENETICS (THEORY)
COURSE CODE: BOT-IV.C-6
NAME OF THE FACULTY: Ms. Amisha Shirodker
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

This course will enable the students to understand fundamentals of genetics and evolution.

LEARNING OUTCOMES :

It will enable the students to understand the mechanism, role and importance of cell division, linkage and crossing over. The students will also know the various gene mutations and variations & their adverse effects.

SEMESTER-IV CYTOGENETICS THEORY -75 MARKS

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	HOURS
UNIT I Mendelian genetics and principles of inheritance		**04**
1.1 1.2	Mendel's Laws, backcross and test cross, Allelic and non-allelic interactions, Epistatic interactions	**02** **02**
UNIT II Multiple allelism		**03**
2.1	Multiple alleles in Drosophila (eye colour), man (blood groups) and plants (self-incompatibility).	**01** **01** **01**
UNIT III Linkage and Crossing over		**05**

3.1 3.2	Meiosis, Comparison of Mitosis and Meiosis; Linkage- Coupling and Repulsion Hypothesis Crossing over- Chromosome mapping, Three point test cross, Interference and coincidence	**03** **02**
Unit IV	**Extranuclear inheritance and Maternal influence**	**07**
4.1 4.2	Extranuclear inheritance and maternal influence: Kappa particles in *Paramecium;* Streptomycin sensitivity in *Chlamydomonas*, CO_2 sensitivity in *Drosophila*; cytoplasmic inheritance in mitochondria and plastids; Shell coiling in snails; eye colour in flour moth. Cytoplasmic male sterility Chemical basis of cytoplasmic inheritance	**06** **01**
UNIT V	**Sex Determination and Sex Linkage**	**07**
5.1 5.2 5.3	Sex Chromosomes, Mechanisms of sex determination; Genic balance mechanism. Sex-linked inheritance- X linked and Y linked inheritance. Nutrition and environment theory Sex determination	**03** **03** **01**
UNIT VI	**Genetic and Cytological effects of Mutations at genetic level**	**07**
6.1 6.2 6.3	Mutations and its types. Types of mutagens, mode of action Chromosomal aberrations – duplications, deletions, inversions and translocation	**01** **03** **03**
UNIT VII	**Molecular basis of mutations**	**06**
7.1 7.2 7.3	Transitions and transversions; frame shift mutations. DNA repair mechanisms Applications of mutations	**02** **03** **01**
UNIT VIII	**Genetic variation due to chromosome number**	**06**
8.1	Variations in chromosome number; auto-and allo-polyploidy - types and effects; artificial induction of polyploidy. Auto and allo-polyploid crop	**03**

8.2 8.3	species Aneuploid segregations in plants- tetrasomics and nullisomics; triploid and tetraploid plants . Applications of polyploidy	02 01
	TOTAL	**45 HOURS**

COURSE TITLE: CYTOGENETICS (PRACTICAL)
COURSE CODE: BOT-IV.C-6
NAME OF THE FACULTY: Ms. AmishaShirodker
MARKS: 25
CREDITS: 1

Sr. No	Experiments	Practical
1.	Study of Mitosis using suitable plant material.	**01**
2.	Study of Meiosis suitable plant material.	**01**
3.	Karyotype analysis and preparation of idiogram	**01**
4.	Detection of anomalies in cell division using suitable plant material.	**01**
5.	Study of multiple allelism in blood groups of human beings.	**01**
6.	Effect of chemical mutagen on seed germination	**01**
7.	Effect of physical mutagen on seed germination	**01**
8.	Preparation of chromosome maps from 3-point test cross data and calculation of Interference and coincidence	**01**
9.	Induction of polyploidy using Colchicine treatment.	**01**
10.	Study of sex linked inheritance	**01**
11.	Study of CO_2 sensitivity in *Drosophila*	**01**
12.	Study of Streptomycin sensitivity in *Chlamydomonas*	**01**
	TOTAL	**12 P**

Reference Books:

1. Concepts of Genetics W. S. Klug, M. R. Cummings, C. A. Spencer. 8 Edition, Pearson Education International (2006)
2. Gardner, Eldon J.; Snustad, Peter D.; Principles of genetics; 7th edition; New York: John Wiley &Sons ,(1984).
3. Genetics : A Conceptual Approach B. Pierce, 3rd Edition, Freeman & Co., (2008)
4. Genetics Peter Russell, 2nd Edition, Pearson International, (2006)
5. Gupta, P.K. Genetics. Rastogi Publications. (1990).
6. Gupta, P.K.; Cytogenetics; 1st edition, reprint; Meerut :Rastogi Publications , (2004).

7. Gupta, P.K.; Genetics: A textbook for University students; 3rd edition; Meerut: Rastogi Publications , (2007).
8. Introduction to Genetic Analysis A. J. Griffiths, S. R. Wessler, R. C. Lewontin, S. B. Carroll. 9th Edition, Freeman and Company (2008)
   Molecular Biology of the Gene J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick. 5th Edition, Pearson Education (2004)
9. Principles of Genetics P. Snustad, M. Simmons, 4th Edition, John Wiley and Sons Co., (2006)
10. Shukla, R.S. and Chandel, P.S.; Cytogenetics, Evolution, Biostatistics and Plant Breeding. (2007)

COURSE TITLE: PLANT BREEDING & BIOSTATISTICS (THEORY)
COURSE CODE: BOT-IV.E-5
NAME OF THE FACULTY: Ms. Amisha Shirodker
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

To enable the students to learn various techniques in plant breeding with regards to crop productivity.

LEARNING OBJECTIVES:

This course will enable the students to have basic knowledge of genetic improvement of crop plants.

BOT-IV.E-5 PLANT BREEDING & BIOSTATISTICS THEORY -75 MARKS

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	HOURS
UNIT I - Plant breeding		**08**
1.1	Introduction, history, objectives, achievements and prospects	**04**
1.2	Genetic variability and its role in plant breeding	**03**
1.3	Centres of origin of crop plants.	**01**
UNIT II – Organizations & their mandate		**03**
2.1	ICAR, ICRISAT , IRRI (Indian & International)	**03**
UNIT III - Breeding for biotic and abiotic stresses		**05**
3.1	Physiological races and types.	**01**

3.2	Genetics of pathogenecity; vertical and horizontal resistance & breeding for various biotic stresses in rice/wheat .	**02**
3.3	Breeding for abiotic stresses - salinity and drought resistance	**02**
UNIT IV- Plant breeders' rights		**03**
4.1	Plant breeders' & Farmers' Rights	**02**
4.2	Phytosanitary and Seed Certifications	**01**
UNIT V–Hybridisation, Heterosis and Inbreeding Depression		**12**
5.1	Pure line and mass selection	**03**
5.2	Types and Techniques in hybridization	**02**
5.3	Hybridization in self- and cross-pollinated crops	**03**
5.4	Introduction, domestication and acclimatization	**02**
5.5	Heterosis and inbreeding depression.	**02**
UNIT VI- Mutations and polyploidy in plant improvement.		**04**
6.1	Varieties developed in India through mutation breeding	**02**
6.2	Limitations of mutation breeding	**02**
UNIT VII- Biostatistical methods		**10**
7.1	Introduction to biostatistics: Terms used in biostatistics, types of data	**01**
7.2	Sampling theories- random sample, sample size determination, precision,data collection, processing and presentation of data: qualitative and quantitative	**03**
7.3	Measures of central tendency: Mean, Median, Mode	**01**
7.4	Measures of variation: standard deviation, standard error	**01**
7.5	Concept of correlation between two variables and regression line	**02**
7.6	Chi square	**01**
7.7	Student's t- test	**01**
	TOTAL	**45 HOURS**

COURSE TITLE: PLANT BREEDING & BIOSTATISTICS (PRACTICAL) COURSE CODE: BOT-IV.E-5
NAME OF THE FACULTY: Ms. Amisha Shirodker
MARKS: 25
CREDITS: 1

Sr. No	Experiments	Practical
1.	Emasculation and bagging of flowers using suitable plant material.	**01**
2.	Estimation of fruit and seed set in emasculated flowers	**01**
3.	Correlation of floral structure with pollination system	**01**
4.	Estimation of pollen fertility (pollen viability) in locally grown crop species.	**01**
5.	Study of centres of origin of some important crop plants.	**01**
6.	Study of soil pH using different soil types & relate it to crops	**01**
7.	Study of soil testing for N,P,K	**01**
8.	Analysis of data for mean, median & mode	**01**
9.	Standard deviation and standard error using suitable plant samples	**01**
10.	Setting of experimental design for randomized and non randomized design using pot	**01**
11.	Determination of correlation and regression	**01**
12.	Chi square analysis	**01**
13.	Students T-test	**01**
14.	Visit to ICAR	**01**
	TOTAL	**14 P**

Reference Books:

1. Mahajan, B.K.; Methods in biostatistics; 6th edition; New Delhi : Jaypee Brothers, (1997)

2. Rastogi, Veer Bala.; Fundamentals of Biostatistics; 2nd edition, reprint; New Delhi :Ane Books India , 2006(2008).

3. Shukla, R.S. and Chandel, P.S.; Cytogenetics, Evolution, Biostatistics and Plant Breeding. (2007)
4. Singh, B.D.; A textbook of Plant Breeding; Kalyani Publishers. (2009)
5. Sokal R R and Rahlf H A. Biometry: the principles and practice of Statistics for Biology. research. 3rd edi W H Freeman and Co. (1995)
6. Zar J H, Biostatistical analysis 4th ed. Prentice Hall. (1998)

PAPER TITLE: SYSTEMATICS OF FLOWERING PLANTS AND PHYLOGENY
PAPER CODE: BOT-IV.E-6
NAME OF FACULTY: Dr. (MRS). UMA MASUR
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

To study the morphology , systematics and phylogeny of flowering plants.

LEARNING OUTCOME:

To enable the student to identify & classify the flowering plants and know their phylogenetic relationship.

BOT-IV.E-6 SYSTEMATICS OF FLOWERING PLANTS AND PHYLOGENY

THEORY-75 MARKS

Sr.No	**UNITS, TOPICS AND SUB-TOPICS**	**Hours**
	UNIT – I: INTRODUCTION	**03**
1.1	Plant classification, nomenclature & biosystematics	**03**
	UNIT – II: HERBARIUM	**06**
2.1	Field inventory; Functions of Herbarium; Important herbaria and botanical gardens (India & world), virtual herbarium; e-flora	02
2.2	Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access	04
	UNIT – III: SYSTEMATICS AND TAXONOMIC HIERARCHY	**12**

3.1	Principles and rules (ICBN); Ranks and names; Typification, author citation, valid publication	03
3.2 **3.3** **3.4**	Rejection of names, principle of priority and its limitations; Names of hybrids. Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; species concept (taxonomic, biological, evolutionary). Evidence from palynology, cytology, phytochemistry and molecular data.	03 03 03
UNIT – IV: SYSTEMS OF CLASSIFICATION; POSITION AND DIAGNOSTIC FEATURES OF FAMILIES		**15**
4.1 **4.2** **4.3**	Concepts of evolution and phylogeny Major contributions of Linnaeus, Bentham and Hooker, Engler and Prantl; Brief reference of Angiosperm Phylogeny group (APG III) classification. Annonaceae, Capparidaceae, Brassicaceae, Tiliaceae, Rutaceae, Myrtaceae, Cucurbitaceae, Rubiaceae, Apocyanaceae, Asclepiadaceae, Solanaceae, Verbenaceae, Lamiaceae, Amaranthaceae, Orchidaceae, Araceae, Asteraceae, Zingiberaceae, Commelinaceae, Poaceae.	01 04 10
Unit V:	**Biometrics, numerical taxonomy and cladistics**	**06**
5.1 **5.2**	Characters; Variations; OTUs, character weighting and coding; cluster analysis Phenograms, cladograms (definitions and differences)	03 03
UNIT VI: PHYLOGENY OF ANGIOSPERMS		**03**
6.1 **6.2**	Origin & evolution of angiosperms Co-evolution of angiosperms	02 01
	Total:	**45**

PAPER TITLE: SYSTEMATICS OF FLOWERING PLANTS AND PHYLOGENY
PAPER CODE: BOT-IV.E-6
NAME OF FACULTY: Dr. (MRS). UMA MASUR
MARKS: 75
CREDITS: 3

Sr. No	Topics	Practical
1	Plant identification using flora book and database	**01**
2	Preparation of herbarium	**01**
3	Identification of 20 families mentioned in unit IV (Bentham & Hooker's system) studied in theory from locally available specimens (with floral diagram).	**10**
4	Use of taxonomic keys and construction of dichotomous keys	**01**
5	Taxonomic interpretation using pollen of related species	**01**
6	Construction of Phenogram and Cladogram	**01**
	Total	**15**

Suggested Reference Books:

1. Singh, G. 1999. Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi.
2. Chopra, G. L. 1985. Angiosperm (Systematics& Life cycles). Pradeep Publications, Jaladhar, India, pp. 339-350.
3. Pandey, B. P. 1969. Taxonomy of Angiosperms. S. Chand and company Ltd. New Delhi, India, pp. 102-105.
4. Subrahmanyam N S, Modern plant taxonomy, Vikas publishing house pvt. Ltd.,1995.
5. Pandey S N , Taxonomy of angiosperms, ASE books India, 2008.
6. Mondal
7. Naik, V.N. 1984. Taxonomy of Angiosperms. Tata McGraw Hill, New Delhi.
8. Radford, A.E. 1986. Fundamentals of Plant Systematics. Harper and Row, New York.
9. Davis, P.H. and Heywood, V.H. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd, London.
10. Heywood, V.H. and Moore, D.M. 1984. Current Concepts in Plant Taxonomy. Academic Press, London.

PAPER TITLE: PLANT PATHOLOGY (THEORY)
PAPER CODE: BOT.IV.E-7
NAME OF THE FACULTY: Dr. SANGEETA G. SANKHALKAR
MARKS: 75
CREDITS: 3

Course Objectives

Make the students aware of various plant pathogens and their control

Learning outcome

It will enable the students to understand fundamental basis of plant-microbe interactions and plant health management.

BOT.IV.E-7: PLANT PATHOLOGY THEORY: 75 MARKS

Sr. No	UNITS, TOPICS AND SUB-TOPICS	Hours
UNIT-I: AN INTRODUCTION TO PLANTS DISEASES		**08**
1.1	Definitions and Importance	1
1.2	History and growth of plant pathology	1
1.3	Biotic causes of plant diseases.	02
1.4	Concepts of disease in plants	1
1.4	Types of plant diseases & their significances	03
UNIT-II: EPIDEMOLOGY OF PLANT DISEASES		**08**
2.1	Infectious agents (nematodes, protozoans, bacteria & viruses)	3
2.2	Growth, reproduction, survival and dispersal of important plant pathogens	3
2.3	Role of environment and host nutrition on disease development	2
UNIT III: PLANT DISEASE DEVELOPMENT (PATHOGENESIS)		**05**
3.1	Parasitism and pathogenicity	1
3.2	Symptomatology	1
3.3	Host parasite interaction	1
3.4	Recognition concept and infection,	1
3.5	Role of enzymes, toxins & growth regulators in pathogenesis	1
UNIT IV: BRIEF STUDY OF PLANT DISEASES IN INDIA		**07**

4.1	**Study of Diseases** (Name of disease, pathogen, symptoms and control measures need to be studied) Important diseases of Arecanut, Paddy, wheat &citrus, Vein clearing of Bhendi, Bunchytop of Banana Coffee rust, Stem bleeding of coconut; bud rot of coconut, Root wilt of coconut, Red rot of sugarcane	**07**
UNIT V: PLANT DISEASE MANAGEMENT		**10**
5.1	Quantitative resistance (Physical, Biological & cultural methods)	03
5.2	Biochemical defences	01
5.3	Defense strategies (oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors responses)	03
5.4	Defence through antimicrobial substances & Plantibodies	01
5.5	Resistance through chemical treatment & genetically engineered techniques.	01
5.6	Quarantine measures	01
UNIT VI: GENETICS OF PLANT DISEASE		**07**
6.1	Altered plant metabolism due to pathogens attack	1
6.2	Genetics of resistance ('R' & avr genes)	1
6.3	Mechanism of genetic variation in pathogens	2
6.4	Molecular basis for resistance & marker-assisted selection	2
6.5	Signalling and programmed cell death	1
	TOTAL	**45**

PAPER TITLE: PLANT PATHOLOGY (PRACTICAL)
PAPER CODE: BOT.IV.E-7
NAME OF FACULTY: Dr. SANGEETA G. SANKHALKAR
MARKS: 25
CREDITS: 1

	BOT.IV.E-7 PACTICAL (25 marks)	
Sr. No	**Topics**	**Practicals**
1	Isolation and culture of pathogens from fungal pathogen	01
2	Isolation and culture of pathogens from bacterial pathogen	01
3	Demonstration of Koch's postulates	01
4	Extraction of proteolytic enzymes from a fungal pathogen (*Penicillum* or *Fusarium*)	01
5	Assay for cellulase /pectinase enzyme from diseased plant	01

6	Study of plant diseases with reference to pathogen & symptomology (Fungal, Bacterial & viral) (any 10 as per theory)	05
7	Anatomical observations of fungal infected plants (rust, blight, rots)	03
8	Study of antagonistic behaviour of bacterial pathogens	01
	Total	**14**

References

1. Agros, G.N. (1997) Plant Pathology (4th ed) Academic Press.
2. Bilgrami K.H. & H.C. Dube (1976) A textbook of Modern Plant Pathology. International Book Distributing Co. Lucknow.
3. Mehrotra, R.S. (1980) Plant Pathology, TMH, New Delhi.
4 Pandey, B.P. (1999) Plant Pathology. Pathogen and Plant diseases. Chand & Co. New Delhi.
5 Rangaswami, G. (1999) Disease of Crop plants of India Prentice Hall of India Pvt. Ltd.
6 Sharma P.D. (2004). Plant Pathology Rastogi Publishers.
7 P Gunasekaran (2005)Laboratory manual in Microbiology. New Age International (P) Limited, Pub. New Delhi.
8 K.R. Aneja (2009).Experiments in Microbiology Plant Pathology & Biotechnology, 4th edition New Age International (P) Limited, Pub. New Delhi.

PAPER TITLE: HORTICULTURE, FLORICULTURE & LANSCAPING (THEORY)
PAPER CODE: BOT-IV.E-8
NAME OF FACULTY: Dr. (MRS). UMA MASUR
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

Is to provide entrepreneur opportunities.

LEARNING OUTCOMES:

The course would enable student to learn technical knowhow in Horticulture, Floriculture & Landscaping

BOT-IV.E-8: HORTICULTURE, FLORICULTURE & LANDSCAPING THEORY: 75 MARKS

Sr.No	Units, Topics and Sub-topics	Hours
UNIT – I: HORTICULTURE		**11**

1.1	Definition and importance; scope of Pomoculture Olericulture, Floriculture	04
1.2	Fertilizers: inorganic, Organic – biofertilizers: vermi composting, green manure, algal culture, FYM.	04
1.3	Pots & potting:– Earthen, Fibre, Polythene bags, Potting mixture, Potting, Re-potting, Top dressing.	01
1.4	Irrigation:- Surface, Sprinkle, Drip and Gravity irrigation	02
UNIT – II: PROPAGATION METHODS		**08**
2.1	Sexual methods (seed propagation) – Definition, Merits and Demerits, Criteria for selection of seeds.	02
3.2	Asexual (Vegetative) propagation – Definition, and types- Cutting (root, stem, leaf), Layering (simple, air), Grafting (Whip, Approach) and Budding (T, patch), Stock –scion relationship in important horticultural crops.	03
3.3	Use of plant growth regulators in horticulture: Induction of rooting, flowering, fruit set, fruit development and control of fruit crops.	03
UNIT – III: FLORICULTURE		**11**
3.1	knowledge of annual, biennials and perennials with reference to ornamental flowers.	02
3.2	Cultivation of commercial flowers – Rose, Jasmine, Chrysanthemum., crossendra & Orchid	03
3.3	Nursery maintenance; Cut flowers ; flower arrangements (including ikebana); improving shelf life of cut flowers.	03
3.4	Green house, Poly house, Moist chamber, Net frame	03
UNIT – IV: LANDSCAPING		**15**

4.1	Types of garden: Formal, informal and kitchen garden.	03
4.2	Locations in the garden- edges, hedges, fence, lawn, flower beds, Avenue, water garden (with two examples of each). Focal point. Auto CAD in garden designing	05
4.3	National parks, Botanical gardens, water garden, rockery plants, Bonsai techniques, Hydroponics.	04
4.4	Lawn making: type of lawn grasses and maintenance. Plants suitable for hedges.	02
4.5	Aftercare: Weeding, top dressing methods of pruning and topiary	01
	Total:	**45**

PAPER TITLE: HORTICULTURE, FLORICULTURE & LANDSCAPING (PRACTICAL)

PAPER CODE: BOT-IV.E-8
NAME OF FACULTY: Dr. (MRS). UMA MASUR
MARKS: 25
CREDITS: 1

Sr. No.	Topics	Practical
1.	Preparation of nursery bed and polybag filling	01
2.	Preparation of potting mixture – Potting, repotting.	02
3.	Field work in cutting, grafting, budding, layering	02
4.	Garden designing using Auto CAD software	01
5. *	Familiarizing gardening tools and implements	01
6.	Preparation of organic compost& vermicompost	02
7.	Establishment of vegetable garden using organic compost & vermi-compost	03
8.	Flower arrangement	01
9.	Visit to nurseries, gardens and Report.	01
10	Improving the shelf life of cut flowers using chemicals	01
	Total	**15**

Suggested Reference Books:

1. Swarup V. (1997). Ornamental horticulture. MaMillan India Limited, New Delhi.
2. Randhava, G.S, 1973 – Ornamental horticultural in India Today andTomorrow Printers and Publishers, New Delhi.
3. Trivedi TP (2007). Ornamental horticultural in India. Indian Council of Agricultural Research New Delhi.
4. Nayak, K.C. South Indian fruits and their culture P.L. Varadaraj& Co.,&Lingichetti Street, Madras.
5. EdmentSenn Andrews 1994 Fundamentals of Horticulture – TataMcGraw Hill Publishing Co., Ltd., Delhi

COURSE STRUCTURE – DEPARTMENT OF BOTANY

Three year B.Sc Degree Course in BOTANY

Semester	Core		Elective			
I	**BOT-I.C-1** Plant diversity	**BOT-I.C-2** Cell Biology & Biomolecules	--------	--------	--------	--------
II	**BOT-II.C-3** Plant Anatomy and Embryology	**BOT-II.C-4** Microbiology	--------	--------	--------	--------
III	**BOT-III.C-5** Physiology of Plants		**BOT-III.E-1** Ecology & Conservation	**BOT-III.E-2** Techniques and Instrumentation in Botany	**BOT-III.E-3** Enzymes and It's metabolic pathways	**BOT-III.E-4** Herbal Cosmetology
IV	**BOT-IV.C-6** Cytogenetics		**BOT-IV.E-5** Plant Breeding and Biostatistics	**BOT-IV.E-6** Systematics of Flowering plants and Phylogeny	**BOT-IV.E-7** Plant pathology	**BOT-IV.E-8** Horticulture, Floriculture & Landscaping
V	**BOT-V.C-7** Plant Molecular Biology		**BOT-V.E-9** Bioinformatics	**BOT-V.E-10** Seed Technology	**BOT-V.E-11** Pharmacognosy	**BOT-V.E-12** Organic Farming
VI	**BOT-VI.C-8** Plant Genetic Engineering		**BOT-VI.E-13** Plant tissue culture	**BOT-VI.E-14** Algal Biotechnology	**BOT-VI.E-15** Plant Drug Technology	**BOT-VI.E-16** Field Botany

PARVATIBAI CHOWGULE COLLEGE OF ARTS & SCIENCE, MARGAO GOA
(AUTONOMOUS)
DEPARTMENT OF BOTANY

PAPER TITLE: **PLANT MOLECULAR BIOLOGY** (THEORY)
PAPER CODE: **BOT-V.C-7**
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES

To introduce the students with fundamental knowledge of molecular system in cells.

LEARNING OUTCOME

The students will be able to understand general principles of gene organization and functions.

BOT-V.C- 7 PLANT MOLECULAR BIOLOGY THEORY: 75 MARKS

Sr. No	UNITS, TOPICS AND SUB-TOPICS	Hours
UNIT-I: NATURE OF GENETIC MATERIAL		**08**
1.1	Characteristics of genetic material, physical and biological evidences to prove DNA & RNA as genetic material, Watson and Crick's model of DNA, structure , organization and polymorphism of DNA; comparison between DNA and RNA.	5
1.2	Central Dogma of molecular biology, Model organism for studying molecular biology; DNA content of the cell and C-value paradox	2
1.3	Chargoff's Law, Franklin's and Wilkin's work	1
UNIT II: REPLICATION OF DNA		**09**
2.1	General feature of DNA replication (replication eye, replication forks)	2
2.2	Types of DNA replication Molecular mechanism of DNA replication in Prokaryotes (Transduction, transformation and conjugation), & in Eukaryotes (Dispersive, Conservative and Semi- conservative)	5
2.3	Enzymes of replication –DNA Primase ; DNA polymerases I, II, III, Topoisomerases, Helicases, Binding proteins and Ligases	2
UNIT III: DNA DAMAGE AND REPAIR		**06**
3.1	Types of DNA damages and repair (direct reversal of damage, excision repair, recombination repair and SOS repair)	4
3.2	Gene mutation and its types (site directed mutational changes)	2
UNIT IV: TRANSCRIPTION		**09**

4.1 4.2 4.3	Structure and functions of mRNA, tRNA and rRNA Transcription of mRNA in Prokaryotes & eukaryotes Post transcriptional event, eukaryotes splicing, RNA editing and processing of mRNA.	2 4 3
UNIT V: GENE REGULATION & EXPRESSION		**07**
5.1 5.2	Units of Gene (Cistron, recon, muton, Enhancers, Split genes, overlapping genes; transposons and its role in gene structure , promoters & terminators Gene regulation in prokaryotes (Lac operon concept) and eukaryotes (Britten and Davidson's model); Inducible and repressible mechanism	3 4
UNIT VI: TRANSLATION-PROTEIN SYNTHESIS		**06**
6.1 6.2 6.3	Secondary structure of mRNA; Ribosome structure and functions Genetic code; Mechanism of Translation; RNA polymerases; Enzymes and factors Post translational modifications; Protein targeting	2 3 1
		45

SEMESTER V
PAPER TITLE: PLANT MOLECULAR BIOLOGY (Practical)
PAPER CODE: BOT-V-C-7
MARKS: 25
CREDIT:1

Sr. No	TOPICS	PRACTICALS
1	Isolation of plant genomic- DNA	1
2	Phenol chloroform extraction of DNA	1
3	Ethanol precipitation of DNA	1
4	Spooling of DNA	1
5	Quantification of DNA by DPA method.	1
6	Spectrophotometric determination of Nucleic acid purity	1
7	Isolation of total RNA from plant tissue	1
8	Estimation of RNA by Orcinol method	1
9	Preparation of Agarose gel and running of DNA (demonstration)	1
10	Formaldehyde-Agarose gel Electrophoresis for RNA (denatured gel) (demonstration only)	2
11	Primer designing for PCR	2
12	PCR amplification of DNA (Demonstration)	2
	Total	**15**

Reference Books :

1. Alberts B., Bray, D Lewis, J., Raff, M., Roberts, K and Walter 1999. Molecular Biology of the Cell. Garland Publishing, Inc., New York
2. David Freifelder, 1983 Jones & Bartlett publishers. 2ed Molecular biology. Reprint 1993. Narosa Publishing House.
3. Pal J.K.and Ghaskadabi S.S. 2008 Fundamentals of Molecular Biology. Oxford.
4. James D. Watson, 2007.Molecular Biology of the Gene (6th Edition) by, Tania A. Baker, Stephen P. Bell, and Alexander Gann.
5. Kleinsmith L.J and Kish V.M 1995. Principles of Cell and Molecular Biology (Second Edition). Happer Collins College Publishers, New York,
6. Lehninger 2008. Principles of Biochemistry by David L. Nelson and Michael M.
7. Dube R.C. 2008. A Text Book of Biotechnology S. Chand pub.
8. Adams R.L., Knowler, J.T. and Leader, D.P. 1992. The Biochemistry of the Nucleic Acids.
9. Lewin B. 2000. Genes VII. Oxford University Press, New York.
10. Buchanan B.B, Gruissm W. and Jones R.L 2000. Biochemistry and Molecular biology.

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)
DEPARTMENT OF BOTANY

SEMESTER-V
COURSE TITLE: BIOINFORMATICS (THEORY)
COURSE CODE: BOT-V. E-9
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES: The course will help the students to understand the fundamentals of bioinformatics and tools available.

LEARNING OUTCOMES:

It will enable the students to gain knowledge in vast data handling and analysis, and to develop skills.

BOT-V. E-9 **BIOINFORMATICS** **THEORY -75 MARKS**

Sr.No.	**UNITS, TOPICS AND SUB-TOPICS**	**HOURS**
UNIT I: INTRODUCTION TO BIOINFORMATICS		**08**
1.1	Introduction to bio-informatics, The biological sequence / structure deficit	02
1.2	Genome projects, Pattern recognition and prediction, Levels of protein structure	03
1.3	Role of Chaperons, Sequence analysis	01
1.4	Fields Related to Bioinformatics: Computational Biology, Genomics, Proteomics, Pharmacogenomics, Cheminformatics, Medical Informatics Importance of Bioinformatics	02
UNIT II: INFORMATION NETWORKS		**07**
11.	Internet and the facilities available on it, computational biology, What is World Wide Web, Web browsers and Web addresses	03
2.2	HTTP, HTML, CORBA and URLs	01

2.3	The National Centre for Biotechnology Information- NCBI The European Molecular Biology Network- EMBnet	02
2.4	Bioinformatics programme in India- BTISNet, BPI-2004	01
UNIT III : INTRODUCTION TO BIOLOGICAL DATABASE		**04**
3.1	Introduction To Biological Database : GenBank, EMBL, SwissProt, PROSITE, EC-ENZYME, PDB, GDB, OMIM, PIR-PSD,	04
UNIT IV : PROTEIN INFORMATION RESOURCES		**07**
4.1	Introduction	01
4.2	Primary Sequence Databases, Composite protein sequence databases, Secondary databases, Composite protein pattern databases	04
4.3	Structure classification databases	02
UNIT V : GENOME INFORMATION RESOURCES		**08**
5.1	Introduction	01
5.2	DNA sequence databases	02
5.3	Specialised genomic resources, ORF (Open Reading Frame Finder), TIGR Genome Resources	03
5.4	Genome comparison, Genome Annotation	01
5.5	Microarray image analysis	01
UNIT VI : HOMOLOGY, ANALOGY, ORTHOLOGY AND PARALOGY		**05**
6.1	Introduction	01
6.2	Comparision of Homology, Analogy, Orthology And Paralogy.	02
6.3.	Alignment based methods and Hybrid method	01
6.4	Comparision of Computer Prediction Algorithms	01
UNIT VII : PAIRWISE ALIGNMENT AND MULTIPLE SEQUENCE ALIGNMENTS		**06**
7.1	Introduction	01
7.2	Database interrogation, Alphabets and complexity, Comparison of sequences	02
7.3	Global alignment: The Needleman and Wunsch algorithm	02

7.4	Pairwise database searching, BLAST Databases of Multiple Alignments, Clustal W	01
	TOTAL	**45 HOURS**

COURSE TITLE: BIOINFORMATICS (PRACTICALS)
COURSE CODE: BOT-V. E-9
MARKS: 25
CREDITS: 1
ANY 10

SR. NO	TOPICS	PRACTICAL
1	Biological databases and exploring various websites- NCBI, PUBMED and Gen Bank databases	3
2	To explore EBI server and searching EMBL	2
3	Exploring and querying UniProt KB	1
4	To study the file formats- FASTA, PDB, Mol	2
5	Pairwise global alignment of protein and DNA using Needleman- Wunsh algorithm	2
6	Obtaining sequences for Pairwise alignment and to interpret the results to study the homology between the sequences	2
7	Database searching using different versions of BLAST and FASTA and Derivation of relationships of query sequences	2
8	Use of ClustalW for multiple sequence alignment	1
	TOTAL	**15**

REFERENCES:

1. Attwood, D. J., Parry Smith D.J. and Phukan, S. (2011). Introduction to Bioinformatics; Pearson education.
2. Ignacimuthu, S. (2005). Basic Bioinformatics. Narosa Publishing House
3. Khan, I. A. and Khanum, A. (2003). Fundamentals of Bioinformatics –Ukaaz publications.
4. Mani, K. and Vijayaraj, K.A. (2002). Bioinformatics for Beginners. Aparnaa Publication.
5. Murthy, C. S. V. (2004). Bioinformatics. Himalaya Publishing House.

Web Resources

1. http://genes.mit.edu/GENSCAN.html

2. http://vmoc.museophile.org Computer History

3. http://www.clcbio.com/index

4. http://www.genome.jp

5. http://www.genome.jp/dbget/ LinkDB

6. http://www.ncbi.nlm.nih.gov/Structure/CN3D/cn3d.shtml

7. http://www.softberry.com/berry

8. http://www.studentworkzone.com/

9. www.ebi.ac.uk

10. www.fgcu.edu/support/office2000

11. www.learnthenet.com Web Primer

12. www.clustawomega.org

13. www.embl.org

PARVATIBAI CHOWGULE COLLEGE OF ARTS & SCIENCE, MARGAO GOA (AUTONOMOUS)
DEPARTMENT OF BOTANY

SEMESTER -V
PAPER TITLE: SEED TECHNOLOGY (THEORY)
PAPER CODE: BOT-V.E-10
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

The course is focused in training students with knowledge of seed health, seed storage, seed certification techniques and regulation.

LEARNING OUTCOMES:

Student will have better understanding of seed physiology and vigour. The course knowledge will create trained human resource for seed industry and research organizations.

BOT-V.E-10 SEED TECHNOLOGY THEORY: 75 MARKS

Sr. No	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT-I: PRINCIPLES OF SEED TECHNOLOGY	**06**
1.1	Concepts, role & aim of seed technology	1
1.2	Seed defination and its types (nucleus seed, breeders seed, foundation seed, certified seed and truthful seed),characteristics of good seeds; seed dormancy and germination.	2
1.3	Difference between seed and grain, Seed development programmes and their role in Indian seed industry, National seed corporation.	3
	UNIT-II: ORGANIZATIONS OF SEED TESTING	**07**
2.1	International seed testing association	2
2.2	Association of official seed analysts.	2
2.3	Central and state seed testing laboratories	2
2.4	Role of ICRISAT	1

UNIT III: SEED CERTIFICATION		07
3.1	Objectives and concept of seed certification, Phases of seed certification	2
3.2	Procedure of seed certification: Minimum seed certification standards ; General seed certification standard and Specific crop standards	4
3.3	Seed certification agencies and its organization	1
UNIT IV: SEED TESTING		**04**
4.1	Principles and procedure of seed testing	1
4.2	Equipments for seed testing	1
4.3	Importance of seed testing, Seed heterogeneity test and tolerance value	2
UNIT V: PLANT BREEDING IN RELATION TO SEED TECHNOLOGY		**08**
5.1	Maintenance of breeders seed methods in self and cross fertilized crops	2
5.2	Development trial and release of seed variety	1
5.3	Germ plasm and its conservation, seed banks and types of seed collections	2
5.4	Hybridization methods: Heterosis & its types; uses of heterosis in crop improvement	3
UNIT VI: SEED PROTECTION		**06**
6.1	Importance of epidemic and seed borne diseases (Rice and Wheat)	2
6.2	Factors affecting seed infection	2
6.3	Seed borne pathogens and control measures	2
UNIT VII: SEED PROCESSING AND STORAGE		**07**
7.1	Seed drying- principles, its advantages and methods	2
7.2	Seed treating chemicals and equipments	1
7.3	Pest problems and their treatment during storage	2
7.4	Concept of seed marketing	1
7.5	Forecasting of seed demand and supply	1
	TOTAL	**45**

SEMESTER -V
PAPER TITLE: SEED TECHNOLOGY (Practical)
PAPER CODE: BOT-V.E-10
MARKS: 25
CREDITS: 1

Sr. No	TOPICS	Practicals
1.	Study of internal and external structure of dicot and monocot seed	2
2.	Analysis of physical properties of seed (seed weight variations in seed size)	1
3	Analysis of chemical properties of seed (carbohydrate, oil/ protein)	1
4	Microscopic examination of monocot and dicot seeds for disease symptoms	2
5	Testing of seed viability (2,3,5-triphenyl tetrazolium chloride test)	1
6	Effect of drying temperature & duration on seed germination	2
7	Estimation of moisture content in seed (oven method)	1
8	Breaking of seed dormancy methods (chemical, hormone & temperature)	3
9	Study of chalkiness in rice seeds.	1
10	Visit to seed production plant and report submission	1
	Total	**15**

REFERENCES:

1. Agrawal R.L. 2005. Seed Technology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Dutta A.C, 2000. A Class book of Botany, Oxford University Press, USA, 17th edition.
3. Pandey B.P 2010. A text book of Botany. S. Chand and Company Ltd., New Delhi.
4. Reddy S.R. 2008. Principles of crop production. Kalyani Publishers, New Delhi.
5. Santra S.C. and Chatterjee T.P., 2007. College Botany, New Central Book Agency (P) Ltd., Kolkata.
6. Singh B.D. 2009. Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi.
7. Umaraniet. A.L. 2006. Experimental Seed Science and Technology, Agrobios, Jodhpur.
8. Paul Neergaard (1977).Seed pathology, Macmillan; 2nd edition.

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)
DEPARTMENT OF BOTANY

SEMESTER-V
COURSE TITLE: PHARMACOGNOSY (THEORY)
COURSE CODE: BOT-V.E-11
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

The course provides fundamental knowledge to understand drug discovery and development.

LEARNING OUTCOMES:

Creating human resource in the field of drug development and pharmacognosy.

BOT-V.E-11 PHARMACOGNOSY THEORY -75 MARKS

Sr. No.	UNITS, TOPICS AND SUB-TOPICS	Hours
UNIT I- INTRODUCTION TO PHARMACOGNOSY		**09**
1.1	History, scope and development of Pharmacognosy	04
1.2	Classification of drugs: Morphological, Taxonomical, Chemical And Pharmacological.	05
UNIT II: General Introduction, Cultivation and Collection, Description, Histology, Constituents, Substitutes of plants of Pharmacognosic importance under following categories:		**12**
2.1	**LEAVES:** Eucalyptus and Adathoda	03
2.2	**SEEDS:** Castor and Nutmeg	03
2.3	**FRUITS:** Coriander and Senna pod	03
2.4	**FLOWERS:** Clove and Rose	03
UNIT III- STARCHES AND UNORGANISED DRUGS		**05**
3.1	Rice, Potato and Curcuma starch, Modified starches.	02
3.2	Unorganised Drugs: Dried Latex, Opium, Catechu	03
UNIT IV- STUDY OF RHIZOMES AND ROOTS OF PHARMACOGNOSIC IMPORTANCE		**05**

4.1	**Source plant, Cultivation, Collection and drying, Description, Histology, Constituents and Uses of:** • Curcuma • Ginger • Colchicum	
UNIT V- STUDY OF RESINS, GUM-RESINS AND OLEO-RESINS OF PHARMACOGNOSIC IMPORTANCE:		**04**
5.1	**Source plant, Collection, Description, Constituents, Varieties, adulterants and Uses of:** • Rubber • Acacia gum • Coniferous gum • Canada Balsum	
UNIT VI- STUDY OF OILS, FATS AND WAXES OF PHARMACOGNOSIC IMPORTANCE:		**02**
6.1	**Preparation, Description, Constituents and Uses of:** • Coconut oil • Sesame oil	 01 01
UNIT VII- STUDY OF FIBRES OF PHARMACOGNOSIC IMPORTANCE:		**03**
7.1	**Source plant, Cultivation, Collection and storage, Description, Microscopy, Constituents and Uses of:** • Cotton • Jute • Hemp	 01 01 01
UNIT VIII- COMMERCE IN DRUGS		**05**
8.1	Transport and Marketing	01
8.2	Deterioration and storage	01
8.3	Adulteration and its detection	01
8.4	Drug standardisation procedures	01
8.5	Bio-safety / regulations, bio ethics.	01
	TOTAL	**45 hours**

COURSE TITLE: PHARMACOGNOSY (PRACTICAL)
COURSE CODE: BOT-V.E-11
MARKS: 25
CREDITS: 1
ANY 10

Sr. No	Experiments	Practical
1.	Chemical tests for *Rauwolfia* and *Cinchona*	02
2.	Study of Anatomy of *Nux vomica* seeds	01
3.	Powder microscopy of *Nux vomica* seeds	01
4.	Micro-chemical tests for: i. Cellulose, ii. Lignin, iii. Protein, iv. Tannins v. Starch	03
5.	Histochemical tests for Fixed Oils And Fats	01
6.	Microscopic observation and measurements of Starch grains	01
7.	Microscopic observation and measurements of fibres.	01
8.	Adulteration of crude drugs (honey)	01
9.	Borntrager test for anthraquinone derivatives in Senna leaves.	01
10.	Microchemical test of *Datura* and *Adathoda* leaves for observation of Calcium oxalate crystals.	01
11.	Microchemical test of *Nux vomica* for oil globules and strychnine.	01
12.	Staining / diagonosis/ microchemical test of clove for volatile oils.	01
	TOTAL PRACTICALS	**15**

REFERENCES:

1. Gokhale S.B and Kokate, C.K. (2009). Pharmacognosy. Nirali Prakashan.

12. Khandelwal, K. R. (2008). Practical Pharmacognosy. Nirali Prakashan.

13. Kokate, C. K. (2008). Pharmacognosy. Nirali Prakashan.

14. Qadry, J.S. (2014). A Textbook of Pharmacognosy Theory And Practicals, CBS Publishers & Distributors.

15. Trease, G.E. & Evans, W.C., (2002). Pharmacognosy. Elsevier Science Publishers.

16. Wallis, T. E. (2005). Textbook of Pharmacognosy. CBS Publishers & Distributors.

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)
DEPARTMENT OF BOTANY

SEMESTER-V
COURSE TITLE: ORGANIC FARMING (THEORY)
COURSE CODE: BOT-V.E-12
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

The course provides knowledge of principles and practices of organic agriculture and its role in sustainable crop production.

LEARNING OUTCOMES:

On completion of the course: the students will develop an understanding of the social, economic and environmental context for current and future organic agriculture production and management.

BOT-V.E-12 ORGANIC FARMING THEORY -75 MARKS

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT I: Concept of Organic Farming	**09**
1.1	Introduction: Farming, organic farming, concept and development of organic farming.	02
1.2	Principles of organic farming, Types of organic farming	02
1.3	Needs and benefits of organic farming.	02
1.4	Agencies and institutions related to organic agriculture	01
1.5	Farm components for an organic farm	02

UNIT II: Composts, Manures and its application		**11**
2.1	Manure application: Composted vs. uncomposted manure	03
2.2	Composting- principles, stages, types and factors	03
2.3	Composting methods, Vermicomposting Bio-fertilizers, M.I., F.I.M., Neem cake, Mulching, Elley farming, Bio-innoculation	02 03
UNIT III: Soils, Soil Fertility Management and fertilizers		**13**
3.1	Soil types, Soil profile and Soil tillage	03
3.2	Factors affecting soil fertility and productivity	02
3.3	Land preparation	01
3.4	Water management for good soil, Commercial fertilizers, composition	03
3.5	Residual effects and fertilizer use efficiency	02
3.6	Foliar application and its concept	02
UNIT IV: Organic plant protection and Seed Certification		**07**
4.1	Plant protection- cultural and mechanical methods	02
4.2	Plant protection- bio pesticide and bio control agents	02
4.3	Allelopathic methods of weed control	02
4.4	Certification of organically produces seeds.	01
UNIT V: Entrepreneurship Development		**05**
5.1	Entrepreneurship – Concept, characteristics, approaches, need for entrepreneurship in Organic farming	02
5.2	Popularization of organic farming. Marketing of organic produce. Organic farming in the rest of the world.	03
	TOTAL	**45**

COURSE TITLE: ORGANIC FARMING (PRACTICAL)
COURSE CODE: BOT-V.E-12
MARKS: 25
CREDITS: 1
ANY 10

Sr. No.	Experiments	Practical
1.	Comparative analysis of pH, EC, organic C, total N, available N, P, K and S from organic and inorganic data (obtained data).	1
2.	Survey of weeds in crop fields (Organic v/s inorganic farming)	1
3.	Study of soil types.	1
4.	Preparation of M.I.	1
5.	Study of bio pesticide (Neem cake)	1
6.	Preparation of Compost/ vermi-compost.	2
7.	Study of Mulching	1
8.	Study of nitrogen fixing bacteria in leguminous plants.	1
9.	Visit to an organic farm	2
10.	Study of recycling of farm waste	1
11.	Effect of various manures on plant growth.	3
	TOTAL 15	

REFERENCES:

1. Chakraverty, A. (1991). Post-harvest technology of cereal, pulses and oil seeds. Oxford IBH Publishing Co. Pvt Ltd.

2. Deshmukh, S.N. (2012). Organic Farming: Principles, Prospects and Problems, Agrobios Publishers (India).
3. Gehlot, D. (2010). Organic Farming: Components and Management, Agrobios Publishers (India).
4. Gupta, O.P. (2010). Modern weed management. Agrobios Publishers .
5. Israelsen, O.W. and Hansen, V.E. (2015). Irrigation Principles and Practices. John Wiley & Sons Inc.
6. Kanwar, J.S. (1978). Soil Fertility, Theory and Practice. Indian Council of Agricultural Research Publication.
7. Palaniappan, S.P. and Annadurai, K.A. (2010). Organic Farming: Theory and Practice. Indian Council of Agricultural Research, Scientific Publishers Journals Dept.
8. Rao, V.S. (2000). Principles of Weed science. Taylor & Francis Publishers.
9. Reddy, T.Y. and Sankar Reddi, G. H. (2015). Principles of Agronomy. Kalyani Publishers.
10. Sadhu, A.N. and Singh, A. (2014). Fundamentals of Agricultural Economics. Himalaya Publishing House.
11. Saraswat, V.N., Bhan, V. M. and Yaduraju, N.T. (2003). Weed management - (ICAR), Indian Council of Agricultural Research Publication.
12. Sharma, A.K. (2002). A hand book of Organic Farming. Agrobios Publishers.
13. Singh, B. D. (2006). Plant Breeding Principles and Methods. Kalyani Publishers.
14. Tisdale, S.L., Nelson, W.L., Beaton, J.D. and Havlin, J. L. (2013). Soil fertility and fertilizers. Pearson Publishers.
15. Yawalkar, K. S., Agrawal, J.P. and Bokde, S. (1962). Manures and Fertilizers. Agri-Horticulture Publishing House.

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)
DEPARTMENT OF BOTANY

PAPER TITLE: PLANT GENETIC ENGINEERING
PAPER CODE: BOT- VI.C-8
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES: This course is to develop fundamental knowledge and skills in various aspects of Genetic engineering.

LEARNING OUTCOME: Students will understand basic concepts in Plant Genetic engineering simultaneously getting trained at laboratory skills.

BOT- VI. C-8 PLANT GENETIC ENGINEERING THEORY-75 MARKS

Sr.No	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT – I: Recombinant DNA technology: Tools	**15**
1.1	Enzymes- Exonucleases; Endonucleases; Restriction endonucleases Type I, II&III; ligases, methylases; Reverse Transcriptase, Polymerase.	05
1. 2	Prokaryotic and eukaryotic cloning vectors; General account of plasmids, cosmids, bacteriophages, Phasmids – Advantages and disadvantages; Structure of pBR 322; Artificial chromosome vectors – BAC, YAC, Shuttle vectors.	05
1.3	DNA Ligation – Linkers, adaptors, Homopolymer tailing,Transformation, selection of transformed bacteria – antibiotic selection, reporter genes - GUS,GFP.	05
	UNIT – II: Recombinant DNA technology: Techniques	**10**
2.1	Polymerase chain reaction – Principle, types of primers, Taq polymerase, Protocol, Reverse Transcriptase PCR and Real Time PCR	02
2.2	Prokaryotic expression of foreign genes; Isolation of gene of interest – Construction of cDNA library; Genomic Library	02
2.3	DNA sequencing – Maxam Gilbert’s method, Sanger’s method,	02

	Automated DNA sequencing	
2.4	Molecular Analysis of gene and gene products – Southern, Northern and Western blotting, ELISA, RIA	02
2.5	Molecular markers – RAPD, RFLP, AFLP, Brief account of DNA Finger printing and Bar coding of plants Brief account of: Antisense RNA technology – FLAVR SAVR Tomato; Gene Silencing; RNA interference; mtRNA	02
UNIT – III: Gene transfer methods in plants		**10**
3.1	Vector mediated gene transfer- Agrobacterium mediated gene transfer – T DNA, Ti plasmid and Ri plasmid derived vector systems; hairy-root culture; **Plastid/ Mitochondria transformation.**	05
3.2	Process of transfer - Bacterial colonization, Induction of virulence, generation of TDNA transfer complex, T-DNA transfer, Integration of TDNA into plant genome	03
3.3	Direct methods of gene transfer – Biolistics, Lipofection, Electroporation, microinjection – Advantages and disadvantages	02
UNIT – IV: BIOSAFETY		**05**
4.1	Intellectual Property Rights	02
4.2	Genetic engineering and Public issues	02
4.3	Biosafety regulation	01
UNIT V: Application of Genetic engineering		**05**
5.1	Agricultural: Bt cotton, Golden rice	01
5.2	Environmental: Biodiversity and conservation; Waste management and Bioremediation	02
	Industrial- Large scale production of beverages, Pharmaceuticals, hormones.	01
5.3	Molecular Taxonomy and Food – SCP, Improved food and food products.	01
		45

PAPER TITLE: PLANT GENETIC ENGINEERING
PAPER CODE: BOT- VI.C-8
MARKS: 25
CREDITS: 1

Sr. No	**Topics**	**Practical**
1	DNA isolation by CTAB method	02
2.	Estimation of DNA	02
3.	DNA electrophoresis in Agarose gels	02
4.	Restriction of DNA	02
5	Sequence reading – Sanger method/Maxam Gilbert method – problem	02
6	*Agrobacterium tumefaciens*-mediated plant transformation.	02
7	Small scale plasmid preparation from *E. coli*	02
8	Visit to a leading biotechnology institute and Report making.	01
	Total	**15**

Reference Books:

1. Brown TA (2006) Gene cloning and DNA analysis; Blackwell scientific publishers
2. Sobti RC & Pachauri SS (2009) Essentials of Biotechnology; Ane Books, New Delhi
3. Dubey RC Introduction to Plant Biotechnology; S Chand & Co
4. Purohit SS (2003) Agricultural Biotechnology, Agrobios (India)
5. Chawla HS (2000) Introduction to Plant Biotechnology
6. Dovstekel (2005) Microarray Bioinformatics; Cambridge University press
7. Ignacimuthu S (1997) Plant Biotechnology, New Hampshire Science Publishers
8. Gupta PK (1996) Elements of Biotechnology; Rastogi and Company, Meerut
9. Lewin B (2004) Genes VIII. Oxford University Press
10. Primrose SB, Twyman RM & Old RW (2001). Principles of gene manipulation: An Introduction to genetic engineering. 6th Edn. Blackwell Oxford
11. Smith JE (2005) Biotechnology; Cambridge University press, UK
12. Wilson K & Walker J (2008) Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press
13. Brown TA (2002) Genome, Black well.

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)
DEPARTMENT OF BOTANY

PAPER TITLE: PLANT TISSUE CULTURE
PAPER CODE: BOT-VI-E-13
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES: To develop the plant tissue culture skills.

LEARNING OUTCOME: Students will be able to develop skills and techniques in in plant tissue culture.

BOT-VI-E- 13 PLANT TISSUE CULTURE THEORY-75 MARKS

Sr.No	**UNITS, TOPICS AND SUB-TOPICS**	**Hours**
UNIT – I: Introduction		**05**
1.1	Scope and history of plant tissue culture, Laboratory organization.	02
1.2	Culture techniques –Constituents of Various medias, Sterilization methods of glasswares, Explant preparation, sterilization	03
UNIT – II: Concept of differentiation and culture types		**15**
2.1	Cellular differentiation and totipotency; effect of growth regulators on differentiation	05
2.2	Cell culture types- callus, single cell and suspension culture	05
2.3	Organogenesis and embryogenesis; Somaclonal variation; meristem culture, anther and pollen culture, embryo culture	05
UNIT – III: Techniques in Tissue culture		**15**
3.1	Micropropagation, Germplasm conservation; Isolation and regeneration of protoplasm; Somatic hybridization, Synthetic seeds	05
3.2	Cryopreservation of cells, tissues and cell organelles, secondary metabolite production, Hairy root cultures	05
3.3	The screening of high-yielding cell lines ;Precursor feeding; Biotic	05

	and abiotic elicitors ; Metabolic engineering; Bioreactors	
UNIT –IV: Application of Plant tissue culture		**10**
4.1	Horticulture	04
4.2	Agriculture	04
4.3	Forestry	02
	Total	**45**

PAPER TITLE: PLANT TISSUE CULTURE
PAPER CODE: BOT-VI.E-13
MARKS: 25

CREDITS: 1

Sr. No	Topics	Practical
1	Preparation of MS Medium; Sterilization techniques	03
2	Embryo culture of maize	01
3	Callus induction and its morphological studies	02
4	Subculturing callus for rooting and shooting	02
5	Suspension culture	01
6	Single cell culture- Bergmann's technique	02
7	Enzymatic Isolation of plant protoplast	01
8	Synthetic seed production	01
9	Secondary metabolite in suspension culture	01
10	Visit to Plant tissue culture unit	01
	Total	**15**

Reference Books:

17. Bhojwani, S.S. 1990. Plant Tissue Culture: Applications and Limitations. Elsevier Science Publishers, New York, USA.
18. Kumar, U. (1999). *Methods in Plant Tissue Culture.* Jodhpur: Agrobios (India).

19. Razdan, M. K. (2002). *Introduction to Plant Tissue Culture.* New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd.
20. Satyanarayana U.(2013). Biotechnology. Books and allied (P) Ltd.
21. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers, The Netherlands.

PARVATIBAI CHOWGULE COLLEGE OF ARTS & SCIENCE, MARGAO GOA (AUTONOMOUS)
DEPARTMENT OF BOTANY

SEMESTER -VI
PAPER TITLE: ALGAL BIOTECHNOLOGY (THEORY)
PAPER CODE: BOT-VI.E-14
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

Goa being a coastal state, this course will provide an understanding of alternate resources of food, fuel and environment.

LEARNING OUTCOMES:

This course will enable the students for exploring bio-resources from algae through various algal techniques for sustainable development.

BOT-VI.E-14 ALGAL BIOTECHNOLOGY (Theory) MARKS: 75

Sr. No	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT-I: METHODS OF ALGAL ISOLATION AND CULTURE	**10**
1.1	Method of algal isolation	2
1.2	Types of algal cultures (synchronous, continuous, mass and "in vitro" culture)	3
1.3	Maintenance and growth of algal culture (freshwater and marine algae)	3
1.4	Multiplication of economically important algae (Rhodophyta, Phaeophyta, Chlorophyta, Cyanophyta)	2
	UNIT-II: PHYCOREMEDIATION	**08**
2.1	Phycoremediation	3
2.2	Sewage disposal and waste treatment, textile and effluent sugar industry	3
2.3	Single cell algal protein and phycocolloids	

		2
	UNIT III: ALGAE AND POLLUTION	**11**
3.1	Algae as indicator ofpollution, aquatic pollution by algae: causes and consequences	3
3.2	Eutrophication and its impact on water quality	3
3.3	Algae in environmental health, sewage treatment & treatment in industrial water quality	3
3.4	Algal Blooms and their control	2

	UNIT IV: COMMERCIAL APPLICATIONS OF ALGAL TECHNOLOGY	16
4.1	Application of algae in carbon sequestration	2
4.2	Application of algae as food and fodder	2
4.3	Application of algae in pharmaceutical industries	2
4.4	Algae in biofuels	3
4.5	Algae as Biofertilzers	3
4.6	Algae as secondary metabolites	2
4.7	Applications of algae in entrepreneurship development	2
	TOTAL	**45**

SEMESTER -VI
PAPER TITLE: ALGAL BIOTECHNOLOGY (Practical)
PAPER CODE: BOT-V.E-14
MARKS: 25
CREDIT:1

Sr. No	TOPICS	Practicals
1	Survey of market products of algal material	1
2	Culture of algae (Fresh & marine water, one each)	4
3	Chromatographic separation of algal pigments (β-carotene containing algal species eg. *Synechococcus*)	2
4.	Use of algae as biofertilizer	2
5	Isolation and estimation of algal proteins and lipids	4
6	Visit to NIO and submission of report.	2
	Total	**15**

REFERENCES:

1 Becker S. W. 1994. Micro Algae Biotechnology and Microbiology. Cambridge University Press.
2. Ignacimuthu S. 1996. Basic Biotechnology. Tata McGraw Hill Publishing Limited. New Delhi.
3. Power M., Van der Meer, J., Tchelat, R. 1998. Molecular based methods can contribute to assessments of toxological risks and bioremediation strategies. J. Microbiol. Methods, 32: 107 –119.
4. Tridevi P. C. 2001. Algal Biotechnology. Point Publisher, Jaipur, India.
5. Venkatraman G. S. 1972. Algal Biofertilizers and rice cultivation. Today and Tomorrows Printers and Publishers, New Delhi.
6. Zajic J. E. 1970. Properties and Products of Algae. Plenum Press, New York.
7. Bold H.C.and Wynne ,M.J. 1976 Introduction to Algae structure and reproduction. Prentice -hall.
8. Presott G.W. 1970 How to know freshwater Algae W.C. Braun & Co. 11. Round , F.E. 1966
9. Desikachary T.V. 1972. Taxonomy and Biology of Blue Green Algae. University of Madras

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)
DEPARTMENT OF BOTANY

PAPER TITLE: PLANT DRUG TECHNOLOGY
PAPER CODE: BOT-VI. E-15
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES: To enable students to learn and understand the techniques and skills used in plant drug industry.

LEARNING OUTCOME: Students will be able to understand and use of various techniques used in plant drug industry along with bioassays.

BOT-VI.E-15: PLANT DRUG TECHNOLOGY THEORY-75 MARKS

Sr.No	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT – I: Introduction	**05**
1.1	History, present status, future scope & Development of plant drug technology	05

UNIT – II: Phytochemicals		**07**
2.1 **2.2**	Synthesis; Regulation ; Parameters affecting phytochemicals; Crude drugs, metabolic pathways with secondary metabolite biosynthesis Molecular biology of plant drugs.	**04** **03**
UNIT – III: Extraction and analysis of Phytochemicals		**08**
3.1 **3.2**	Extraction methods and principles. Traditional, analytical and preparative seperations of plant drugs. Analysis of Pigments, Phenolics, Flavonoids and Alkaloids	04 04
UNIT IV: Characterization of plant drugs		**10**
4.1 **4.2**	Methods of characterization: NMR, MS, UV-Vis; GC-Ms, LC-MS Classification of drugs. Major type and chemical nature	05 05
UNIT – V: Bioassays and testing drugs		**15**
5.1 **5.2** **5.3**	Identification of marker compounds in the formulations. Fingerprint identification of plant drugs. Microbial, Invitro cell based; invertebrate based; biochemical screens; Evaluation through structural interactions via NMR and MS methods Toxicology, Efficacy and Biosafety	05 05 05
	Total:	**45**

PAPER TITLE: PLANT DRUG TECHNOLOGY
PAPER CODE: BOT-VI. E- 15
MARKS: 25
CREDITS: 1

Sr. No	**Topics**	**Practical**
1	Plant collection procedures	02
2	Extraction of biologically important compounds	02
3	Isolation and Estimation of total alkaloids	02
4	Test for alkaloids: Mayer'sreagent: Dragendorff's reagent; Wagner's reagent	01
5	Isolation of flavonoids	01

6	Flavonoid separation by TLC	02
7	Alkaloid separation by Paper Chromatography	01
8	Disc diffusion evaluation for antimicrobial assay	02
9	MIC evaluation for antimicrobial assay	02
	Total	**15**

Reference Books:

1. Leleand J. Cseke. 2006. Natural products from Plants. Taylor and Francis. New York.
2. Harborne J.B. 2010. Phytochemical methods. Springer International edition, New Delhi.
3. Daniel Mammen. 1991. Methods in Plant chemistry and economic botany. Kalyani Publishers New Delhi.

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)
DEPARTMENT OF BOTANY

PAPER TITLE: FIELD BOTANY
PAPER CODE: BOT-VI.E-16
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES: To make students understand and appreciate environment that aims to connect prior knowledge of plant studies with identification in the field.

LEARNING OUTCOME: Students will learn to connect classroom learning with environment. Spot-identify plant species using a herbarium collection, literature and online resources.

BOT-VI.E-16 FIELD BOTANY **THEORY: 75 MARKS**

Sr.No	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT – I: Introduction to Field Botany	**05**
1.1	Identification: Fungi, Algae, Bryophytes, Pteridophytes,	03

	Gymnosperms, Angiosperms.	
1.2	Keys for identification	02
UNIT – II: Techniques		**15**
2.1	Plant handling, Collection, preservation (temporary/ permanent/ herbarium, e- herbarium, Chemical), identification (use of keys, e-Keys)	05
2.2	Field Techniques: Survey, Introduction; Methods of test area; Data on habitat; Lower plant habitat mapping; Sampling techniques; Pin-frames,Transects , Forestry techniques., Soil differences among microhabitats.	10
UNIT – III: Field analysis methods		**15**
3.1	Morphology (Vegetative features, Reproductive features); Population Analysis, Tree demography, Spatial dispersion, Species area curves ;	05
3.2	Introduction to digital cameras, Compasses, maps, GPS, Remote sensing (Working and analysing), Satellite	10
UNIT – IV: Field work planning		**10**
4.1 4.2 4.3	General Field Procedures Standard Field Equipment Field Journaling Science Inquiry Planning Getting a Representative Sample Forest Ecology Plant Ecology (Pollination) Lichen Ecology Wetland Ecology	02 04 04
	Total	**45**

PAPER TITLE: FIELD BOTANY
PAPER CODE: BOT-VI.E-16
MARKS: 25
CREDITS: 1

Sr. No	Topics	Practical
1	Lower Plant identification using floras, books and databases (Algae, Bryophytes, Pteridophytes, Gymnosperms)	**03**
2	Angiosperm identifications using floras, books and online resources	**02**

3	Preparation of herbarium	**02**
4	Sample Preservation Techniques (Temporary/ Permanent)	**02**
5	Field analysis methods- Pin frames, Transects	**02**
6	Field Photography	**01**
7	Field observation, reference collection and making report (diagnostic characters and ecological characteristics)	**03**
	Total	**15**

Reference Books:

1. Ambrose, H.W. III and K.P. Ambrose. 2001. A Handbook of Biological Investigation. 5th Ed. Hunter Textbooks Inc. Winston-Salem, NC, U.S.A.
2. Crawley, M.J. 1996. Plant Ecology. 2nd ed. Blackwell Publishing. Malden, MA, U.S.A.
3. Gurevitch, J., S.M. Scheiner, and G.A. Fox. 2002. The Ecology of Plants. Sinauer Associates, Inc. Sunderland, MA, U.S.A.
4. Pollan, M. Botany of Desire. 2002. Random House Trade Paperbacks. NY, NY, U.S.A.
5. Subramanyam NS and Sambamurty AVSS. 2006. Ecology.2nd edition. Narosa Publishing house. New Delhi. India
6. Bendre A.and Kumar A. 2000. A text book of Practical Botany. 8th Edition. Rastogi Publications. Meerut.
7. Dahiya P. and Ahlawat M.2015. Environmental science a new approach. Narosa Publishing House. Delhi.
8. Gurucharan S. Plant systematic theory and Practice .2007.2nd Edition. Oxford and IBH publishing co-op. Pvt. Ltd. New Delhi.

SYLLABUS FOR THREE YEAR B.Sc. DEGREE COURSE IN BOTANY

COURSE STRUCTURE – DEPARTMENT OF BOTANY

Three year B.Sc Degree Course in BOTANY

Semester	Core		Elective			
I	**BOT-I.C-1** Plant diversity	**BOT-I.C-2** Cell Biology & Biomolecules	--------	--------	--------	--------
II	**BOT-II.C-3** Plant Anatomy and Embryology	**BOT-II.C-4** Microbiology	--------	--------	--------	--------
III	**BOT-III.C-5** Physiology of Plants		**BOT-III.E-1** Ecology & Conservation	**BOT-III.E-2** Techniques and Instrumentation in Botany	**BOT-III.E-3** Enzymes and metabolic pathways	**BOT-III.E-4** Herbal Cosmetology
IV	**BOT-IV.C-6** Cytogenetics		**BOT-IV.E-1** Plant Breeding and Biostatistics	**BOT-IV.E-2** Systematics of Flowering plants and Phylogeny	**BOT-IV.E-3** Plant pathology	**BOT-IV.E-4** Horticulture, Floriculture & Landscaping
V	**BOT-V.C-7** Plant Molecular Biology		**BOT-V.E-1** Bioinformatics	**BOT-V.E-2** Seed Technology	**BOT-V.E-3** Plant drug Technology & Pharmacognosy	**BOT-V.E-4** Organic Farming
VI	**BOT-VI.C-8** Plant Biotechnology and Genetic Engineering		**BOT-VI.E-1** Plant tissue culture	**BOT-VI.E-2** Algal Biotechnology	**BOT-VI.E-3** Economic Botany	**BOT-VI.E-4** Applied Mycology

COURSE TITLE: PLANT DRUG TECHNOLOGY AND PHARMACOGNOSY (THEORY)
COURSE CODE: BOT-V. E-3
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

To enable the students to learn and understand fundamental knowledge, the techniques & skills in plant drug industry, drug discovery and development.

LEARNING OUTCOMES:

To understand and use the techniques in plant drug industry along with bioassays and creating human resource in the field of drug development and pharmacognosy.

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT I: INTRODUCTION	**11**
1.1	History, present status, future scope & development of plant drug technology and Pharmacognosy	05
1.2	Classification of drugs: Morphological, Chemical And Pharmacological.	06
	UNIT II: General Introduction, Cultivation and Collection, Description, Histology, Constituents, Substitutes of plants of Pharmacognosic importance under following categories:	**18**
2.1	ROOTS/ RHIZOME: Rauwolfia and Curcuma	03
2.2	LEAVES: Adathoda and Ocimum	04

2.3	SEEDS: Fenugreek and Nutmeg	04
2.4	FRUITS: Coriander and Senna pod	04
2.5	FLOWERS: Clove and Rose	03
	UNIT III: Phytochemicals	**08**
3.1 3.2	Biosynthesis of alkaloids and effect of biological and chemical factors which affects biosynthetic pathway with special reference to Rauwolfia, Tulsi and Curcumin Metabolic pathways of selected plants (synthesis of Tulsi and Rauwolfia)	05 03
	UNIT IV:Extraction and analysis of Phytochemicals	**08**
4.1	Extraction methods and principles. Traditional and modern techniques	04
4.2	Analysis of Pigments, Phenolics, Flavonoids and Alkaloids	04

COURSE TITLE: PLANT DRUG TECHNOLOGY AND PHARMACOGNOSY (PRACTICAL)
COURSE CODE: BOT-V. E-3
MARKS: 25
CREDITS: 1

Sr.No.	**Experiments**	**Practical**
1.	Plant Collection Procedures	**01**
2.	Isolation and estimation of alkaloids and Phenolics	**02**
3.	Microchemical Tests for Tannins	**01**
4.	Alkaloid separation by Paper Chromatography	**01**
5.	Flavonoid separation by TLC	**01**
6.	Anatomical study of *Nux vomica* seeds, Ginger, Citronella leaf, Senna leaf & its medicinal properties	**04**
7.	Powder microscopy of Adathoda seeds	**01**
8.	Histochemical tests for Oils And Fats – Castor seed/ Citrus	**01**
9.	Quantification of Hydroxycitric acid (HCA) from *Garcinia indica*	**01**
10.	Adulteration of crude drugs	**01**
11.	Microchemical test of Arum / *Colocasia* leaves for observation of Calcium oxalate crystals.	**01**
	TOTAL	**15**

<u>REFERENCES:</u>

1. Gokhale S.B and Kokate, C.K. (2009). Pharmacognosy. Nirali Prakashan.

2. Khandelwal, K. R. (2008). Practical Pharmacognosy. Nirali Prakashan.

3. Kokate, C. K. (2008). Pharmacognosy. Nirali Prakashan.

4. Qadry, J.S. (2014). A Textbook of Pharmacognosy Theory And Practicals, CBS Publishers & Distributors.

5. Trease, G.E. & Evans, W.C., (2002). Pharmacognosy. Elsevier Science Publishers.

6. Wallis, T. E. (2005). Textbook of Pharmacognosy. CBS Publishers & Distributors.

7. Leleand J. Cseke.(2006). Natural products from Plants. Taylor and Francis. New York

8. Harborne J. B. (2010). Phytochemical methods. Springer International edition, New Delhi

9. Daniel Mammen. (1991). Methods in plant chemistry and economic botany, Kalyani publishers, New Delhi.

COURSE TITLE: ECONOMIC BOTANY (THEORY) COURSE CODE: BOT-VI.E-3
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:
This course provides knowledge on the value of plants with scientific information and critical thinking to enhance economic botany.

LEARNING OUTCOMES:
Student will be able to identify, describe the impact of economic botany on the society and environment and will help in understanding the biological relationships.

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	Hours
	Unit 1: Origin of Cultivated Plants (Cereals, Legumes, Spices and Beverages)	**20**
1.1	**Centres Origin**: Concept, their importance with reference to Vavilov's work, examples of major plant introductions; Evolution of new crops/ varieties; Crop domestication, Genetic diversity and its loss; Importance of Germplasm	06
1.2	**Origin, Morphology and Uses:** **Cereals:** Wheat, Rice (local varieties) and Millets **Legumes**: Chick pea, Cow pea and Pigeon pea and fodder legumes	08
1.3	**Morphology, Processing and Uses:** **Spices:** Fennel, Saffron, Clove and Black pepper **Beverages:** Tea and Coffee	06
	Unit 2: Sources of sugars, Starch, Oils and Fats	**10**
2.1	**Morphology, processing and Uses:** **Sugars**: Sugarcane, **Starch** (Potato, Dioscorea and Arroroot)	04
2.2	**Classification, General description**, **Extraction and Applications** **Fat and Oils**: Groundnut, Coconut, Soybean and Mustard oil; Essential oils (Citronella, Eucalyptus Menthol, Lavendula); Comparison of essential oils with fatty oils.	06
	Unit 3: Drug Yielding plants and Natural Rubber	**08**
3.1	**Therapeutic and habit-forming drugs**: *Cinchona*, *Digitalis*, *Papaver* and *Cannabis*; Tobacco (Morphology, processing, uses and health hazards)	06
3.2	**Tapping, processing and uses:** *Gutta percha* and *Hevea brasiliensis*	02

	Unit 4: Fruit and Nuts, Fibers and Timber Plants	**07**
4.1	**Classification, General description and Uses of Fruits:** Mango and Cashew.	02
4.2	**Classification, Morphology, Extraction and Uses of Fibers**: Cotton, Coir and Jute.	03
4.3	**General account of Timber Plants:** Teak and Matti.	02
	TOTAL	**45**

COURSE TITLE: ECONOMIC BOTANY (PRACTICAL) COURSE CODE: BOT-VI.E-3
MARKS: 25
CREDITS: 1

Sr. No	Experiments	Practical
1.	**Cereals**: Rice (habit sketch. grain, Microscopic study of starch grain and micro- chemical tests)	01
2.	**Legumes:** Soybean, Groundnut (habit, fruit, seed structure and micro- chemical tests)	01
3.	**Sources of sugars and starch**: *Dioscorea* (habit sketch, and tuber morphology, T.S of tuber to show localization of starch grains, w.m. starch grains and micro- chemical tests).	02
4.	**Spices:** Black pepper, Fennel and Clove (habit and sections) **Beverages :** Tea and Coffee (plant specimen/ tea leaves and coffee beans).	01
5.	**Sources of Fat and Oil**: Coconut- (T.S. nut) and test for oil: Mustard- plant specimen, seeds; tests for fats in crushed seeds.	01
6.	**Essential oil-yielding plants**: Habit sketch of Citronella, Menthol, *Eucalyptus* (specimens/photographs).	01
7.	**Rubber**: specimen, photograph/model of tapping, samples of rubber products.	01
8.	**Drug-yielding plants**: Specimens/ photographs of *Digitalis, Papaver* and *Cannabis* **Tobacco**: specimen and products of Tobacco	02
9	**Woods:** Teak and Matti (Specimen and Section of young stem).	01
10.	**Visit to Spice Farm/ Rubber Plantation**	01
11.	**Fiber-yielding plants**: **Cotton** (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), **Jute** (specimen, T.S.of stem, Test for lignin)	02
12.	**Study of Local Fruits and Nuts (Specimen / Photograph)**	01
	TOTAL	**15**

REFERENCES:

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.

2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, the Netherlands.

3. Chrispeels, M.J. and Sadava, D.E. (1994) Plants, Genes and Agriculture. Jones & Bartlett Publishers.

4. Subrahmanyam N.S. Sammbamurty A.V.S.S.(2008). A textbook of Modern economic Botany. CBS Publishers & Distributors.

COURSE TITLE: APPLIED MYCOLOGY (THEORY)
COURSE CODE: BOT-VI.E-4
MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:
This paper provides knowledge on culture techniques and the applicative aspects of fungi.

LEARNING OUTCOMES:
On completion of the course: The students will have the knowledge of sampling, culturing and maintaining fungal cultures and its applications.

Sr.No.	**UNITS, TOPICS AND SUB-TOPICS**	**Hours**
UNIT I: INTRODUCTION		**05**
1.1	General account of fungi. Microscopic structure, Chemical composition and understanding of fungal cell wall	03
1.2	Environmental factors influencing fungal growth	02
UNIT II: STUDIES OF FUNGAL CULTURE		**11**
2.1	Introduction to culture collections, Culture Media formulations and types used in mycology. Culture databases, culture maintenance	02
2.2	Various techniques for pure culture isolation and maximum recovery from different habitats (Soil, Litter, Water, Dung) Baiting, moist-chamber and particle-plating techniques	05
2.3	Isolation of pure cultures and maintenance of cultures by sub-culturing.	02
2.4	Study of colony characters and growth patterns	01
2.5	Fungal gene banks- Culture Collection Centres.	01
UNIT III: INDUSTRIAL MYCOLOGY		**19**

<table>
<tr><td>3.1</td><td>Role of fungi in biotechnology</td><td>01</td></tr>
<tr><td>3.2</td><td>Applications of fungi in food industry
• Flavour and texture
• Fermentation and baking
• Organic acids (Preferably Citric acid)
• Enzymes (Preferably Cellulases and Pectinases)
Mycoproteins– SCP (Yeast)</td><td>10</td></tr>
<tr><td>3.3</td><td>Medical mycology - Secondary metabolites- Pharmaceutical preparations from fungi, antibiotics from fungi. (Preferably Penicillium and Ganoderma)</td><td>05</td></tr>
<tr><td>3.4</td><td>Endophytic fungi and its industrial applications.</td><td>03</td></tr>
<tr><td colspan="2">UNIT IV: FUNGI IN AGRICULTURE</td><td>03</td></tr>
<tr><td>4.1</td><td>Fungi as biofertilizers (Preferably Trichoderma)
Fungi as biocontrol agents- Mycofungicides, Mycoherbicides, Mycoinsecticides</td><td>02</td></tr>
<tr><td>4.2</td><td>Mycorrhizae and its role</td><td>01</td></tr>
<tr><td colspan="2">UNIT V: MUSHROOM CULTIVATION</td><td>02</td></tr>
<tr><td>5.1</td><td>Mushroom cultivation techniques: Oyster and Button mushrooms.</td><td>02</td></tr>
<tr><td colspan="2">UNIT VI: RECENT ADVANCES IN MYCOTECHNOLOGY</td><td>05</td></tr>
<tr><td>6.1</td><td>Applications of PCR and other molecular techniques in mycology</td><td>02</td></tr>
<tr><td>6.2</td><td>Mycoinformatics</td><td>02</td></tr>
<tr><td>6.3</td><td>Mycoremediation</td><td>01</td></tr>
<tr><td colspan="3" align="right">TOTAL: 45 Hours</td></tr>
</table>

COURSE TITLE: APPLIED MYCOLOGY (PRACTICAL)
COURSE CODE: BOT-VI.E-4
CREDITS: 1

Sr. No.	Experiments	Practical
1.	Isolation of pure culture from a mixed culture plate on solid media	02
2.	Preparation of moist chamber and incubation of fungi	01
3.	Particle dilution plating for fungi	01
4.	Isolation of endophytic fungi from plant leaves	01
5.	Study of effect of incubation temperatures on fungal growth	01
6.	Study of effect of pH on fungal growth	01
7.	Colorimetric estimation of cellulase produced by fungi	01
8.	Colorimetric estimation of amylase produced by fungi	01
9.	Production of Citric acid (using *Aspergillus*) in broth and testing for its presence.	02

MARKS: 25

10.	Mushroom cultivation- Oyster mushrooms	02
11.	Evaluation of presence of proteins in mushrooms	01
12.	Understanding structures of fungal enzymes using Bioinformatics tools.	01
	TOTAL	15

REFERNCES:

1. Aneja, K. R. (2007) Experiments in Microbiology Plant Pathology & Biotechnology. 5th ed., New Age International Publishers.

2. Bhat, D. J. (2010) Fascinating Microfungi (Hyphomycetes) of Western Ghats – India. First edition.,Broadway Book Centre, Goa.

3. Powar, C.B. and Daginawala, H.F.(1982) General Microbiology–Volume II. Himalaya Publishing house: Bombay.

4. Prescott, L. M. (2005) Microbiology. 6th ed., Mc Graw-Hill.

5. Shivkumar, P.K., Joe, M.M. &Sukesh K.(2010) An Introduction to Industrial Microbiology. 1st ed., S.Chand& Company Pvt. Ltd.

6. Trivedi, P.S. and Pandey, S.N. (2009) A Textbook of Botany. Volume I. Vikas Publishing House Pvt Limited, New Delhi.

REVISED

COURSE TITLE: PLANT DIVERSITY (THEORY)
COURSE CODE: BOT-I.C1

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

This paper provides knowledge on morphology, structure and importance of the lower group of organisms. Education and awareness about plant diversity, its role in sustainable livelihoods.

LEARNING OUTCOMES:

On completion of the course: The students will be able to differentiate between various groups of algae, fungi, lichens, bryophytes and pteridophytes. Students will gain knowledge about the economic and ecological importance of the lower group of plants also to effectively conserve the plantbiodiversity.

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT I: ALGAE	09
1.1	Five kingdom classification	1
1.2	Classification of algae (Cyanobacteria, Chlorophyta, Phaeophyta and Rhodophyta) following Lee (1999) upto groups with general characters and examples	2
1.3	Endosymbiotic theory: origin of plastids	1
1.4	Cyanophyceae: Ecology, importance, evolutionary Significance. Distribution,systematic position and life cycle of *Nostoc*and Charophyta: *Chara*	4
1.5	Economic importance of algae: as Medicine, food, phycocolloids& Algal toxins	1
	UNIT II: FUNGI	08
2.1	General characteristics, Classification, economic importance. systematic position, life history of *Puccinia*and *Penicillium*	6

2.2	Plant diseases in wheat and arecanut. General account of plant diseases caused by fungiand their control	2
UNIT III: LICHENS		02
3.1	Structure and reproduction: Ecologicaland economic importance	2
UNIT IV: BRYOPHYTES		09
4.1	General characters, classification and alternation ofgeneration	2
4.2	General study of *Riccia and Funaria.* Structure, reproduction, life history and systematicposition of *Anthoceros*and *Marchantia* Evolution of sporophyte in bryophytes.	7
UNIT V: PTERIDOPHYTES		08
5.1	General characters, classification, alternation of generation.	2
5.2	Structure, reproduction, life history and systematic position of *Lycopodium* and *Marsilea*. Evolution of sporophyte.	6
UNIT VI: GYMNOSPERMS		08
6.1	General characters, classification, alternation of generation.	2
6.2	Systematic position, life history of *Pinus*and *Gnetum*	6
UNIT VII: PALEOBOTANY		01
7.1	Introduction, fossils andfossilization, importance of fossils	1
	TOTAL	**45**

COURSE TITLE: PLANT DIVERSITY (PRACTICAL)
COURSE CODE: BOT-I.C-1
MARKS: 25
CREDITS: 1

Sr. No	Experiments	Practical
1	Morphological study of algal forms: *Anabena, Nostoc,Chara, Sargassum*and *Polysiphonia*	3
2 3	Morphological study of fungal forms: *Puccinia, PenicilliumAlbugo*and *Rhizopus* Morphological study of bryophytes: *Anthoceros*and *Marcantia*	3 1
4	Culture of algal forms: *Nostoc / Spirulina*	2
5	Pure culture of Fungi using PDA medium	1
6	Field visit: study of habitats of lower forms of plants	1
7	Comparative anatomical study in *Pinus*and *Gnetum*	1
8	Study of fossils: (Permanent slide/ specimen)	1
9	Study of locally available forms of Pteridophyte and Gymnosperms	1
10	Study of lichens (Permanent slide/ specimen)	1
	TOTAL	**15**

REFERNCES:

1. Alexopoulos, Constantine J.;Mims, Charles W. (1983). Introductory Mycology; 3rd edition; New Delhi: Wiley EasternLimited.
2. Kar, Ashok Kumar;Gangulee, Hirendra Chandra (2006). College Botany: Volume II; 2nd Edition; Kolkata: New Central Book Agency (P)Ltd.
3. Smith, Gilbert M. (1955).Cryptogamic Botany Algae & Fungi Volume 1;2nd Edition; McGraw-Hill Book Comp. Tokyo.
4. Smith, Gilbert M. (1955). Cryptogamic Botany Bryophyta&Pteridophyta Volume 2; 2nd Edition; McGraw-Hill book Comp.Tokyo.
5. Vasishtha B.R. And Sinha A. K. (2005). Botany for degree students Part 1 Algae; 1st Edition S. Chand & CompanyLtd.

COURSE STRUCTURE – DEPARTMENT OF BOTANY

Three year B.Sc Degree Course in BOTANY 2018-19

Sem.	Core		Elective			
I	**BOT-I.C-1** Plant diversity	**BOT-I.C-2** Cell Biology & Biomolecules	--------	--------	--------	--------
II	**BOT-II.C-3** Plant Anatomy and Embryology	**BOT-II.C-4** Microbiology	--------	--------	--------	--------
III	**BOT-III.C-5** Physiology of Plants		**BOT- E-1** Ecology & Conservation	**BOT-.E-2** Techniques and Instrumentation in Botany	**BOT-E-3** Enzymes and metabolic pathways	**BOT- E-4** Herbal Cosmetology
IV	**BOT-IV.C-6** Cytogenetics		**BOT-E-5** Plant Breeding and Biostatistics	**BOT- E-6** Systematics of Flowering plants and Phylogeny	**BOT- E-7** Plant pathology	**BOT- E-8** Horticulture, Floriculture & Landscaping
V	**BOT-V.C-7** Plant Molecular Biology		**BOT- E-9** Bioinformatics	**BOT-E-10** Seed Technology	**BOT- E-11** Plant Drug Technology and Pharmacognosy	**BOT-E-12** Organic Farming
VI	**BOT-VI.C-8** Plant Biotechnology and Genetic Engineering		**BOT- E-13** Plant tissue culture	**BOT-E-14** Algal Biotechnology	**BOT-E-15** Economic Botany	**BOT-E-16** Applied Mycology

COURSE TITLE: PLANT DIVERSITY (THEORY)

COURSE CODE: BOT-I.C1

MARKS: 75

CREDITS: 3

COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

This paper provides knowledge on morphology, structure and importance of the lower group of organisms. Education and awareness about plant diversity, its role in sustainable livelihoods.

LEARNING OUTCOMES:

On completion of the course: The students will be able to differentiate between various groups of algae, fungi, lichens, bryophytes and pteridophytes. Students will gain knowledge about the economic and ecological importance of the lower group of plants also to effectively conserve the plantbiodiversity.

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT I: ALGAE AND LICHENS	11
1.1	Five kingdom classification	1
1.2	Classification of algae (Cyanobacteria, Chlorophyta, Phaeophyta and Rhodophyta) following Lee (1999) upto groups with general characters and examples	2
1.3	Endosymbiotic theory: origin of plastids	1
1.4	Cyanophyceae: Ecology, importance. Distribution,systematic position and life cycle of *Nostoc* and Charophyta: *Chara*	4
1.5	Economic importance of algae	1
1.6	Structure and reproduction: Ecological and economic importance of lichens	2
	UNIT II: FUNGI	08
2.1	General characteristics, Classification, economic importance. systematic position, life history of *Puccinia* and *Penicillium*	8
	UNIT III: BRYOPHYTES	09
3.1	General characters, brief classification and alternation of generation	2
3.2	Study of morphological and anatomical studies and reproductive character of *Riccia, Marchantia , Anthoceros*	7

	and Funaria.	
UNIT IV: PTERIDOPHYTES		08
4.1	General characters, brief classification, alternation of generation.	2
4.2	Structure, reproduction, life history and systematic position of *Psilotum*, *Lycopodium* and *Marsilea*.	6
UNIT V: GYMNOSPERMS AND PALEOBOTANY		09
5.1	General characters, brief classification, alternation of generation of Gymnosperms	2
5.2	Systematic position, life history of *Pinus* and *Gnetum*	6
5.3	Fossils and fossilization, importance of fossils (with a mention of Birbal Sahni institute)	1
	TOTAL	**45**

COURSE TITLE: PLANT DIVERSITY (PRACTICAL)
COURSE CODE: BOT-I.C-1
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

Sr. No	Topics	Practical Sessions
1.	Morphological study of algal and Blue green algal forms: *Oscillatoria/Nostoc,Chara,Sargassum, Polysiphonia*	03
2.	Morphological study of fungal forms: *Puccinia, Penicillium, Albugo* and *Rhizopus*	03
3.	Study of lichens (Permanent slide/ specimen)	01
4.	Study of fossils: (Permanent slide/ specimen)	01
5.	Morphological and anatomical study of: i. Bryophyte (preferably *Riccia* or *Anthoceros*) ii. Pteridophyte (preferably *Selaginella*) iii. Gymnosperm (preferably *Cycas*)	05
6.	Mini project: Collection and field study of locally available Algae, Bryophytes, Pteridophyte, Gymnosperms and Lichens	02
	Total	15

REFERENCES:

1. Alexopoulos, Constantine J.;Mims, Charles W. (1983). Introductory Mycology; 3rd edition; New Delhi: Wiley EasternLimited.

2. Kar, Ashok Kumar;Gangulee, Hirendra Chandra (2006). College Botany: Volume II; 2nd Edition; Kolkata: New Central Book Agency (P)Ltd.

3. Smith, Gilbert M. (1955).Cryptogamic Botany Algae & Fungi Volume 1;2nd Edition; McGraw-Hill Book Comp. Tokyo.

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5. Vasishtha B.R. And Sinha A. K. (2005). Botany for degree students Part 1 Algae; 1st Edition S. Chand & CompanyLtd.

6. Parihar N.S., (2013); An introduction to Embryophyta: Bryophyta.Vol I, fifth

edition, Surjeet Publications.

7. Parihar N.S., (2012); An introduction to Embryophyta: Pteridophytes.Vol II, fifth edition, Surjeet Publications.

8. Fritsch, F.E.,(1956). The structure and reproduction of the Algae; Volume I and II. Cambridge University Press.

COURSE TITLE: CELL BIOLOGY AND BIOMOLECULES (THEORY)
COURSE CODE: BOT-I.C-2
MARKS: 75 MARKS
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

This course will provide a detailed discussion on a wide range of topics in Cell biology & Bio-molecules emphasizing experimental approaches and key experiments that have provided important insights. The course is aimed at conveying an understanding of how cellular structure and function arise as a result of the properties of cellular macromolecules. Emphasis will be on the dynamic nature of cellular organization, structure and function.

LEARNING OUTCOME:

Students will understand the structures and purpose of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, organelles and importance of cells as basic units of living organisms & the role of cell membrane in movement of substances into and out of cells. It will also help to understand the chemical structure of water, carbohydrates, lipids and proteins and their role in living organisms.

Sr. No	Units, Topics and Sub- Topics	Hours
	Unit-I: Overview of cells	**04**
1.1	Discovery of cells, Basic properties of cells	1
1.2	Prokaryotic and Eukaryotic cell; Cell theory	2
1.3	Cell evolution and biogenesis	1
	Unit-II: Cytoskeleton and its role in motility	**03**
2.1	Structure and functions of cytoskeleton; Structure and function of Microtubule, Intermediate filaments, Microfilaments	03
	Unit-III: The Ultra-structure and Function of Cell wall and Plasma membrane	**11**
3.1	Structure and function of cell wall; Chemical composition of cell wall; Extracellular matrix and cell interactions; Gap -Junctions & plasmodesmata	4
3.2	Structure and function of plasma membrane; Active and Passive transport of solute (channels & pumps); Cell signaling- molecules and receptors, signaling network	7
	Unit-IV: The Cell Organelle studies	**14**

4.1	Structural organization and functions; Semiautonomy and gene control; Structure & functions of peroxisome, glyoxysome & lysosomes	5
4.2	Nucleus and its Organization; Nuclear envelope, nuclear pore complex Nuclear matrix, Chromosomes and chromatin structure	5
4.3	Structure and function of ribosome ; Endomembrane systems- Endoplasmic reticulum and Golgi complex	4
UNIT- V: BIOCHEMISTRY OF CARBOHYDRATES AND LIPIDS		**08**
5.1	Definition & importance of biomolecules; types of bonds in bio-molecules; pH and buffers ; Water as a biological solvent	4
5.2	Classification and biological functions of carbohydrates and lipids	4
UNIT VI: AMINO ACIDS AND PROTEINS		**05**
6.1	Classification and biological functions of amino acids and proteins	05
	Total	**45**

COURSE TITLE: CELL BIOLOGY & BIOMOLECULES (PRACTICAL)
COURSE CODE: BOT-I.C-2
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

Sr.No	TOPICS	PRACTICAL SESSIONS
1.	Study of cell structure in *Hydrilla* and *Tradescantia* staminal hairs	1
2.	Examination of prokaryotic cell, eukaryotic cell and cell organelles by EM graphs	1
3.	Preparation of temporary slides to observe different types of cells	2
4.	Staining and Preparation of slides	6
	I. Cytochemical staining of Nucleus- Acetocarmine II. Cytochemical staining of polysaccharides- Periodic Acid Schiff's (PAS) III. Cytochemical staining of Mitochondria – Jannis Green IV. Cytochemical staining of Total proteins –Bromophenol blue V. Cytochemical staining of Histones – Fast Green	
5.	Determination of pH using pH meter	1
6.	Quantitative determination of carbohydrates (Anthrone reagent)	1
7.	Estimation of oil in fatty seeds	2
8.	Estimation of proteins	1
	Total	**15**

REFERENCES:

1. David L. Nelson. & Michael M. Cox. (2013). Lehninger Principles of Biochemistry, 4th ed. W.H. Freeman & Co,New York.
2. Donald Voet., Judith G. Voet and Charlotte W. Pratt. (2002). Fundamentals of Biochemistry**,** 2nd edition, John Wiley and Sons (Asia) Pvt Ltd.
3. Gupta, P.K. (1999). A Text-book of Cell and Molecular Biology. Rastogi Publications, Meerut, India.
4. H.Robert Horton. (2006).Principals of biochemistry.4th ed. Pearson Prentice Hall.
5. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer.(2002). Biochemistry 5th edition, W.H.Freeman & Company, New York
6. Karp, G. (1999). Cell and molecular Biology, Concepts and experiments (John Wiley and Sons Inc) 2nd edition. USA.
7. Paul Flinch (1999). Carbohydrates structure, Synthesis & Dynamics. Kluwer Academic Pub.The Netherlands.
8. U. Satyanarayana and U. Chakrapani. (2000).Biochemistry, 4th edition., Elsvier Pub. Kolkata.
9. Verma P.S. and Agarwal V. K. (1998).Cell Biology, Genetics, Molecular Biology, Evolution and ecology. Edn.14

COURSE TITLE: PHYSIOLOGY OF PLANTS (THEORY)
COURSE CODE: BOT.III.C-5
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

Objective of this introductory course is to provide understanding of how plants function. The course explain principle of plant functions covering physiological processes in plants, such as biochemical metabolism, secondary products, water & solute (organic & inorganic) uptake and growth & development.

LEARNING OUTCOMES: Upon completing this course, students will be familiar with contemporary concepts in Plant Physiology and the physiological mechanisms controlling plant growth and development. Students will have an understanding of movement of water and solutes in plant, know the importance of the photosynthesis as related to harvesting solar energy and plant productivity, hormone and its relation with plant growth and development.

Sr. No	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT-I: PLANT WATER RELATIONS	**09**
1.1	Water and its significance to plants	3
1.2	Osmotic & water potential of cell	3
1.3	Transpiration, stomatal regulation & anti-transpirants	3
	UNIT-II: SOLUTE TRANSPORT	**08**
2.1	Uptake, transport and translocation of water	3
2.2	Essentiality of mineral nutrition and its uptake (active, passive and its role on membranes)	2
2.3	Transport of organic solutes (source sink relationship)	3
	UNIT III: PHOTOSYNTHESIS	**12**
3.1	Chloroplast and Light harvesting complexes	3
3.2	Z scheme of photosynthesis & Mechanisms of electron transport	3
3.3	CO_2 fixation (C3, C4 and CAM pathways)	3
3.4	Photoprotective mechanisms (photorespiration); Environmental change and its impact on photosynthesis	3
	UNIT IV: PLANT GROWTH AND DEVELOPMENT	**09**
4.1	Role of phytochromes & cryptochromes and its functions	2
4.2	Plant hormones, transport and physiological functions	3
4.3	Photoperiodism and & vernalization	2
4.4	Senescence, seed dormancy & germination	2
	UNIT V: SECONDARY METABOLITES AND STRESS PHYSIOLOGY	**07**

5.1 5.2	Responses of plants to abiotic (water, temperature and salt) stresses Biosynthetic pathway of terpenes, phenols and alkaloids and their functions.	4 3
	TOTAL	**45**

COURSE TITLE: PHYSIOLOGY OF PLANTS (PRACTICALS)
COURSE CODE: BOT.III.C-5
MARKS: 25
CREDITS: 1
PRACTICAL SESSION: 15

Sr. No	TOPICS	PRACTICAL SESSIONS
1	Determination of osmotic potential of plant cell sap by plasmolytic method.	2
2	Determine water potential of given tissue by falling drop method	2
3.	Chromatographic separation of plant pigments and plant sugars	4
4	Quantitation of total free amino acids	2
5	**Mini Project**: 1. Mineral deficiency symptoms in plants 2. Secondary metabolites in plants. 3. Oxygen consumption during respiration 4. Role of Plant hormones in plant growth 5. Light intensity and starch production	5
		15

REFERENCES:

1. William G. Hopkins (1999). Introduction to Plant Physiology, 2nd edition, John Wiley A Sons, Inc.
2. Taiz, L. and Zeiger, E. (2006). Plant Physiology, 4th edition, Sinauer Associates Inc .MA, USA.
3. Frank B. Salisbury and Cleon W. Ross (2002). Plant Physiology 3rd edition. CBS publishers and distributers.
4. G. Ray Noggle and George J.Fritz (2010) Introductory Plant Physiology Prentice Hall.
5. Goodwin Y.W., and Mercer E.I. (2003) Introduction to Plant Biochemistry. 2nd edition CBS Publishers and distributors.
6. Galstone A.W. (1989). Life processes in Plants. Scientific American Library, Springer Verlag, New York,
7. Moore T.C. (1989). Biochemistry and Physiology of Plant Hormones Springer –Verlag, New York,USA.
8. Singhal G.S.,Renger G., Sopory, S.K. Irrgang K.D and Govindjee (1999).Concept in Photobiology; Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi
9. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
10. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.
11. David I. Nelson and Michael M. Cox (2000). Lehninger. Principles of biochemistry, 3rd edition, Macmillan U.K.
12. David T Plummer (1985).An introduction to Practical Biochemistry 2nd edition. Tata Mcgraw Hill Publishing company Ltd.

13. D. Bajracharya (1999). Experiments in Plant Physiology. Narosa Publishing House new Delhi.

CURRENT LITERATURE (JOURNAL ARTICLES):

Plant Physiology, The Plant Cell, Journal of Plant Physiology, Physiologia Plantarum, Plant Physiology and Biochemistry, Postharvest Biology and Technology, Journal of the American Society for Horticultural Science, Science, Nature, Scientific American.

COURSE TITLE: ECOLOGY & CONSERVATION (THEORY)
COURSE CODE: BOT E-1
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

Objective of this paper is to provide introductory knowledge on biotic and abiotic environmental factors, pollution and phytogeography with regards to Govt regulations towards environmental management with respect to agriculture and food security.

LEARNING OUTCOMES:

The Students will be able to understand the role and importance of biotic and abiotic environment factors in the sustenance of plant life and causes, consequences, prevention, remediation of pollution and efforts taken in reducing or controlling the pollution causing factor. The course will impart importance of phytogeography and forestry to teach managing regional flora.

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	HOURS
UNIT I: CONCEPT OF ECOSYSTEM		**05**
1.1	Concept of Ecosystem: Components and their interactions, food chains and food web; Ecological pyramids; Ecological adaptations of plants belonging to following ecological groups: Hydrophytes, Xerophytes and Halophytes	**5**

UNIT II: ECOLOGICAL FACTORS (Biotic & Abiotic)		**16**
2.1	Light - quality, duration, absorption, intensity & effects on plants	**03**
2.2	Temperature-variation due to altitude effects on plants, thermal constant and stratification	**03**
2.3	Water- precipitation, moisture & measurement of rainfall	**03**
2.4	Wind - speed, advantages and damage caused to plants	**03**
2.5	Soil- soil profile, texture, classification and organic matter	**03**
2.6	Biotic-community relationships	**01**
UNIT III: POLLUTION , CAUSES AND CONSEQUENCES		**11**
3.1	Air pollution- polluting gases; ozone depletion, greenhouse effect, global warming, acid rain and smog	**03**
3.2	Water pollution-eutrophication, sewage, industrial waste, heavy metals	**04**
3.3	Soil pollution – chemical pollutants	**03**
3.4	Bioremediation	**01**
UNIT IV: PHYTOGEOGRAPHY AND FORESTRY		**13**
4.1	Phytogeography- plant distribution, theories on plant distribution	**03**
4.2	Endemism, major biomes of the world, minor biomes, and phytogeographical regions of India	**02**
4.3	Forestry- destruction of forest, deforestation, afforestation, reforestation, forest research, education and training institutes, biosphere reserves	**03**
4.4	Forest conservation act, Indian forest act, biodiversity act, western Ghat protection act, Kasthurirangan Act, Gadgil committee report, Mining committee reports, wild life act (**recent acts to be studied**)	**05**
	TOTAL	**45**

COURSE TITLE: ECOLOGY & CONSERVATION (PRACTICAL)
COURSE CODE: BOT.E-1
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

Sr. No	Topics	Practical sessions
1.	Study of ecological instruments i.e. lux meter, rain guage, hygrometer, wet and dry bulb thermometer, maximum and minimum thermometer	02
2.	To study the physical and chemical characters (moisture, texture and pH) of different types of soils.	02
3.	Analysis of different water samples for oxygen and carbon-dioxide content	03
4.	Estimation of total carbonates from soil sample	01
5.	Visual interpretation of remotely sensed image for vegetation types	01
6.	Study of community relationships- Mutualism (mycorrhizae)	01
7.	Mini project: To determine minimum area of sampling unit (quadrat) for the study of local community and to determine species diversity index (Simpson's & Shannon-Weiner) of herbaceous vegetation	05
	Total	**15**

REFERENCES:

1. Ambasht, R.S. A Text Book of Plant Ecology. Students Friends Co., Varanasi. 1988
2. Ecology and environment; P. D. Sharma, Rastogi publications, Meerut. 7th ed – 2004.
3. Ecology- N.S. Subrahmanyam and A.V.S.S. Sambamurty, Narosa Publishing House, 2000.

4. Environmental Biotechnology. Jogdand, SN 1995. Himalaya Publishing House, Mumbai.
5. Environmental chemistry by B. K. Sharma, Goel publication house, Meerut, Sixth revised edition – 2001.
6. Environmental Chemistry, A. K. Day, Fourth Edition, New Age International Publishers-2002
7. Environmental Science; by-Santra SC; Central Publ. New Delhi.
8. Fundamental of Ecology: EP Odum; WB Saunders Company. 1971
9. Moore, P.W.and Chapman, S.B. 1986. Methods in Plant Ecology. Blackwell Scientific Publications.
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11. Sharma, P.D. Ecology and Environment; 7th edition; Meerut :Rastogi Publishers , 1998.
12. Subrahmanyam, N.S.;Sambamurty, A.V.S.S.; Ecology; 1st edition; New Delhi : Narosa Publishing House , 2000.

COURSE TITLE: TECHNIQUES & INSTRUMENTATION IN BOTANY
COURSE CODE: BOT.E-2
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

Objective of the course is to impart knowledge of principle, methodology and application of various techniques & instrumentation.

LEARNING OUTCOMES:

Students will learn the principle, working and applications of various instruments essential to study different facets of Botany.

Sr.No	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT I: MICROSCOPY	**11**
1.1	Light microscopy (compound microscopy and Phase contrast microscopy)	**3**
1.2	Fluorescence microscopy	**2**
1.3	Transmission and Scanning electron microscopy (sample preparation for electron microscopy, cryofixation,)	**4**
1.4	Microscopic measurements and photography (Micrometry & cytometry)	2
	UNIT-II : CENTRIFUGATION AND RADIOISOTOPY: PRINCIPLE, METHODOLOGY AND APPLICATIONS	**09**
2.1	Centrifugation: Low speed, high speed, cooling centrifuges and ultracentrifugation Analytical, preparatory and gradient centrifugation	04
2.2	Various types of rotor heads and their maintenance	01
2.3	Radioactivity and its measurements (Geiger Muller and Scintillation	04

	counter and autoradiography)	

UNIT – III: SPECTROPHOTOMETRY: PRINCIPLE, METHODOLOGY AND APPLICATIONS		**08**
3.1	UV visual spectrophotometry	02
3.2	Fluorescence spectrophotometry	02
3.3	Flame (Atomic absorption) spectrophotometry	02
3.4	Mass spectrophotometry	02
UNIT –IV: CHROMATOGRAPHY: PRINCIPLE, METHODOLOGY AND APPLICATIONS		**09**
4.1	Adsorption and partition chromatography	03
4.2	Column chromatography (isocratic and gradient)	03
4.3	HPLC & GC	03
UNIT- V: ELECTROPHORESIS & MOLECULAR TECHNIQUES: PRINCIPLE, METHODOLOGY AND APPLICATIONS		**08**
5.1	Electrophoresis: AGE,SDS- PAGE , IEF and 2D Electrophoresis	05
5.2	PCR, Real Time PCR	03
	TOTAL	**45**

COURSE TITLE: TECHNIQUES & INSTRUMENTATION IN BOTANY (PRACTICAL)
COURSE CODE: BOT.E-2
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

SR.NO	TOPICS	PRACTICAL SESSIONS
1	Use of pH meter to set pH of a given solution	1
2	Determination of Lambda (λ) max of a given solution Verification of Beer's Law	2
3	Micrometric dimensions (cytometry and micrometry)	2
4	Demonstration of SDS- PAGE/ Agarose gel Electrophoresis	2
5	Preparation of TLC and Separation of biomolecule	2
6	Centrifugation	1
7.	Visit to Instrumentation Lab (NIO,/College/ GoaUniversity)	1
8	Microscopy and photography	2
9	Flame photometry	2
	Total	**15**

REFERENCES:

1. Karp, G. (1999). Cell and molecular Biology, Concepts and experiments (John Wiley and Sons Inc) 2nd edition. USA.

2. Bajpai P. K. (2006). Biological instrumentation and methodology (S. Chand and Company. Ltd. Mumbai.
3. Plummer D.T. (2009). An Introduction to Practical Biochemistry. 3rd edition. Tata Mc Graw Hill Education Private ltd. New Delhi.

COURSE TITLE: ENZYMES AND METABOLIC PATHWAYS (THEORY)
COURSE CODE: BOT. E-3
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:
The objective of this course is to understand the importance and mechanisms of enzyme action. The course also discusses about enzymatic regulation & metabolic control of biochemical reactions.

LEARNING OUTCOMES:
On completion of this course students will be able to relate the relationship between structure and function of enzymes, importance of enzymes in regulation of metabolic processes.

Sr.No	UNITS, TOPICS AND SUB-TOPICS	Hours
UNIT I: NOMENCLATURE, CLASSIFICATION AND HARACTERISTICS OF ENZYMES ,		**11**
1.1	Classifications & nomenclature (IUB system); Biological role of enzymes; Concept of holoenzyme & apoenzymes, prosthetic group, iso-enzymes and allosteric enzymes.	5
1.2	Chemical nature of enzymes; Characteristics (Physico-chemical and biological properties); specificity of enzyme action (thermolability, reversibility and pH sensitivity)	6
UNIT II: MECHANISM OF ENZYME ACTION		**10**
2.1	Applications of Michalis Menten equation; Active sites, Fisher's lock and key module and Koschland (induced fit theory);	5
2.2	Enzyme action (competitive, noncompetitive and reversible)	5
UNIT III: METABOLIC CONCEPTS		**14**
3.1	Catabolic and anabolic pathway of Carbohydrate, Lipids and Proteins.	7
3.2	Respiratory substrate , Glycolysis (aerobic & anaerobic) Citric acid cycle and Mitochondrial electron transport (alternate oxidase pathway)	7
UNIT IV: AMINO ACID METABOLISM		**10**
4.1	Nitrogen cycle	3
4.2	Biological Nitrogen Fixation Pathway of amino acid catabolism	5
4.3	Nitrogenase enzyme complex , NIF and Nod genes.	2
	TOTAL	**45**

COURSE TITLE: ENZYMES AND METABOLIC PATHWAYS (practicals)
COURSE CODE: BOT. E-3
MARKS: 25 MARKS
CREDITS: 1
COURSE DURATION: 15 SESSIONS

Sr. No	TOPICS	PRACTICAL SESSIONS
1	Qualitative determination for amylase enzyme in the given plant samples.	3
2	Effect of enzyme concentration, temperature, substrate, inhibitors and pH on the activity of α-amylases	5
3	To demonstrate anaerobic respiration in germinating seeds	2
4	To extract and study the activity of catalase , lipase and peroxidase enzymes Mini project on role of Nitrogen in plants	5
	TOTAL	**15**

REFERENCES:

1. Bennett, T. P., and Frieden, (1969) E.: Modern Topics in Biochemistry, pg. 43-45, Macmillan, London
2. Breaker, Ronald R. "Making Catalytic DNAs." *Science* 290 (2000): 2095–2096.
3. Campbell, Neil A., Jane B. Reece, and Lawrence G. Mitchell (1999) *Biology,* 5th ed. Menlo Park, CA: Benjamin/Cummings.
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5. Harrow, B., and Mazur, A.(1958): Textbook of Biochemistry, 109, Saunders, Philadelphia.
6. Holum, J (1968): Elements of General and Biological Chemistry, 2nd ed., 377, Wiley, NY.
7. Koshland, Daniel E.,(1973). Jr. "Protein Shape and Biological Control." *Scientific American* 229: 52–64.
8. Madigan, Michael R., and Barry L. Marrs. (1997) "Extremophiles." *Scientific American* 276: 82–87.
9. Martinek, R.: Practical Clinical Enzymology(1969). *J. Am. Med. Tech., 31,* 162.
10. Pfeiffer, J. (1954). Enzymes, the Physics and Chemistry of Life, pg 171-173, Simon and Schuster, NY.
11. Price C. Nicholas, Stevens Lewis: Fundamentals of Enzymology (1999) Oxford University Press.

COURSE TITLE: HERBAL COSMETOLOGY (THEORY)
COURSE CODE: BOT.E-4
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

Objective of this course is to impart knowledge about the different plants that play a very important role in enriching inner health and skin quality.

LEARNING OUTCOMES:

The student by the end of this course will gain knowledge of most of the herbs that are useful in the cosmetic industry.

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	HOURS
	UNIT I - INTRODUCTION TO HERBAL COSMETICS	**09**
1.1	Definition, Collection and processing of herbal material, Natural and artificial drying of herbal material	02
1.2	Herbal remedies for holistic health (including weight gain and weight loss)	04
1.3	Current status and future prospects of Herbal Cosmetic Industry	03
	UNIT II- IDENTIFICATION (BOTANICAL NAME AND FAMILY), UTILIZATION OF FOLLOWING PLANTS WITH COSMETIC BENEFITS & THEIR COSMETIC USES	**20**
2.1	*Curcuma longa, Aloe vera, Azadirachta indica, Ocimum sp., Cymbopogon flexuosus, Murraya koenigii, Citrus limon, Rosa sp., Rubia cordifolia*	13
2.2	Commonly used herbs in the following herbal cosmetics -Herbal Shampoo , Herbal Conditioner, Herbal Hair Dye/ Herbal Hair Oil/Hair Cream/Hair Gel, Herbal Face Mask, Herbal Bath Oil and aroma therapy.	07

UNIT III - STANDARDIZATION OF RAW MATERIAL		06
3.1	Importance of standardization, Physical and chemical methods of standardization Quantitative and qualitative estimation of phytoconstituents	06
UNIT IV- PROTOCOLS FOR PREPARATION		**06**
4.1	Different types of Herbal face masks- for dry skin, oily skin, pigmented skin & wrinkled skin, Special Herbal masks for sensitive skin, Herbal Shampoo	06
UNIT V -HERBAL EDIBLE CHURNAS BENEFICIAL FOR SKIN TO HAIR		**04**
	TOTAL	**45**

COURSE TITLE: HERBAL COSMETOLOGY (PRACTICAL)
COURSE CODE: BOT. E-4
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

Sr. No	TOPICS	PRACTICAL SESSIONS
1	Herbal face masks for dry skin, oily skin, pigmented skin, wrinkled skin	02
2	Study of plants valued in the cosmetic industry- skin and hair	02
3	Preparation of Herbal Shampoo	02
4	Visit to Ayurvedic institute and a local clinic.	02
5	Demonstration of Churna preparation	01
6	Extraction of plant pigments- *Lawsonia inermis* (mehndi) and *Curcuma longa* (turmeric),	01

7	Mini projects: 1. Local Survey to know about awareness about home remedies for cosmetic purposes 2. Study of various skin and hair care herbal products available in the market 3. Comparision of Herbal products to non-herbal products 4. Study of herbal products for weight loss and weight gain 5. Study of locally available herbal Churnas.	05
	TOTAL	**15**

REFERENCES:

1. Fuller, K.W. and Gallon, J.A. Plant Products and New Technology. Clarendon Press, Oxford, New York. 1985
2. Kocchar, S.L. Economic Botany in Tropics, 'i.'d edition. Macmillan India Ltd., New Delhi. 1998.
3. Simpson, B.B. and Conner-Ogorzaly, M. Economic Botany- Plants in Our World. McGraw Hill, New York. 1986.
4. Sachs, M. Ayurvedic Beauty Care: Ageless Techniques to Invoke Natural Beauty. ISBN: 9788120818804. 2014
5. Sharma, O.P. Hill's Economic Botany. Tata McGraw Hill Publishing Company Ltd., New Delhi. 1996.

COURSE TITLE: PLANT MOLECULAR BIOLOGY (THEORY)
COURSE: BOT-V.C-7
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:
To introduce the students with fundamental knowledge of molecular system in cells.

LEARNING OUTCOMES:
The students will be able to understand general principles of gene organization and functions.

Sr. No	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT-I: NATURE OF GENETIC MATERIAL	**08**
1.1	Characteristics of genetic material, physical and biological evidences to prove DNA & RNA as genetic material, Watson and Crick's model of DNA, polymorphism of DNA; comparison between DNA and RNA.	5
1.2	Central Dogma of molecular biology, Model organism for studying molecular biology; C-value paradox	2
1.3	Chargoff's Law, Franklin's and Wilkin's work	1
	UNIT II: REPLICATION OF DNA	**12**
2.1	General feature of DNA replication (replication eye, replication forks);	3
	Types of DNA replication, mechanism of DNA replication in;	
	Prokaryotes (Transduction, transformation and conjugation), & in Eukaryotes (Dispersive, Conservative and Semi- conservative)	3
2.2	Enzymes of replication –DNA Primase; DNA polymerases I, II, III,	3
2.3	Types of DNA damages and repair (direct reversal of damage, excision repair)	3
	UNIT III: TRANSCRIPTION	**09**

3.1 3.2 3.3	Structure and functions of mRNA, tRNA and rRNA Transcription of mRNA in Prokaryotes & eukaryotes Post transcriptional event; eukaryotes splicing, processing	2 4 3
UNIT IV: GENE REGULATION & EXPRESSION		**10**
4.1 4.2	Units of Gene (Cistron, recon, muton, Enhancers, Split genes, overlapping genes; transposons and its role in gene structure, promoters & terminators. Gene regulation in prokaryotes (Lac operon concept) and eukaryotes Inducible and repressible mechanism.	5 5
UNIT V: TRANSLATION-PROTEIN SYNTHESIS		**06**
5.1 5.2 5.3	Secondary structure of mRNA and its functions; Genetic code. Mechanism & factors Translation; RNA polymerases; and factors Post translational modifications; Protein targeting	2 2 2
	Total	**45**

COURSE TITLE: PLANT MOLECULAR BIOLOGY (PRACTICALS)
COURSE CODE: BOT-V. C-7
MARKS 25
CREDIT 1
PRACTICAL SESSIONS: 15

SR. NO	TOPICS	PRACTICAL SESSIONS
1	Isolation of plant genomic-DNA	3
2	Spooling of DNA from different plant samples	3
3	Quantification of DNA by DPA method.	2
4	Isolation and estimation of RNA from plant tissue	3
5 6	Preparation of Agarose gel and running of DNA (demonstration) Demonstration of DNA amplification by PCR	2 2
	Total	**15**

REFERENCES:

1. Alberts, B., Bray, D Lewis, J., Raff, M., Roberts, K and Walter (1999). Molecular Biology of the Cell. Garland Publishing, Inc., New York

2. David Freifelder (1983) Jones & Bartlett publishers. 2ed Molecular biology. Reprint

1993. Narosa Publishing House.

3. J.K.Pal and S.S.Ghaskadabi (2008) Fundamentals of Molecular Biology. Oxford.

4. James D. Watson (2007). Molecular Biology of the Gene (6th Edition) by, Tania A. Baker, Stephen P. Bell, and Alexander Gann.

5. Kleinsmith L.J and Kish V.M (1995). Principles of Cell and Molecular Biology (Second Edition). Happer Collins College Publishers, New York,

6. Lehninger (2008). Principles of Biochemistry by David L. Nelson and Michael M.

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8. R.L. Adams, J.T. Knowler, and D.P. Leader (1992). The Biochemistry of the Nucleic Acids.

9. Lewin B. (2000). Genes VII. Oxford University Press, New York.

10. Buchanan B.B, Gruissm W. and Jones R.L (2000). Biochemistry and Molecular biology.

COURSE TITLE: BIOINFORMATICS (THEORY)
COURSE CODE: BOT. E-9
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES: The course will help the students to understand the fundamentals of bioinformatics and tools available.

LEARNING OUTCOMES:

It will enable the students to gain knowledge in vast data handling and analysis, and to develop skills.

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	HOURS
UNIT I: INTRODUCTION TO BIOINFORMATICS		**08**
1.1	Introduction to bio-informatics, The biological sequence / structure deficit	02
1.2	Genome projects, Pattern recognition and prediction, Levels of protein structure	03
1.3	Role of Chaperons, Sequence analysis	01
1.4	Fields Related to Bioinformatics: Computational Biology, Genomics, Proteomics, Pharmacogenomics, Cheminformatics, Medical Informatics Importance of Bioinformatics	02
UNIT II: INFORMATION NETWORKS		**07**
2.1	Internet and the facilities available on it, computational biology, What is World Wide Web, Web browsers and Web Addresses	03
2.2	HTTP, HTML, CORBA and URLs	01

2.3	The National Centre for Biotechnology Information- NCBI The European Molecular Biology Network- EMBnet	02
2.4	Bioinformatics programme in India- BTISNet, BPI-2004	01
UNIT III : INTRODUCTION TO BIOLOGICAL DATABASE		**04**
3.1	Introduction To Biological Database : GenBank, EMBL, SwissProt, PROSITE, EC-ENZYME, PDB, GDB, PIR-PSD,	04
UNIT IV : PROTEIN AND GENOME INFORMATION RESOURCES		**15**
4.1	Introduction to Protein information resources, Primary Sequence Databases, Composite protein sequence databases, Secondary databases, Composite protein pattern databases; Structure classification databases.	07
4.2	Introduction to genome information resources, DNA sequence databases, Specialised genomic resources, ORF (Open Reading Frame Finder), TIGR Genome Resources , Genome comparison, Genome Annotation, Microarray image analysis	08
UNIT V : HOMOLOGY, ANALOGY, ORTHOLOGY, PARALOGY, PAIRWISE ALIGNMENT AND MULTIPLE SEQUENCE ALIGNMENTS		**11**
5.1	Introduction, Comparision of Homology, Analogy, Orthology And Paralogy. Alignment based methods and Hybrid method; Comparision of Computer Prediction Algorithms.	05
5.2	Introduction to pairwise and multiple sequence alignment; Comparison of sequences; Global alignment: The Needleman and Wunsch algorithm; Database interrogation, Alphabets and complexity; Pairwise database searching, BLAST; Databases of Multiple Alignments, Clustal Omega	06
	TOTAL	**45**

COURSE TITLE: BIOINFORMATICS (PRACTICALS)
COURSE CODE: BOT.E-9
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS:15

SR. NO	TOPICS	PRACTICAL SESSIONS
1	Biological databases and exploring various websites- NCBI, PUBMED and Gen Bank databases, To study the file formats- FASTA, PDB, Mol	5
2	To explore EBI server and searching EMBL	2
3	Exploring and querying UniProt KB	1
4	Pairwise global alignment of protein and DNA using Needleman- Wunsh algorithm with 6	2
5	Obtaining sequences for Pairwise alignment and to interpret the results to study the homology between the sequences Database searching using different versions of BLAST and FASTA and Derivation of relationships of query sequences	4
6	Use of Clustal Omega for multiple sequence alignment	1
	TOTAL	**15**

REFERENCES:

1. Attwood, D. J., Parry Smith D.J. and Phukan, S. (2011). Introduction to Bioinformatics; Pearson education.
2. Ignacimuthu, S. (2005). Basic Bioinformatics. Narosa Publishing House
3. Khan, I. A. and Khanum, A. (2003). Fundamentals of Bioinformatics –Ukaaz publications.
4. Mani, K. and Vijayaraj, K.A. (2002). Bioinformatics for Beginners. Aparnaa Publication.
5. Murthy, C. S. V. (2004). Bioinformatics. Himalaya Publishing House.

Web Resources

1. http://genes.mit.edu/GENSCAN.html

2. http://vmoc.museophile.org Computer History

3. http://www.clcbio.com/index

4. http://www.genome.jp

5. http://www.genome.jp/dbget/ LinkDB

6. http://www.ncbi.nlm.nih.gov/Structure/CN3D/cn3d.shtml

7. http://www.softberry.com/berry

8. http://www.studentworkzone.com/

9. www.ebi.ac.uk

10. www.fgcu.edu/support/office2000

11. www.learnthenet.com Web Primer

12. www.clustawomega.org

13. www.embl.org

COURSE TITLE: SEED TECHNOLOGY (THEORY)
COURSE CODE: BOT. E-10
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HRS

COURSE OBJECTIVES:
The course is focused in training students with knowledge of seed health, seed testing techniques, importance of plant breeding for production of high yielding seeds and various storage & protection techniques.

LEARNING OUTCOMES:
Student will have better understanding of seed physiology and vigor. The course knowledge will create trained human resource for seed industry and research organizations dealing with seed.

Sr. No	UNITS, TOPICS AND SUB-TOPICS	Hours
UNIT-I: PRINCIPLES OF SEED TECHNOLOGY		**07**
1.1	History, concepts, and role of seed technology	2
1.2	Seed definition and its types (nucleus seed, breeders seed, foundation seed, certified seed and truthful seed),characteristics of good seeds	2
1.3	Difference between seed and grain, Seed development programmes in Indian seed industry, national seed corporation.	3
UNIT-II: ORGANIZATIONS OF SEED TESTING		**08**
2.1	International seed testing association	2
2.2	Association of official seed analysts.	2
2.3	Central and state seed testing laboratory	2
2.4	Role of ICRISAT and ICAR	2
UNIT III: SEED TESTING AND CERTIFICATION		**10**
3.1	Objectives and concept of seed certification, Phases of seed certification	3
3.2	Procedure of seed certification: Minimum seed certification standards , General seed certification standard, and Specific crop standards.	4
3.3	Principles and procedure of seed testing; Equipments for seed testing	3

	Importance of seed testing, Seed heterogeneity test and tolerance value	
UNIT IV: PLANT BREEDING IN RELATION TO SEED TECHNOLOGY , SEED PROTECTION, PROCESSING AND STORAGE		**10**
4.1	Maintenance of breeders seed methods in self and cross fertilized crops.	3
4.2	Development trial and release of seed variety	2
4.3	Germ plasm and its conservation, seed banks and types of seed collections	3
4.4	Use of heterosis in crop improvement	2
UNIT V: SEED PROTECTION, PROCESSING AND STORAGE		**10**
5.1	Importance of epidemic and seed borne diseases	3
5.2	Factors affecting seed infection	1
5.3	Seed borne pathogens and control measures; Seed drying- principles; its advantages and methods; Seed treating chemicals and equipments Pest problems and their treatment during storage; Concept of seed marketing	5
5.4	Forecasting of seed demand and supply.	1
	TOTAL	**45**

COURSE TITLE: SEED TECHNOLOGY (Practicals)
COURSE CODE: BOT-V.E-2
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

Sr. No	TOPICS	Practical sessions
1	Analysis of physical and chemical properties of seed	3
2	Study of structure of dicot and monocot seeds from various plant species	3
3	Testing of seed viability (2,3,5-triphenyl tetrazolium chloride test)	2
4	**Mini Projects** 1. Breaking of seed dormancy methods (chemical, hormone &	6

	temperature) 2. Seeds and diseases 3. Seed moisture and germination	
5	Visit to seed production plant and report submission	1
	Total	15

REFERENCES:

1. Agrawal (2005). Seed Technology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Dutta (1983). A Class book of Botany, Oxford University Press, Calcutta
3. Pandey (2010). A text book of Botany. S. Chand and Company Ltd., New Delhi.
4. Reddy (2008). Principles of crop production. Kalyani Publishers, New Delhi.
5. Santra and Chatterjee (2007).College Botany, New Central Book Agency (P) Ltd., Kolkata .
6. Singh, (2009). Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi.
7. Umaraniet. A.L. (2006). Experimental Seed Science and Technology, Agrobios, Jodhpur

COURSE TITLE: PLANT DRUG TECHNOLOGY AND PHARMACOGNOSY (THEORY)
COURSE CODE: BOT.E-11
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS
COURSE OBJECTIVES:

To enable the students to learn and understand fundamental knowledge, the techniques & skills in plant drug industry, drug discovery and development.

LEARNING OUTCOMES:

To understand and use the techniques in plant drug industry along with bioassays and creating human resource in the field of drug development and pharmacognosy.

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT I: INTRODUCTION	**08**
1.1	History, present status, future scope & development of plant drug technology and Pharmacognosy	04
1.2	Classification of drugs: Morphological, Chemical And Pharmacological.	04
	UNIT II: CULTIVATION COLLECTION AND CONSTITUENTS OF FOLLOWING	**15**
2.1	ROOTS/ RHIZOME: *Rauwolfia* and *Curcuma*	03
2.2	LEAVES: *Adathoda* and *Ocimum*	03
2.3	SEEDS: Fenugreek and Nutmeg	03
2.4	FRUITS: Coriander and Senna pod	03
2.5	FLOWERS: Clove and Rose	03
	UNIT III: PHYTOCHEMICALS	**11**
3.1	Biosynthesis of alkaloids and effect of biological and chemical factors which affects biosynthetic pathways with e`xamples. Metabolic pathways of selected plants (from Tulsi and Rauwolfia).	05
3.2	Methods of Characterization: NMR,MS,UV-Vis,GC-MS.LC-MS	06
	UNIT IV:Extraction and analysis of Phytochemicals	**11**
4.1	Extraction methods and principles. Traditional and modern techniques	04
4.2	Analysis of Pigments, Phenolics, Flavonoids and Alkaloids	04
4.3	Bioassays: Identification of marker compounds in the formulations. Fingerprint and identification of plant drugs.	03
	Total	**45**

COURSE TITLE: PLANT DRUG TECHNOLOGY AND PHARMACOGNOSY (PRACTICAL)
COURSE CODE: BOT.E-11
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

Sr. No.	Experiments	Practical
1.	Test for alkaloids: Mayer’s, Wagner’s, Dragendorffs’ reagent	**01**
2.	Isolation of alkaloids and Phenolics	**02**
3.	Disc diffusion for antimicrobial assay	**02**
4.	MIC evaluation for antimicrobial assay	**02**
5.	Anatomical study of *Nux vomica* seeds, Ginger, Citronella leaf, Senna leaf & its medicinal properties	**04**
6.	Histochemical tests for Oils And Fats – Castor seed/ Citrus	**01**
7.	Microchemical test of Arum / *Colocasia* leaves for observation of Calcium oxalate crystals.	**01**
8.	Mini project Adulteration of crude drugs	**02**
	TOTAL	**15**

REFERENCES:

1. Gokhale S.B and Kokate, C.K. (2009). Pharmacognosy. Nirali Prakashan.
2. Khandelwal, K. R. (2008). Practical Pharmacognosy. Nirali Prakashan.
3. Kokate, C. K. (2008). Pharmacognosy. Nirali Prakashan.
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6. Wallis, T. E. (2005). Textbook of Pharmacognosy. CBS Publishers & Distributors.
7. Leleand J. Cseke.(2006). Natural products from Plants. Taylor and Francis. New York
8. Harborne J. B. (2010). Phytochemical methods. Springer International edition, New Delhi
9. Daniel Mammen. (1991). Methods in plant chemistry and economic botany, Kalyani publishers, New Delhi.

COURSE TITLE: ORGANIC FARMING (THEORY)
COURSE CODE: BOT.E-12
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

The course provides knowledge of principles and practices of organic agriculture and its role in sustainable crop production.

LEARNING OUTCOMES:

On completion of the course: the students will develop an understanding of the social, economic and environmental context for current and future organic agriculture production and management.

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT I: CONCEPT OF ORGANIC FARMING	**09**
1.1	Introduction: Farming, organic farming, concept and development of organic farming.	02
1.2	Principles of organic farming, Types of organic farming	02
1.3	Needs and benefits of organic farming.	02
1.4	Agencies and institutions related to organic agriculture	01
1.5	Farm components for an organic farm	02
	UNIT II: COMPOSTS, MANURES AND ITS APPLICATION	**11**
2.1	Manure application: Composted vs. uncomposted manure	03
2.2	Composting- principles, stages, types and factors	03
2.3	Composting methods, Vermicomposting Bio-fertilizers, Microbial inoculants , FarmYard Manure, Neem cake, Mulching, Alley farming/ cropping.	02 03

UNIT III: SOILS, SOIL FERTILITY MANAGEMENT AND FERTILIZERS		**13**
3.1	Soil types, Soil profile and Soil tillage	03
3.2	Factors affecting soil fertility and productivity	02
3.3	Land preparation	01
3.4	Water management for good soil, Commercial fertilizers, composition	03
3.5	Residual effects and fertilizer use efficiency	02
3.6	Foliar application and its concept	02
UNIT IV: ORGANIC PLANT PROTECTION AND SEED CERTIFICATION		**07**
4.1	Plant protection- cultural and mechanical methods	02
4.2	Plant protection- bio pesticide and bio control agents	02
4.3	Allelopathic methods of weed control	02
4.4	Certification of organically produces seeds.	01
UNIT V: ENTREPRENEURSHIP DEVELOPMENT		**05**
5.1	Entrepreneurship – Concept, characteristics, approaches, need for entrepreneurship in Organic farming	02
5.2	Popularization of organic farming. Marketing of organic produce. Organic farming in the rest of the world.	03
	TOTAL	**45**

COURSE TITLE: ORGANIC FARMING (PRACTICAL)
COURSE CODE: BOT.E-12
MARKS: 25
CREDITS: 1
PRACTICAL SESSION: 15

Sr. No.	TOPICS	PRACTICAL SESSIONS
1.	Comparative analysis of pH, EC, organic C, total N, available N, P, K and S from organic and inorganic data (obtained data).	1
2.	Survey of weeds in crop fields (Organic v/s inorganic farming)	1
3.	Study of soil types.	1
4.	Study of bio pesticide (Neem cake)	1
5.	Study of Mulching	1
6.	Visit to an organic farm	2
7.	Effectt of various manures on plant growth	3
8.	Mini projects - Preparation of Compost/ vermi-compost Study of Algal biofertilisers	5
	TOTAL 15	

REFERENCES:

1. Chakraverty, A. (1991). Post-harvest technology of cereal, pulses and oil seeds. Oxford IBH Publishing Co. Pvt Ltd.

2. Deshmukh, S.N. (2012). Organic Farming: Principles, Prospects and Problems, Agrobios Publishers (India).
3. Gehlot, D. (2010). Organic Farming: Components and Management, Agrobios Publishers (India).
4. Gupta, O.P. (2010). Modern weed management. Agrobios Publishers .
5. Israelsen, O.W. and Hansen, V.E. (2015). Irrigation Principles and Practices. John Wiley & Sons Inc.
6. Kanwar, J.S. (1978). Soil Fertility, Theory and Practice. Indian Council of Agricultural Research Publication.
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8. Rao, V.S. (2000). Principles of Weed science. Taylor & Francis Publishers.
9. Reddy, T.Y. and Sankar Reddi, G. H. (2015). Principles of Agronomy. Kalyani Publishers.
10. Sadhu, A.N. and Singh, A. (2014). Fundamentals of Agricultural Economics. Himalaya Publishing House.
11. Saraswat, V.N., Bhan, V. M. and Yaduraju, N.T. (2003). Weed management - (ICAR), Indian Council of Agricultural Research Publication.
12. Sharma, A.K. (2002). A hand book of Organic Farming. Agrobios Publishers.
13. Singh, B. D. (2006). Plant Breeding Principles and Methods. Kalyani Publishers.
14. Tisdale, S.L., Nelson, W.L., Beaton, J.D. and Havlin, J. L. (2013). Soil fertility and fertilizers. Pearson Publishers.
15. Yawalkar, K. S., Agrawal, J.P. and Bokde, S. (1962). Manures and Fertilizers. Agri-Horticulture Publishing House.

<u>**COURSE STRUCTURE – DEPARTMENT OF BOTANY**</u>

Three year B.Sc Degree Course in BOTANY

Semester	**Core**		**Elective**			
I	**BOT-I.C-1** Plant diversity	**BOT-I.C-2** Cell Biology & Biomolecules	--------	--------	--------	--------
II	**BOT-II.C-3** Plant Anatomy and Embryology	**BOT-II.C-4** Microbiology	--------	--------	--------	--------
III	**BOT-III.C-5** Physiology of Plants		**BOT-III.E-1** Ecology & Conservation	**BOT-III.E-2** Techniques and Instrumentation in Botany	**BOT-III.E-3** Enzymes and It's metabolic pathways	**BOT-III.E-4** Herbal Cosmetology
IV	**BOT-IV.C-6** Cytogenetics		**BOT-IV.E-5** Plant Breeding and Biostatistics	**BOT-IV.E-6** Systematics of Flowering plants and Phylogeny	**BOT-IV.E-7** Plant pathology	**BOT-IV.E-8** Algal Biotechnology
V	**BOT-V.C-7** Plant Molecular Biology		**BOT-V.E-9** Bioinformatics	**BOT-V.E-10** Seed Technology	**BOT-V.E-11** Plant Drug Technology and Pharmacognosy	**BOT-V.E-12** Organic Farming
VI	**BOT-VI.C-8** Plant Biotechnology and Genetic Engineering		**BOT-VI.E-13** Plant tissue culture	**BOT-VI.E-14** Horticulture, Floriculture & Landscaping	**BOT-VI.E-15** Economic Botany	**BOT-VI.E-16** Applied Mycology

SEMESTER II

COURSE TITLE: PLANT ANATOMY AND EMBRYOLOGY (THEORY)

COURSE CODE : BOT-II. C-3

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

This paper deals to understand the plant anatomy and embryology of angiospermic plant. Importance of studying this paper is highlighted reflecting on the current changing needs of the students by providing latest information. Practical component will provide an ample understanding of anatomical and embryological features.

COURSE OUTCOME:

- Define, describe and explain the basic plant anatomical and embryological features
- Compare the interrelatedness of organ-systems and their functions
- Examine the features through histological techniques.
- Define, describe, explain, compare theories in organization of tissues

Sr.No.	TOPICS	Hours
Module I: Shoot, Root and Leaf Anatomy		15
1.1	Organization of Shoot apical meristem	
1.2	Apical cell theory, Histogen theory, Tunica-Corpus theory, Cyto-histological zonation.	
1.3	Organization of root apical meristem	
1.4	Korper-Kappe theory, Quiescent centre.	
1.5	Anatomy of leaf: epidermis, mesophyll and vascular tissue	
1.6	Stomata and its diversity, leaf abscission	
Module II: Wood Structure		15
2.1	Vascular cambium, Secondary xylem, Xylary elements	
2.2	Secondary phloem, Phloem elements and Periderm	
2.3	Conifer wood, Dicotyledon wood, wood anatomy-TS, TLS, RLS.	
Module III: Reproductive biology, Pollination and fertilization		15
3.1	Floral development: ABC model of flowering	
3.2		

3.3	Structure and development of male gametophyte- Microsporangium Microsporogenesis & Pollen grains Structure and development female gametophyte – Megasporangium, Megasporogenesis, Forms of ovule-Monosporic, bisporic and Tetrasporic		
3.4 3.5	Mechanism of pollination and fertilization- types of pollination, germination of pollen grain, pollen pistil interaction, self-incompatibility Double fertilization, embryo (dicot and monocot) and endosperm formation. General account of Apomixis and Polyembryony		
		TOTAL	45

COURSE TITLE: PLANT ANATOMY AND EMBRYOLOGY (PRACTICAL)

COURSE CODE : BOT-II.C-3

MARKS: 25

CREDITS: 1

Sr.No.	Module 4: TOPICS	PRACTICAL
1.	Study of simple and complex tissues by using permanent slides/ EM graphs.	**2**
2.	Microscopic study of wood tissues in T.S, T.L.S. and R.L.S. and maceration (Any one species)**1**	**3**
3.	Study of Meristems, Microsporogenesis and Megasporogenesis through permanent slides	**2**
4.	Mini Project- Study of diversity in leaf anatomy, stomata and female gametophyte exhibiting self-incompatibility.	**3**
5.	Embryo and Endosperm with haustoria mounting (*Tridax/ Cucurbit*).	**2**
6.	In vitro growth of pollen tube in *Portulaca/ Vinca.*	**1**
7.	Pollen studies: Chitaley's method for analysis in *Ipomoea, Ocimum, Hibiscus*, *Acacia auriculiformis* and Grass.	**2**
	TOTAL	**15**

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1. Bhojwani, S. S and Bhatnagar, S.P. The Embryology of Angiosperms, Vikas Publishing House Pvt. Ltd., New Delhi.
2. Dwivedi. J.N. (1988). Embryology of Angiosperms. Rastogi and Co. Meerut.
3. Esau, K. (1977). Plant Anatomy, 2nd Edition. Wiley Eastern Private Limited. New Delhi.
4. Fahn, A. (1982). Plant Anatomy (3rd edition).Pergoman Press, Oxford.
5. John Jothi Prakash, E. (1987). A Text Book of Plant Anatomy.
6. Mauselth, J.D. (1988). Plant Anatomy. The Benjamin Cummings Publishing Co. Inc., Mehlo Park, California, USA.
7. Maheswari, P. (1971). An Introduction to the Embryology of Angiosperms. Tata McGra
8. Pandey, B.P. (1981). A textbook of Botany Angiosperms. S. Chand and Co., New Delhi.
9. Pandey, B.P. (1978). Plant Anatomy, S. Chand and Co., New Delhi.
10. Vashista, P.C. (1968). A text Book of plant Anatomy.

COURSE TITLE: MICROBIOLOGY (THEORY)

COURSE CODE: BOT.II.C-4

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

The objective of this course is to familiarize the student with basic concepts that help in understanding of microbial world. The course is aimed to understand microbial survival and distribution, it's relation and interaction with environment and human beings. The laboratory exercises are designed so that students acquire basic and bacteriological skills and are able to successfully use them.

COURSE OUTCOME: Students will be able to:

- Appraise student's to fundamental basis of all living organisms (Plant and Microbes) and their interactions with the environment.
- Apply the knowledge of microbial world for sustainable usage of resources for the quality human survival on planet earth and protect environment.

Sr.No.	**TOPICS**	**Hours**
Module I: Overview of microbial world & development		**15**
1.1	Developments of microbiology in the twentieth century Microbial taxonomy & phylogeny (archea, bacteria, fungi, algae, protozoa)	
1.2	Structure & General characteristics of viruses, viroids, Prions, Bacteriophages, TMV & mycoplasma	
1.3	Distribution of microbes in the environment (air, soil & water) Scope of microbiology and Microbial diseases	
Module 2: Isolation, characterization, growth of microorganisms & microbial genetics		**15**
2.1	**Control of microbial growth:** Biochemical characterization & nutritional types; Sterilization techniques,	
2.2	Preparation of pure cultures; growth factors & growth curve.	
2.3	Staining techniques	
2.4	**Bacterial Reproduction**: Conjugation, Transformation & transduction;	

2.5	**Methods of viral replication** (Lytic & Lysogenic mode)	
Module 3: Application Microbiology		**15**
3.1	**Applications in Environment**: Applications of microbes in environment sustenance (microbial degradation of cellulose, hemicelluloses, lignin, biodegradation of hydrocarbons),	
3.2	**Applications in Agriculture**: Association of plants with cyanobacteria, actinomycetes, fungus; Xenobiotics (biodegradation of pesticides, herbicides; metals, biofuels	
3.3	**Applications in Medicine**: Microbial antibiotics	
3.4	**Applications in Industry:** Microbes in Fermentation technology & dairy industry.	
	TOTAL	**45**

COURSE TITLE: MICROBIOLOGY (PRACTICAL)

COURSE CODE: BOT.II.C-4

MARKS: 25

CREDITS: 1

Sr.No.	Module 4: Topics	Practical
1	Preparation of culture media for bacteria, pure cultures and aseptic transfer of pure culture	3
2	Staining of microorganisms	2
3	Measurement of bacterial growth, cell number in a culture (Turbidity, serial dilution & Haemocytometer	3
4.	Distribution of microorganisms in our environment (Skin, air, water and soil sample)	2
5	Mini Projects: i) Microbiological examination of water ii) Bacteriological testing of milk iii) Fermentation of carbohydrates and wine preparation	5
	TOTAL	**15**

REFRENCES:

1. Aneja, K. R. (2007). Experiments in Microbiology Plant Pathology & Biotechnology. 5th ed., New Age International Publishers.
2. Atlas, RM., Principles of Microbiology, 2nd ed.,(1997), McGraw-Hill
3. Dubey, R.C & Maheshwari, D.K.(2002).Practical Microbiology. S. Chand & Comapany Ltd., New Delhi.
4. Frazier, W.C. and Westhoff, D.C.(2008), Food Microbiology 4th ed., the McGraw Hill.
5. Pelczar. M,(2000). Microbiology, 5th ed., Tata-McGraw Hill.
6. Powar, C.B & Daginawala, H.F.(1982). General Microbiology–Volume II. Himalaya Publishing house: Bombay.
7. Prescott Harley (2008). Microbiology. McGraw-Hill Higher Education, Boston.
8. Prescott, LM. (2005), Microbiology. 6th ed. 2005., McGraw-Hill.
9. Salle, AJ., Fundamental Principles of Bacteriology, 7th ed.,(1999). Tata- McGraw Hill.
10. Shivkumar PK., MM Joe & Sukesh K.(2010).An Introduction to Industrial Microbiology. 1st ed., S.Chand & Company Pvt. Ltd

SEMESTER-IV

COURSE TITLE: CYTOGENETICS (THEORY)

COURSE CODE: BOT-IV.C-6

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

This course will enable the students to understand fundamentals of genetics and evolution.

COURSE OUTCOMES: Students will be able to:

- restate fundamentals of genetics
- identify different stages of cell division.
- construct chromosome maps.
- review the effects of mutagens on seed germination.

Sr.No.	TOPICS	HOURS
Module 1: Mendelian Genetics and Linkage		**15**
Mendelian genetics and principles of inheritance and Multiple allelism		
1.1	Mendel's Laws, backcross and test cross.	
1.2	Allelic and non-allelic interactions, Epistatic interactions	
1.3	Multiple alleles in Drosophila (eye colour), man (blood groups) and plants (self-incompatibility).	
Linkage, Mutations and Molecular basis of mutations		
1.4	Linkage- Coupling and Repulsion Hypothesis Chromosome maps.	
1.5	Mutations and its types. Types of mutagens.	
1.6	Transitions and transversions; frame shift mutations. DNA repair mechanisms, Applications of mutations	

Module 2: Extranuclear inheritance and Sex linked inheritance		**15**
Extranuclear inheritance and Maternal influence		
2.1	Extranuclear inheritance and maternal influence: Kappa particles in *Paramecium;* CO_2 sensitivity in *Drosophila*; cytoplasmic inheritance in mitochondria and plastids; Shell coiling in snails; eye colour in flour moth.	
Sex Determination and Sex Linkage		
2.2 2.3	Sex Chromosomes, Mechanisms of sex determination; Genic balance mechanism. Sex-linked inheritance- X linked and Y linked inheritance.	
Module 3: Genetic variation due to chromosome structure and number		**15**
Genetic variation due to chromosome structure and number		
3.1 3.2	Chromosomal aberrations – duplications, deletions, inversions and translocation Variations in chromosome number; auto-and allo-polyploidy - types and effects; artificial induction of polyploidy. Auto and allo-polyploid crop species Aneuploid segregations in plants- tetrasomics and nullisomics; triploid and tetraploid plants. Applications of polyploidy	
	TOTAL	**45 HOURS**

COURSE TITLE: CYTOGENETICS (PRACTICAL)

COURSE CODE: BOT-IV.C-6

CREDITS: 1

Sr. No	MODULE 4: TOPICS	Practical
1.	Study of Mitosis and meiosis using suitable plant material	**03**
2.	Karyotype analysis and preparation of ideogram	**02**
3.	Detection of anomalies in cell division using suitable plant material.	**02**
4.	Study of multiple allelism in blood groups of human beings.	**01**
5.	Effect of physical and chemical mutagen on seed germination	**03**
6.	Preparation of chromosome maps from 3-point test cross data and calculation of Interference and coincidence	**01**
7.	Induction of polyploidy using Colchicine treatment.	**02**
8.	Study of sex linked inheritance	**01**
	TOTAL	**15 P**

REFERENCES:

1. Concepts of Genetics W. S. Klug, M. R. Cummings, C. A. Spencer. 8 Edition, Pearson Education International (2006)
2. Gardner, Eldon J.; Snustad, Peter D.; Principles of genetics; 7th edition; New York: John Wiley &Sons ,(1984).
3. Genetics : A Conceptual Approach B. Pierce, 3rd Edition, Freeman & Co., (2008)
4. Genetics Peter Russell, 2nd Edition, Pearson International, (2006)
5. Gupta, P.K. Genetics. Rastogi Publications. (1990).
6. Gupta, P.K.; Cytogenetics; 1st edition, reprint; Meerut :Rastogi Publications , (2004).
7. Gupta, P.K.; Genetics: A textbook for University students; 3rd edition; Meerut: Rastogi Publications , (2007).
8. Introduction to Genetic Analysis A. J. Griffiths, S. R. Wessler, R. C. Lewontin, S. B. Carroll. 9th Edition, Freeman and Company (2008)

   Molecular Biology of the Gene J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick. 5th Edition, Pearson Education (2004)

9. Principles of Genetics P. Snustad, M. Simmons, 4th Edition, John Wiley and Sons Co., (2006)
10. Shukla, R.S. and Chandel, P.S.; Cytogenetics, Evolution, Biostatistics and Plant Breeding. (2007)

COURSE TITLE: PLANT BREEDING & BIOSTATISTICS (THEORY)

COURSE CODE: BOT-IV.E-5

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

To enable the students to learn various techniques in plant breeding with regards to crop productivity**.**

COURSE OUTCOMES: Students will be able to:

- To recognise various techniques in plant breeding
- To differentiate between modes of plant breeding
- To employ manual emasculation procedure.
- To calculate mean, median, mode, standard deviation, std. error for provided material.

Sr.No.	TOPICS	HOURS
Module 1: Introduction to Plant breeding, Organisations and Certifications		**15**
Introduction to Plant breeding and Organisations		
1.1	Introduction, history, objectives, achievements and prospects. Centres of origin of crop plants.	
1.2	Organizations & their mandate - ICAR, ICRISAT, IRRI (Indian & International)	
1.3	Plant breeders' & Farmers' Rights Phytosanitary and Seed Certifications	
Module 2: Hybridisation, Heterosis, Inbreeding Depression and Mutation breeding		**15**
Hybridisation, Heterosis and Inbreeding Depression		
2.1	Pure line and mass selection	
2.2	Types and Techniques in hybridization Introduction, domestication and acclimatization.	
2.3	Heterosis and inbreeding depression.	
Mutation Breeding; Plant breeders' rights; Breeding for stresses.		

2.4 **2.5**	Varieties developed in India through mutation breeding; Limitations of mutation breeding	
Module 3: Biostatistical methods and Genetics of Pathogenicity		**15**
Biostatistical methods and Genetics of Pathogenicity		
3.1 **3.2** **3.3** **3.4**	Introduction to biostatistics: Terms used in biostatistics, types of data, Sampling theories- random sample, sample size determination, precision, data collection, processing and presentation of data: qualitative and quantitative Measures of central tendency: Mean, Median, Mode. Measures of variation: standard deviation, standard error Concept of correlation between two variables and regression line Chi square Physiological races and types. Genetics of pathogenicity; vertical and horizontal resistance & breeding for various biotic stresses in rice/wheat.	
	TOTAL	**45**

COURSE TITLE: PLANT BREEDING & BIOSTATISTICS

(PRACTICAL) COURSE CODE: BOT-IV.E-5

MARKS: 25

CREDITS: 1

Sr. No	MODULE 4: TOPICS	Practical
1.	Emasculation and bagging of flowers using suitable plant material and Estimation of fruit and seed set in emasculated flowers	**03**
2.	Correlation of floral structure with pollination system	**01**
3.	Estimation of pollen fertility (pollen viability) in (any two) locally grown crop species.	**02**
4.	Study of centres of origin of some important crop plants.	**01**
5.	Study of soil pH using different soil types & relate it to crops	**01**
6.	Analysis of data for mean, median & mode, Standard deviation and standard error using suitable plant samples	**03**
7.	Determination of correlation and regression, Chi square analysis	**03**
8.	Visit to ICAR	**01**
	TOTAL	**15 P**

REFERENCES:

1. Mahajan, B.K.; Methods in biostatistics; 6th edition; New Delhi: Jaypee Brothers, (1997)
2. Rastogi, Veer Bala.; Fundamentals of Biostatistics; 2nd edition, reprint; New Delhi: Ane Books India, 2006(2008).
3. Shukla, R.S. and Chandel, P.S.; Cytogenetics, Evolution, Biostatistics and Plant Breeding. (2007)
4. Singh, B.D.; A textbook of Plant Breeding; Kalyani Publishers. (2009)

5. Sokal R R and Rahlf H A. Biometry: the principles and practice of Statistics for Biology. research. 3rd edi W H Freeman and Co. (1995)
6. Zar J H, Biostatistical analysis 4th ed. Prentice Hall. (1998)

COURSE TITLE: SYSTEMATICS OF FLOWERING PLANTS AND PHYLOGENY

COURSE CODE: BOT-IV.E-6

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

To study the morphology, systematics and phylogeny of flowering plants.

COURSE OUTCOME: Students will be able to:

- Name, arrange, describe and compare the taxa
- Outline keys for identification of flowering plants
- Interpret phylogenetic trees, cladograms, etc.

	TOPICS	**Hours**
Module 1: Introduction to Plant classification, Nomenclature		**15**
1.1	Plant classification, nomenclature & biosystematics	
1.2	Field inventory; Functions of Herbarium; Important herbaria and botanical gardens (India & world), virtual herbarium; e-flora	
1.3	Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access	
1.4	Principles and rules (ICBN); Ranks and names (names of hybrids); Typification, author citation, valid publication, Rejection of names, principle of priority and its limitations	
Module 2: Concept, Taxonomic evidences and Phylogeny of Angiosperms		**15**
2.1	Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; species concept (taxonomic, biological, evolutionary).	
2.2	Evidence from palynology, cytology, phytochemistry and molecular data.	
2.3	Origin & evolution of angiosperms, Co-evolution of angiosperms Characters; Variations; OTUs, cluster analysis, Phenograms, cladograms (definitions and differences)	

Module 3: Systems of classification; position and diagnostic features of families		15
3.1	Concepts of evolution and phylogeny	
3.2	Study of classification systems (major contributions by Linnaeus, Bentham and Hooker, Engler and Prantl) and Angiosperm Phylogeny group (APG III).	
3.3	Position and diagnostic features of families: Annonaceae, Capparidaceae, Brassicaceae, Fabaceae, Rutaceae, Myrtaceae, Cucurbitaceae, Rubiaceae, Apocyanaceae, Asclepiadaceae, Solanaceae, Verbenaceae, Lamiaceae, Amaranthaceae, Orchidaceae, Araceae, Asteraceae, Zingiberaceae, Commelinaceae, Poaceae.	
	Total:	**45**

COURSE TITLE: SYSTEMATICS OF FLOWERING PLANTS AND PHYLOGENY

COURSE CODE: BOT-IV.E-6

MARKS: 75

CREDITS: 3

Sr.no	Module 4: Topics	Practical
1	Plant identification using flora book and database	**01**
2	Preparation of herbarium	**01**
3	Identification of 15 families mentioned in unit IV (Bentham & Hooker's system) studied in theory from locally available specimens (with floral diagram).	**10**
4	Use of taxonomic keys and construction of dichotomous keys	**01**
5	Taxonomic interpretation using pollen of related species	**01**
6	Construction of Phenogram and Cladogram	**01**
	Total	**15**

REFERENCES:

1. Singh, G. 1999. Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi.
2. Chopra, G. L. 1985. Angiosperm (Systematics& Life cycles). Pradeep Publications, Jaladhar, India, pp. 339-350.
3. Pandey, B. P. 1969. Taxonomy of Angiosperms. S. Chand and company Ltd. New Delhi, India, pp. 102-105.
4. Subrahmanyam N S, Modern plant taxonomy, Vikas publishing house pvt. Ltd.,1995.
5. Pandey S.N. Taxonomy of angiosperms, ASE books India, 2008.
6. Mondal, A.K. Advanced Plant Taxonomy, New Central Book Agency Ltd., 2009.
7. Naik, V.N. 1984. Taxonomy of Angiosperms. Tata McGraw Hill, New Delhi.
8. Radford, A.E. 1986. Fundamentals of Plant Systematics. Harper and Row, New York.
9. Davis, P.H. and Heywood, V.H. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd, London.
10. Heywood, V.H. and Moore, D.M. 1984. Current Concepts in Plant Taxonomy. Academic Press, London.

COURSE TITLE: PLANT PATHOLOGY (THEORY)

COURSE CODE: BOT-IV.E-7

MARKS: 75

CREDITS: 3

Course Objectives

Make the students aware of various plant pathogens and their control

Course Outcome: Students will be able to:

- Identify various diseases and causal agents of economically important plants
- Find effective control measures

Sr. No	TOPICS	Hours
MODULE I: : AN INTRODUCTION AND EPIDEMOLOGY OF PLANTS DISEASES		**15**
1.1 **1.2** **1.3** **1.4**	History, Definitions and Importance of plant pathology Concepts and types of diseases in plants Biotic causes of plant diseases. Infectious agents (nematodes, protozoans, bacteria, fungi & viruses) Growth, reproduction, survival and dispersal of important plant pathogens Role of environment and host nutrition on disease development	
MODULE II:: PLANT DISEASE DEVELOPMENT (PATHOGENESIS) AND MANAGEMENT		**15**
2.1 **2.2** **2.3** **2.4** **2.5** **2.6**	Parasitism and pathogenicity Symptomatology Host parasite interaction Recognition concept and infection, Role of enzymes, toxins & growth regulators in pathogenesis Quantitative resistance (Physical, Biological & cultural methods) Biochemical defences (oxidative burst; Phenolics, Phytoalexins, PR proteins, antimicrobial substances and plantibodies), Quarantine measures	

UNIT IV: GENETICS OF PLANT DISEASE AND STUDY OF PLANT DISEASES IN INDIA			**15**
3.1 **3.2** **3.3** **3.4**	Altered plant metabolism due to pathogens attack Genetics of resistance ('R' & avr genes, elicitors responses) Signalling and programmed cell death **Study of Diseases** (Name of disease, pathogen, symptoms and control measures need to be studied) Important diseases (Any 2 of each) of Paddy, Arecanut, Wheat, Banana, Coconut, Sugarcane, Mango and Amaranth/ Raddish		
		TOTAL	**45**

COURSE TITLE: PLANT PATHOLOGY (PRACTICAL)

COURSE CODE: BOT-IV.E-7

MARKS: 25

CREDIT :1

Sr. No	MODULE 4: Topics	Practicals
1	Isolation and culture of fungal and bacterial pathogens.	02
2.	Demonstration of Koch's postulates	01
3.	Assay for cellulase /pectinase enzyme from diseased plant	02
4.	Study of plant diseases with reference to pathogen & symptomology (Viral, Bacterial & Fungal) (any 10 as per theory)	05
5	Anatomical observations of fungal infected plants (rust, blight, rots)	3
6	Study of antagonistic behaviour of bacterial pathogens	1
7.	Visit to Plant Pathology Laboratory (ICAR)	1
	Total	**15**

References

1. Agros, G.N. (1997) Plant Pathology (4th ed) Academic Press.
2. Bilgrami K.H. & H.C. Dube (1976) A textbook of Modern Plant Pathology. International Book Distributing Co. Lucknow.
3. Mehrotra, R.S. (1980) Plant Pathology, TMH, New Delhi.
4. Pandey, B.P. (1999) Plant Pathology. Pathogen and Plant diseases. Chand & Co. New Delhi.
5. Rangaswami, G. (1999) Disease of Crop plants of India Prentice Hall of India Pvt. Ltd.
6. Sharma P.D. (2004). Plant Pathology Rastogi Publishers.
7. P Gunasekaran (2005) Laboratory manual in Microbiology. New Age International (P) Limited, Pub. New Delhi.
8. K.R. Aneja (2009). Experiments in Microbiology Plant Pathology & Biotechnology, 4th edition New Age International (P) Limited, Pub. New Delhi.

COURSE TITLE: PLANT GENETIC ENGINEERING (THEORY)

COURSE CODE: BOT- VI.C-8

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES: This course is to develop fundamental knowledge and skills in various aspects of Genetic engineering.

COURSE OUTCOME: **Students will be able to:**

- Apply the basic knowledge of Plant Genetic Engineering in research
- Perform experiments by themselves
- Compare and assess the different DNA sequencing techniques
- Design experiments in plant genetics

Sr.No	TOPICS	Hours
	Module 1: Recombinant DNA technology: Tools	**15**
1.1	Enzymes- Exonucleases; Endonucleases; Restriction endonucleases Type I, II&III; ligases, methylases; Reverse Transcriptase, Polymerase.	
1. 2	Prokaryotic and eukaryotic cloning vectors; General account of plasmids, cosmids, bacteriophages, Phasmids – Advantages and disadvantages; Structure of pBR 322; Artificial chromosome vectors – BAC, YAC, Shuttle vectors.	
1.3	DNA Ligation – Linkers, adaptors, Homopolymer tailing, Transformation, selection of transformed bacteria – antibiotic selection, reporter genes - GUS,GFP.	
	Module 2 : Techniques in Recombinant DNA technology	**15**
2.1	Polymerase chain reaction – Principle, types of primers, Taq polymerase, Protocol, Reverse Transcriptase PCR and Real Time PCR	
2.2	Prokaryotic expression of foreign genes; Isolation of gene of interest – Construction of cDNA library; Genomic Library	
2.3	DNA sequencing – Maxam Gilbert's method, Sanger's method, Automated DNA sequencing, Pyrosequencing	

2.4	Molecular Analysis of gene and gene products – Southern, Northern and Western blotting, ELISA, RIA 	
2.5	Molecular markers – RAPD, RFLP, AFLP, Brief account of DNA Fingerprinting and Bar coding of plants	
2.6	Brief account of: Antisense RNA technology – FLAVR SAVR Tomato; Gene Silencing; RNA interference; mtRNA	
	Module 3: Gene transfer methods in plants, Biosafety and Applications of Genetic Engineering	**15**
3.1	Vector mediated gene transfer- Agrobacterium mediated gene transfer – T DNA, Ti plasmid and Ri plasmid derived vector systems; hairy-root culture; Plastid/ Mitochondria transformation.	
3.2	Process of transfer - Bacterial colonization, Induction of virulence, generation of TDNA transfer complex, T-DNA transfer, Integration of TDNA into plant genome	
3.3	Direct methods of gene transfer – Biolistics, Lipofection, Electroporation, microinjection – Advantages and disadvantages	
3.4	Intellectual Property Rights, Genetic engineering and Public issues Biosafety regulation	
3.5	Applications: Agricultural: Bt cotton, Golden rice Environmental: Biodiversity and conservation; Waste management and Bioremediation Industrial- Large scale production of beverages, Pharmaceuticals,	
		45

COURSE TITLE: PLANT GENETIC ENGINEERING (PRACTICAL)

COURSE CODE: BOT- VI.C-8

MARKS: 25

CREDITS: 1

Sr. No	Module 4: Topics	Practical
1	DNA isolation by CTAB/(any other) method	02
2.	Estimation of DNA	02
3.	Agarose Gel Electrophoresis	02
4.	Restriction of DNA	02
5	Sequence reading – Sanger method/Maxam Gilbert method – problem	02
6	*Agrobacterium tumefaciens*-mediated plant transformation. (Virtual Library)	01
7	Small scale plasmid preparation from *E. coli*	03
8	Visit to a leading biotechnology institute and Report making.	01
	Total	**15**

REFERENCES:

1. Brown, T. A. (2006) Gene cloning and DNA analysis; Blackwell scientific publishers
2. Sobti,R.C.&Pachauri,S.S.(2009)EssentialsofBiotechnology;AneBooks,NewDelhi
3. Dubey, R.C. Introduction to Plant Biotechnology; S. Chand & Co
4. Purohit, S.S. (2003) Agricultural Biotechnology, Agrobios (India)
5. Chawla, H.S. (2000) Introduction to Plant Biotechnology
6. Dovstekel (2005) Microarray Bioinformatics; Cambridge University press
7. Ignacimuthu, S. (1997) Plant Biotechnology, New Hampshire Science Publishers
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13. Brown TA (2002) Genome, Blackwell.

COURSE TITLE: PLANT TISSUE CULTURE (THEORY)

COURSE CODE: BOT-VI.E-13

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES: To develop the plant tissue culture skills.

COURSE OUTCOME: **Students will be able to:**

- Explain and discuss the general theoretical backgrounds and practical techniques
- Describe, define, explain/ discuss, compare, concept of differentiation and culture types
- Define, describe, explain/ discuss, techniques in PTC in media preparation, sterilisation, callus culture and organogenesis
- Describe, explain, discuss applications in forestry, agriculture etc

Sr.No	**TOPICS**	**Hours**
	Module – I: Introduction and differentiation Concept	**15**
1.1 **1.2** **1.3**	Scope and history of plant tissue culture, Laboratory organization. Culture techniques – Sterilization methods of glasswares, Explant preparation, sterilization, media composition and preparation. Cellular differentiation and totipotency; effect of growth regulators on differentiation.	
	Module – II: Culture types and Techniques in Tissue culture	**15**
2.1 **2.2**	Cell culture types- callus, single cell and suspension culture Organogenesis and embryogenesis; Somaclonal variation; meristem Micropropagation, Germplasm conservation; Isolation and regeneration of protoplasm; Somatic hybridization, Synthetic seeds, Cryopreservation, secondary metabolite production.	
	Module- III: Application of Plant tissue culture	**15**
3.1 **3.2** **3.3**	Horticulture Agriculture Forestry	
	Total	**45**

COURSE TITLE: PLANT TISSUE CULTURE (Practical)

COURSE CODE: BOT-VI.E-13

MARKS: 25

CREDITS: 1

Sr. No	**MODULE 4: Topics**	**Practical**
1	Preparation of MS Medium; Sterilization techniques	03
2	Embryo culture of maize	02
3	Callus induction and its morphological studies	04
4	Sub-culturing callus for rooting and shooting	03
5	Enzymatic Isolation of plant protoplast	01
6	Synthetic seed production	01
7	Visit to Plant tissue culture unit	01
		15

REFERENCES:

1. Bhojwani, S.S. 1990. Plant Tissue Culture: Applications and Limitations. Elsevier Science Publishers, New York, USA.
2. Kumar, U. (1999). *Methods in Plant Tissue Culture.* Jodhpur: Agrobios (India).
3. Razdan, M. K. (2002). *Introduction to Plant Tissue Culture.* New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd.
4. Satyanarayana U.(2013). Biotechnology. Books and allied (P) Ltd.
5. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers, The Netherlands.

COURSE TITLE: HORTICULTURE, FLORICULTURE & LANDSCAPING (THEORY)

COURSE CODE: BOT-IV.E-14

MARKS: 60

CREDITS: 3

COURSE OBJECTIVES:

Is to provide entrepreneur opportunities.

COURSE OUTCOMES: **Students will be able to:**

- Explain the basics of Horticulture, floriculture and landscaping
- Outline the requirements for building up nurseries, garden, etc.
- Inculcate the technique of vegetative propagation of plants.
- Identify and relate the scope of these fields in building up career

Sr.No	Topics	Hours
Module 1: Tools and Techniques in Horticulture, floriculture		**15**
1.1	**Theory sessions:** Definition and importance; Pomoculture, Olericulture, Floriculture. **Fertilizers**: inorganic, Organic – biofertilizers: vermicomposting, green manure, algal culture, FYM. Knowledge of annual, biennials and perennials with reference to ornamental flowers Irrigation:- Surface, Sprinkle, Drip and Gravity irrigation Introduction to Green house, Poly house, Moist chamber, Net frame, Introduction to Hydroponics.	
1.2	**Practice sessions:** i) Local visits to nurseries, home gardens to know about different pots and its potting system ii) Preparation of potting mixture – Potting, repotting iii) Preparation of organic compost & vermicompost iv) Familiarizing gardening tools and implements v) Improving the shelf life of cut flowers using chemicals vi) Study of Hydroponics vii) Local visit to an established green house/polyhouse and report making.	

Module 2: Propagation Methods		**15**
2.1	**Theory sessions:** Introduction to sexual methods (seed propagation) – Definition, Merits and Demerits, Criteria for selection of seeds. Asexual (Vegetative) propagation – Definition, and types- Cutting (root, stem, leaf), Layering (simple, air), Grafting (Whip, Approach) and Budding (T, patch), Stock –scion relationship in important horticultural crops. Use of plant growth regulators in horticulture	
2.2	Practice sessions: i) Field work in cutting, grafting, budding, layering ii) To design experiments for induction of rooting, flowering, fruit set, fruit development and control of fruit crops iii) To study the cultivation practices of local commercial flowers iv) Field work in Nursery management; Cut flowers; to improve shelf life of cut flowers.	
Module 3: Landscaping		**15**
3.1	**Theory sessions:** Types of garden: Formal, informal and kitchen garden Locations in the garden- edges, hedges, fence, lawn, flower beds, Avenue, water garden (with two examples of each). Focal point. Auto CAD in garden designing. Bonsai techniques	
3.2	**Practice session:** i) Visit to local gardens and giving comparative account of types of garden ii) Listing of plants used for edges, fence, lawn, flower beds, water gardens, etc. iii) Visit to a botanical gardens/ water garden iv) To learn different styles of Bonsai techniques v) Lawn making: type of lawn grasses and maintenance. Plants suitable for hedges. Aftercare: Weeding, top dressing methods of pruning and topiary vi) Garden designing using (preferably Auto CAD) software	

Module 4: Applications of Horticulture, Floriculture and Landscaping		**15**
4.1 4.2	Theory sessions: Entrepreneurship skills, Invited lecture by Guests (Spice Farm owner, Ecotourism sector, Organic farmer/ Organic products outlet owner, Nursery manager/ Landscaper, Krishivigyan Kendra, Agriculture dept, Forest Dept, etc) Latest schemes in horticulture, floriculture, agriculture in Goa. **Practice sessions:** Preparation of garden design (area of the campus) Innovative ideas for beautification of the campus and preparation of the same. Establishment of vegetable garden using organic compost & vermi-compost Or Internship at any firm related to Horticulture.	
	Total	**60**

REFERENCES:

1. Swarup V. (1997). Ornamental horticulture. MaMillan India Limited, NewDelhi.
2. Randhava, G.S, 1973 – Ornamental horticultural in India Today andTomorrow Printers and Publishers, NewDelhi.
3. Trivedi TP (2007). Ornamental horticultural in India. Indian Council of Agricultural Research NewDelhi.
4. Nayak, K.C. South Indian fruits and their culture P.L. Varadaraj&Co.,&Lingichetti Street,Madras.
5. EdmentSenn Andrews 1994 Fundamentals of Horticulture – TataMcGraw Hill Publishing Co., Ltd.,Delhi

COURSE TITLE: ECONOMIC BOTANY (THEORY)

COURSE CODE: BOT-VI. E-15

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

This course provides knowledge on the value of plants with scientific information and critical thinking to enhance economic botany.

COURSE OUTCOMES: Students will be able

- To identify economically important plants/plant parts.
- To identify valuable plant products of potential market and economic value.
- To evaluate, describe and create awareness of the uses of natural plant products as alternative to synthetic and chemical products.

Sr. No	TOPICS	Hours
Module 1: Origin of Cultivated Plants (Centres of Origin, Cereals & legumes)		**15**
1. 1	**Centres of origin**: Concept, Vavilov's work, examples of major plant introductions; evolution of new crops/ varieties; crop domestication,	
1.2	Genetic diversity and its loss, Importance of germplasm	
1.3	**Cereals:** Wheat, Rice (local varieties) and Millets (any one)	
1.4	**Legumes**: Chick pea, Cow pea and one fodder legumes	
Module 2: Sources of sugars & Starch, Oils & Fats, Drugs & Natural Rubber		**15**
2.1	**Sugar & sugarcane sources**: Sugarcane ; Potato & Dioscorea	
2.2	**Fat and Oil sources**: Groundnut, Coconut, Soybean and; extraction and applications of essential oils, Eucalyptus and mustard oils	
2.3	**Therapeutic and habit-forming drugs**: C*inchona*,*Cannabis*; Tobacco (Morphology, processing, uses and health hazards)	
2.4	**Tapping, processing and uses of** *Hevea brasiliensis*	

Module 3: Classification, general description and uses of Spices, & beverages, Fruit and Nuts, Fibers and Timber Plants		**15**
3.1	**Spices & condiments:** Clove, Black pepper, cinnamon, turmeric	
3.2	**Beverages**: Tea & Coffee	
3.3	**Fruits:** Mango, Cashew & Jackfruit	
3.4	**Fibers**: Coconut, cotton & Jute.	
3.5	**General account of Timber Plants**: Teak and Matti	
		45

COURSE TITLE: ECONOMIC BOTANY(PRACTICAL)

COURSE CODE: BOT-VI.E-15

MARKS: 25

CREDITS: 1

Sr. No	Module 4: Topics	Practical
1	Morphological and Microscopic study of cereal and legumes seeds (rice and groundnut)	04
2	Study of essential oil yielding plants (Coconut, Eucalyptus, Citrus)	02
3.	Mini Projects: i. Essential oil from plant sources ii. Analysis of starch content from plant sources(fruits, rhizome, tubers) iii. Analysis of plants for drugs, alkaloids and dyes iv. Fibers from plants v. Study of local fruits and spices .	07
4	Visit to a Spice Farm/ Rubber Plantation/ economically important plant farm	02
	Total	**15**

REFERENCES:

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, the Netherlands.
3. Chrispeels, M.J. and Sadava, D.E. (1994) Plants, Genes and Agriculture. Jones & Bartlett Publishers.
4. Subrahmanyam N.S. Sammbamurty A.V.S.S. (2008). A textbook of Modern economic Botany. CBS Publishers & Distributors.

COURSE TITLE: APPLIED MYCOLOGY (THEORY)

COURSE CODE: BOT-IV.E-16

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

This paper provides knowledge on culture techniques and the applicative aspects of fungi.

COURSE OUTCOMES: The students be able to:

- To explain techniques involved in sampling, culturing and maintaining fungal cultures.
- To discuss industrial and agricultural applications of fungi.

Sr.No.	TOPICS	Hours
Module 1: Introduction and Fungal Culture studies		**15**
INTRODUCTION		
1.1	General account of fungi. Microscopic structure, Chemical composition and understanding of fungal cell wall	
1.2	Environmental factors influencing fungal growth	
STUDIES OF FUNGAL CULTURE		
1.3	Introduction to culture collections, Culture Media formulations and types of media used in mycology. Culture databases.	
1.4	Various techniques for pure culture isolation and maximum recovery from different habitats (Soil, Litter, Water, Dung) Baiting, moist-chamber and particle-plating techniques	
1.5	Isolation of pure cultures and maintenance.	
1.6	Study of colony characters and growth patterns	
1.7	Fungal gene banks- Culture Collection Centres.	
Module 2: Industrial Mycology		
INDUSTRIAL MYCOLOGY		**15**

2.1	Role of fungi in biotechnology	
2.2	Applications of fungi in food industry • Flavour and texture • Fermentation and baking • Organic acids (Preferably Citric acid) • Enzymes (Preferably Cellulases and Pectinases) Mycoproteins– SCP (Yeast)	
2.3	Endophytic fungi and its industrial applications.	
Module 3: Fungi in Agriculture, medicine and recent mycological advances.		**15**
FUNGI IN AGRICULTURE		
3.1	Fungi as biofertilizers (Preferably *Trichoderma*) Fungi as biocontrol agents- Mycofungicides, Mycoherbicides, Mycoinsecticides	
3.2	Mycorrhizae and its role	
3.3	Medical mycology - Secondary metabolites- Pharmaceutical preparations from fungi, antibiotics from fungi. (Preferably *Penicillium* and *Ganoderma*)	
MUSHROOM CULTIVATION & RECENT ADVANCES IN MYCOTECHNOLOGY		
3.4	Mushroom cultivation techniques: Oyster and Button mushrooms.	
3.5	Applications of PCR and other molecular techniques in mycology, Mycoinformatics, Mycoremediation	
		TOTAL: 45 Hours

COURSE TITLE: APPLIED MYCOLOGY (PRACTICAL)

COURSE CODE: BOT-IV.E-8

MARKS: 25

CREDITS: 1

Sr. No.	MODULE 4: TOPICS	Practicals
1.	Isolation and preparation of pure culture from a mixed culture plate on solid medium.	02
2.	Preparation of moist chamber and incubation of fungi	01
3.	Particle dilution plating for fungi	01
4.	Isolation of endophytic fungi from plant leaves	01
5.	Study of effect of incubation temperatures and pH on fungal growth	02
6.	Colorimetric estimation of cellulase and amylase produced by fungi	02
7.	Production of Citric acid (using *Aspergillus*) in broth and testing for its presence.	02
8.	Mushroom cultivation- Oyster mushrooms and its protein estimation	03
9.	Understanding structures of fungal enzymes using Bioinformatics tools.	01
	TOTAL	15

REFERNCES:

1. Aneja, K. R. (2007) Experiments in Microbiology Plant Pathology & Biotechnology. 5th ed., New Age International Publishers.

2. Bhat, D. J. (2010) Fascinating Microfungi (Hyphomycetes) of Western Ghats – India. First edition.,Broadway Book Centre, Goa.

3. Powar, C.B. and Daginawala, H.F.(1982) General Microbiology–Volume II. Himalaya Publishing house: Bombay.

4. Prescott, L. M. (2005) Microbiology. 6th ed., Mc Graw-Hill.

5. Shivkumar, P.K., Joe, M.M. &Sukesh K.(2010) An Introduction to Industrial Microbiology. 1st ed., S.Chand& Company Pvt. Ltd.

6. Trivedi, P.S. and Pandey, S.N. (2009) A Textbook of Botany. Volume I. Vikas Publishing House Pvt Limited, New Delhi.

<u>**ANNEXURE A**</u>

<u>**(Summary of changes incorporated in the syllabus)**</u>

Semester	Course Title	Existing (Indicate only the unit where the change is proposed)	Changes Proposed	Specify the reason for the change
Sem II	**BOT-II.C-3** Plant Anatomy and Embryology	Module 1 Module 2 Module 3 Practicals– Module 4	Initiation of leaf primordia Leaf phyllotaxy Identification of wood Induction of flowering, Floral meristems Origin and development of floral parts and floral development in *Arabidopsis* and *Antirrhinum* Causes and consequences of Apomixis and Polyembryony Practical number reduced. Mini projects included	As per the recommendations of the Academic council, it was decided to teach the important concepts thoroughly by devoting more time. Thus, some concepts which may be learnt at higher classes have been removed from the current syllabus. (This applies for all the courses.)
	BOT-II.C-4 Microbiology	Module 1	PPLO	PPLO is removed because its a type of Mycoplasma and mycoplasma is taken up in revised syllabus.

		Module 2 Practicals–Module 4	Transposons Practical number reduced. Mini projects included	Transposomes is removed as it is a componet of Plant Mol Biology. Its explained under gene regulation and expression in Mol Biol paper Sem V.
Sem IV	**BOT-IV.C-6** Cytogenetics	Module 1 Module 2 Module 2 Practicals–Module 4	Removed chromosome mapping. Removed Streptomycin sensitivity in *Chlamydomonas*, Cytoplasmic male sterility Removed Nutrition and environment theory Sex determination Practical number reduced.	
	BOT-IV.E-5 Plant Breeding and Biostatistics	Module 1 Module 2 Module 2	Genetic variability and its role in plant breeding Hybridization in self- and cross-pollinated crops Breeding for abiotic stresses - salinity and drought resistance Student's t- test Practical number reduced.	

		Module 3 Practicals–Module 4		
	BOT-IV.E-6 Systematics of Flowering plants and Phylogeny	**Module 2** Practicals–Module 4	Character weighting and coding removed Families reduced from 20 to 15	
	BOT-IV.E-7 Plant pathology	Module 2 Module 3 Practicals–Module 4	Resistance through chemical treatment & genetically engineered techniques. Mechanism of genetic variation in pathogens Molecular basis for resistance & marker-assisted selection Plant diseases- Replaced Citrus, Vein clearing of Bhendi, Coffee rust with Mango, Amaranth / raddish diseases. Practical number reduced.	
Sem VI	**BOT-VI.C-8**	Practicals–Module 4	Practical number reduced.	

	Plant Biotechnology and Genetic Engineering			
	BOT-VI.E-13 Plant tissue culture	Module 1 Module 2	Media Constituents removed Tissues in cell organelles, hairy root culture. The screening of high-yielding cell lines ;Precursor feeding; Biotic and abiotic elicitors ; Metabolic engineering; Bioreactors	
	BOT-VI.E-14 Horticulture, Floriculture & Landscaping	Turned to a SEC. Four Module system.	---	---
	BOT-VI.E-15 Economic Botany	Module 2	mint oil, Citronella, Gattaparcha	Mint 7 citronella are removed as one example under essential oil ie. eucalyptus oil is already taken up . Guttapercha as drug is removed since known therapeutic drug Tobacco is studied.
	BOT-VI.E-16 Applied Mycology	Practicals–Module 4	Practical number reduced. Combined practicals.	--

COURSE STRUCTURE – DEPARTMENT OF BOTANY

Three year B.Sc. Degree Course in BOTANY revised w.e.f. June 2020.

Semester	Core		Elective			
I	**BOT-I.C-1** Plant diversity	**BOT-I.C-2** Cell Biology and Biomolecules	--------	--------	--------	--------
II	**BOT-II.C-3** Plant Anatomy and Embryology	**BOT-II.C-4** Microbiology	--------	--------	--------	--------
III	**BOT-III.C-5** Physiology of Plants		**BOT-III.E-1** Ecology and Conservation	**BOT-III.E-2** Systematics of flowering plants and Phylogeny	**BOT-III.E-3** Enzymes and their metabolic pathways	**BOT-III.E-4** Herbal Cosmetology
IV	**BOT-IV.C-6** Cytogenetics		**BOT-IV.E-5** Plant Breeding and Biostatistics	**BOT-IV.E-6** Techniques and Instrumentation in Botany	**BOT-IV.E-7** Plant pathology	**BOT-IV.E-8** Algal Biotechnology
V	**BOT-V.C-7** Plant Molecular Biology		**BOT-V.E-9** Bioinformatics	**BOT-V.E-10** Seed Technology	**BOT-V.E-11** Plant Drug Technology and Pharmacognosy	**BOT-V.E-12** Organic Farming
VI	**BOT-VI.C-8** Plant Genetic Engineering		**BOT-VI.E-13** Plant tissue culture	**BOT-VI.E-14** Horticulture, Floriculture and Landscaping	**BOT-VI.E-15** Economic Botany	**BOT-VI.E-16** Applied Mycology

COURSE TITLE: PLANT DIVERSITY (THEORY) W.e.f. June 2020
COURSE CODE: BOT-I.C-1.
MARKS: 100(75 theory + 25 Practical)
CREDITS: 4 (3 theory + 1 Practical)
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

This paper provides knowledge on morphology, structure and importance of the lower group of organisms. Education and awareness about plant diversity, its role in sustainable livelihoods.

COURSE OUTCOMES:

Upon successful completion of the course, students will be able:

CO 1: Explain the evolutionary aspects of different plant groups of lower plants.
CO 2: Define, Describe, correlate and compare the lower plant groups and fossils.
CO 3: Position a given lower plant as per the classification studied.
CO4: Sketch the morphology and anatomy of selected lower plants.

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	Hours
MODULE 1: ALGAE AND FUNGI		15
UNIT I: ALGAE		
1.1	Five kingdom classification	
1.2	Classification of algae (Cyanobacteria, Chlorophyta, Phaeophyta and Rhodophyta) following Lee (1999) upto groups with general characters and examples	
1.3	Endosymbiotic theory: origin of plastids	
1.4	Cyanophyceae:Distribution,systematic position and life cycle of *Nostoc*and Charophyta: *Chara*	
UNIT II: FUNGI		
2.1	General characteristics, Classification, economic importance. Systematic position, life history of *Puccinia*and *Penicillium*	
MODULE 2: BRYOPHYTES AND PTERIDOPHYTES		**15**
UNIT III: BRYOPHYTES		
3.1	General characters, brief classification and alternation of generation	
3.2	Study of morphological and anatomical studies and reproductive	

	character of *Riccia, Marchantia ,Anthoceros and Funaria.*	
UNIT IV: PTERIDOPHYTES		
4.1	General characters, brief classification,stelar evolution, alternation of generation.	
4.2	Structure, reproduction, life history and systematic position of *Psilotum*, *Lycopodium*and *Marsilea*.	
MODULE 3: GYMNOSPERMS, PALEOBOTANY, LICHENS AND ECONOMIC IMPORTANCE.		15
UNIT V: GYMNOSPERMS, PALEOBOTANY, LICHENS AND ECONOMIC IMPORTANCE.		
5.1	General characters, brief classification, alternation of generation of Gymnosperms	
5.2	Systematic position, life history of *Pinus*and *Gnetum*	
5.3	Fossils and fossilization, importance of fossils (with a mention of BirbalSahni institute)	
5.4	Lichens: Structure, Ecological and economic importance of lichens	
5.5	Economic importance of Cyanobacteria, algae, fungi, bryophytes, pteridophytes and gymnosperms.	
	TOTAL	**45**

COURSE TITLE: PLANT DIVERSITY (PRACTICAL)
COURSE CODE: BOT-I.C-1
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

Sr. No	Module 4: Topics	Practical Sessions
1.	Morphological study of algal and Blue green algal forms: *Oscillatoria/Nostoc,Chara,Sargassum, Polysiphonia*	03
2.	Morphological study of fungal forms: *Puccinia, Penicillium, Albugo*and *Rhizopus*	03
3.	Study of lichens (Permanent slide/ specimen)	01
4.	Study of fossils: (Permanent slide/ specimen)	01
5.	Morphological and anatomical study of: i. Bryophyte (preferably *Riccia* or *Anthoceros*) ii. Pteridophyte (preferably *Selaginella*) iii. Gymnosperm (preferably *Cycas*)	05
6.	Mini project: Collection and field study of locally available Algae, Bryophytes, Pteridophyte, Gymnosperms and Lichens	02
	Total	15

REFERENCES:

1. Alexopoulos, Constantine J.;Mims, Charles W. (1983). Introductory Mycology; 3rd edition; New Delhi: Wiley Eastern Limited.

   Edition; McGraw-Hill Book Comp. Tokyo.

2. Fritsch, F.E.,(1956). The structure and reproduction of the Algae; Volume I and II. Cambridge University Press.

3. Kar, AshokKumar;Gangulee, Hirendra Chandra (2006). College Botany: Volume II; 2nd Edition; Kolkata: New Central Book Agency (P)Ltd.

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Publications.

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7. Sharma, O. P. (2017). *Diversity of Microbes and Cryptogams- Bryophyta.* McGraw Hill Education.

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13. Vasishtha B.R. And Sinha A. K. (2005). Botany for degree students Part 1 Algae; 1st Edition S. Chand &CompanyLtd.

Web References:

1. http://www.mycolog.com/
2. https://www.algaebase.org/
3. https://www.conifers.org/
4. http://www.bsienvis.nic.in/Database/Pteridophytes-in-India_23432.aspx
5. *www.bsip.res.in*

COURSE TITLE: CELL BIOLOGY AND BIOMOLECULES (THEORY) w.e.f June 2020
COURSE CODE: BOT-I.C-2
MARKS: 100 (75 Theory+ 25 Practicals)
CREDITS: 4 (3 Theory+ 1 Practical)
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

This course will provide a detailed discussion on a wide range of topics in Cell biology & Bio-molecules emphasizing experimental approaches and key experiments that have provided important insights. The course is aimed at conveying an understanding of how cellular structure and function arise as a result of the properties of cellular macromolecules. Emphasis will be on the dynamic nature of cellular organization, structure and function.

COURSE OUTCOME:

Upon successful completion of the course, students will be able:
CO 1: Recognise, classify cell, explain cell theory, evolution and biogenesis
CO 2: Define, describe, classify and explain cytoskeleton, cell organelle, biomolecules.
CO 3: Define, describe, compare, explain, illustrate cell wall and plasma membrane
CO 4: Predict and interpret the importance of cell

Sr. No	TOPICS	Hours
Module I: Introduction to Cell, Ultra-structure and Function of Cell Wall and Plasma Membrane		**15**
1.1	Discovery and basic properties of cells	
1.2	Prokaryotic and Eukaryotic cell; Cell theory	
1.3	Cell evolution and biogenesis	
1.4	Structure and functions of cytoskeleton;	
1.5	Structure and function of Microtubule, Intermediate filaments, Microfilaments	
1.6	Structure and function of cell wall; Chemical composition of cell wall; Extracellular matrix and cell interactions; Gap -Junctions &plasmodesmata	
1.7	Structure and function of plasma membrane; Active and Passive transport of solute (channels & pumps); Cell signaling- molecules and receptors, signaling network	

Module II: Study of Cell Organelles		15
2.1	Semiautonomy and gene control;	
2.2	Structure & functions of peroxisome, glyoxysome& lysosomes	
2.3	Nucleus and its Organization; Nuclear envelope, nuclear pore complex Nuclear matrix, Chromosomes and chromatin structure	
2.4	Structure and function of ribosome	
2.5	Endomembrane systems- Endoplasmic reticulum and Golgi complex	
Module III: BIOCHEMISTRY OF CARBOHYDRATES, LIPIDS AMINO ACIDS AND PROTEINS		**15**
3.1	Definition & importance of biomolecules; types of bonds in bio-molecules; pH and buffers ; Water as a biological solvent	
3.2	Classification and biological functions of carbohydrates and lipids	
3.3	Classification and biological functions of amino acids and proteins	
	Total	**45**

COURSE TITLE: CELL BIOLOGY & BIOMOLECULES (PRACTICAL)
COURSE CODE: BOT-I.C-2
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

Sr.No	MODULE IV: TOPICS	PRACTICAL SESSIONS
1.	Study of cell structure in *Hydrilla* and *Tradescantia* staminal hairs	1
2.	Examination of prokaryotic cell, eukaryotic cell and cell organelles by EM graphs	1
3.	Preparation of temporary slides to observe different types of cells	2
4.	Staining and Preparation of slides	6
	I. Cytochemical staining of Nucleus- Acetocarmine II. Cytochemical staining of polysaccharides- Periodic Acid Schiff's (PAS) III. Cytochemical staining of Mitochondria – Jannis Green IV. Cytochemical staining of Total proteins –Bromophenol blue V. Cytochemical staining of Histones – Fast Green	
5.	Determination of pH (of plant extracts) using pH meter	1
6.	Quantitative determination of carbohydrates (Anthrone reagent)	1
7.	Estimation of oil in fatty seeds using (Soxhlet apparatus)	2
8.	Estimation of proteins (Lowry's Method)	1
	Total	**15**

REFERENCES:

1. David L. Nelson.& Michael M. Cox. (2013).Lehninger Principles of Biochemistry, 4th ed. W.H. Freeman & Co,New York.
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4. Robert A. Horton. (2006).Principles of Biochemistry.4th ed. Pearson Prentice Hall.
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12. *BIOLOGY JUNCTION*. (2017, April 21). Retrieved February 13, 2020, from Structure & Function of the Cells: https://www.biologyjunction.com/cell++notes+bi.html

COURSE TITLE: PHYSIOLOGY OF PLANTS (THEORY)
COURSE CODE: BOT.III.C-5
MARKS: 100 (75Theory +25 Practical)
CREDITS: 4 (3 Theory +1 Practical)
COURSE DURATION: 45 HOURS

Course objective:
Relate physiological mechanism of plants and their functioning.
Analyze biosynthesis of valuable plant metabolites (primary/ secondary) and their role.

Course outcome:
Upon successful completion of the course, students will be able to:
CO 1: Analyse Physiological processes in plants.
CO 2: Formulate, design experiments and interpret data.
CO 3: Learn to demonstrate and describe the physiological process through practical's and mini projects.
CO 4: Estimate and evaluate methods of quantitation of pigments, enzymes and metabolites.

Sr. No	UNITS, TOPICS AND SUB-TOPICS	Hours
	MODULE -I: PLANT WATER RELATIONS AND SOLUTE TRANSPORT	**15**
1.1 1.2 1.3 1.4 1.5 1.6	Water and its significance to plants Osmotic & water potential of cell Transpiration, stomatal regulation & anti-transpirants Uptake, transport and translocation of water Essentiality of mineral nutrition and its uptake (active, passive and its role on membranes) Transport of organic solutes (source sink relationship)	
	MODULE II: PHOTOSYNTHESIS AND STRESS PHYSIOLOGY	**15**
2.1 2.2 2.3 2.4 2.5	Chloroplast and Light harvesting complexes Z scheme of photosynthesis & Mechanisms of electron transport CO_2 fixation (C3, C4 and CAM pathways) Photoprotective mechanisms (photorespiration) Environmental change and its impact on photosynthesis Responses of plants to abiotic (water, temperature and salt) stresses	
	MODULE III: PLANT GROWTH AND DEVELOPMENT AND SECONDARY METABOLITES	**15**
3.1 3.2 3.3 3.4 3.5	Role of phytochromes & cryptochromes and its functions Plant hormones, transport and physiological functions Photoperiodism and & vernalization Senescence, seed dormancy & germination Biosynthetic pathway of terpenes, phenols and alkaloids and their Functions	
	TOTAL	**45**

COURSE TITLE: PHYSIOLOGY OF PLANTS (PRACTICALS)
COURSE CODE: BOT.III.C-5
MARKS: 25
CREDITS: 1
PRACTICAL SESSION: 15 (*Inclusive of 3 PA*)

Sr. No	TOPICS	PRACTICAL SESSIONS
1	Determination of osmotic potential of plant cell sap by plasmolytic method.	2
2	Determine water potential of given tissue by falling drop/ tissue weight method	2
3.	Chromatographic separation of plant pigments and plant sugars by paper chromatography	3
4	Quantitation of total free amino acids	2
5	**Mini Project**: 1. Mineral deficiency symptoms in plants 2. Secondary metabolites in plants. 3. Oxygen consumption during respiration 4. Role of Plant hormones in plant growth 5. Starch production during photosynthesis 6. Use of hydroponic technique for plant growth	6
		15

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1. Harvey J.M. Hou, Najafpour, M. Mahdi**.,** Moore, G**.** F.**,** Allakhverdiev **S.** I. (2017) Photosynthesis: Structures, Mechanisms, and Applications. Springer Publications.
2. Jordan Smith (2016) Plant and Crop Physiology. Syrawood Publishing House.
3. Taiz, Lincoln., Zeiger, Eduardo., Møller, I. Max and Murphy Angus (2018) Fundamentals of Plant Physiology. Oxford University Press.
4. Taiz Lincoln and Zeiger, Eduardo (2015).Plant Physiology and Development. Sinauer Associates Inc.U.S.
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8. Goodwin Y.W., and Mercer E.I. (2003) Introduction to Plant Biochemistry. 2nd edition CBS Publishers and distributors.
9. Moore T.C. (1989). Biochemistry and Physiology of Plant Hormones Springer –Verlag, New York,USA.
10. Singhal G.S., Renger G., Sopory, S.K., Irrgang K.D and Govindjee (1999).Concept in Photobiology; Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
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12. Nelson , D.I. and Cox M. M. (2000). Lehninger. Principles of biochemistry, 3rd edition, Macmillan U.K.

11. Plummer D. T. (1985). An introduction to Practical Biochemistry 2nd edition. Tata Mcgraw Hill Publishing company Ltd.

CURRENT LITERATURE (JOURNAL ARTICLES):

Plant Physiology, The Plant Cell, Journal of Plant Physiology, Physiologia Plantarum, Plant Physiology and Biochemistry, Postharvest Biology and Technology, Journal of the American Society for Horticultural Science, Nature, Scientific American and Science.

COURSE TITLE: ECOLOGY & CONSERVATION (THEORY) w.e.f June 2020
COURSE CODE: BOT-III.E-1
MARKS: 100 (75 Theory+ 25 Practical)
CREDITS: 4 (3 Theory+ 1 Practical)
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

Objective of this paper is to provide introductory knowledge on biotic and abiotic environmental factors,

pollution and phytogeography with regards to Government regulations towards environmental management with respect to agriculture and food security.

COURSE OUTCOMES:
Upon successful completion of the course, students will be able:
CO 1: To discuss, explain and review the role and importance of biotic and abiotic environment factors in the sustenance of plant life
CO 2: To analyze and evaluate the pollution scenario of the area.
CO 3: To quantitatively estimate the oxygen and Carbon dioxide from different water samples.
CO 4: To evaluate and determine minimum area of sampling unit (using quadrat) for the study of local vegetation.
CO 5: To relate the theory in the natural environment and work towards conservation of the environment.

Sr.No.	**UNITS, TOPICS AND SUB-TOPICS**	**HOURS**
	Module 1: CONCEPT OF ECOSYSTEM, PHYTOGEOGRAPHY AND POPULATION ECOLOGY	**15**
1.1	Concept of Ecosystem, Ecological adaptations of plants belonging to following ecological groups: Hydrophytes, Xerophytes andHalophytes. Shelford's law of tolerance; Introduction to Species diversity indices (Simpson's & Shannon-Weiner) of herbaceous vegetation.	
1.2 1.3	Phytogeography- plant distribution, theories on plant distribution Endemism, Biomes of the world, and phytogeographical regions ofIndia, biosphere reserves, Forest training institutes, Land bridge theory Population Ecology: Survivorship curves- Type I, Type II, Type III. Population growth: Population growth curves – Carrying capacity K, Exponential growth (J shaped curve) and Logistic growth (S shaped curve).	

	MODULE II: ECOLOGICAL FACTORSAND COMMUNITY RELATIONSHIPS	**15**
2.1	Light - quality, duration, absorption, intensity & effects on plants Temperature-variation due to altitude effects on plants, thermal constant and stratification Water- precipitation, moisture & measurement of rainfall	
2.2	Wind - speed, advantages and damage caused to plants	
2.3	Soil- Soil profile, texture, classification and organic matter	
2.4	Community relationships:Biotic interactions, Gaia Hypothesis, Introduction to Optimal foraging theory	
	MODULE III: POLLUTION,LAWS AND ORGANISATIONS	**15**
3.1	Air pollution- polluting gases; ozone depletion, greenhouse effect, global warming, acid rain andsmog	
3.2	Water pollution-eutrophication, sewage, industrial waste, heavy metal pollution	
3.3	Soil pollution – chemical pollutants	
3.4	Bioremediation	
3.5	Forest conservation act, Indian forest act, Biodiversity act, western Ghat protection act,Kasthurirangan Act, Gadgil committee report, Miningcommittee reports, wild life act (**recent acts to bestudied**).	
3.6	Organizations (National & International) working for conservation (NEERI, TERI, MSSRF, IUCN, TRAFFIC)	
	TOTAL	**45**

COURSE TITLE: ECOLOGY & CONSERVATION (PRACTICAL)
COURSE CODE: BOT-III.E-1
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

Sr. No	**Module IV- Topics**	**Practical sessions**
1.	Study of ecological instruments i.e. lux meter, rain guage, hygrometer, wet and dry bulb thermometer, maximum and minimum thermometer	02
2.	To study the physical and chemical characters (moisture, texture and pH) of Sand, Loam and Clay.	02
3.	Analysis of different water samples for oxygen and carbon-dioxide content	03
4.	Estimation of total carbonates from soil sample	01
5.	Visual interpretation of remotely sensed image for vegetation types (Land use land cover, NDVI)	01
6.	Anatomical study of Hydrophytes (leaf), Xerophytes (succulents) and Halophytes (leaf)	01
7.	Mini project: To determine minimum area of sampling unit (quadrat) for the study of local community and to determine species diversity index (Simpson's & Shannon-Weiner) of herbaceous vegetation	05
	Total	**15**

REFERENCES:

1. Ambasht, R.S. (1988),A Text Book of Plant Ecology. Students Friends Co., Varanasi.
2. P. D. Sharma (2004), Ecology and environment, 7th edition, Rastogi publications, Meerut.
3. Jogdand, SN, (1995), Environmental Biotechnology, Himalaya Publishing House, Mumbai.
4. Sharma B. K., (2001), Environmental chemistry ,Sixth revised edition , Goel publication house, Meerut
5. Day A. K., (2002) Environmental Chemistry, Fourth Edition, New Age International Publishers.
6. Santra S.C., (2017), Environmental Science, New Central Agency, NewDelhi.
7. Odum E.P. and Barret G.W., (2004) Fundamental of Ecology. Fifth edition, Brooks/Cole Publishers.
8. Moore, P.W.and Chapman, S.B. (1986). Methods in Plant Ecology. Blackwell ScientificPublications.
9. Piper, C.S. (1950). Soil and Plant Analysis. University of Adelaide,Australia.
10. Sharma, P.D. (2017) ,Ecology and Environment; 13th edition; Rastogi Publishers ,Meerut.
11. Subrahmanyam, N.S.;Sambamurty, A.V.S.S. (2006); Ecology; 2nd edition; Narosa Publishing House , New Delhi.
12. Sangodkar U.M.X and MasurPatil Uma (2018), Fundamentals in Environmental Biotechnology, 1st Edition,CinnamonTeal Publishers.
13. Science Direct:https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/carrying-capacity.
14. World Wide Fund – India :https://www.wwfindia.org/
15. NEERI: https://www.neeri.res.in/
16. TRAFFIC:https://www.worldwildlife.org/initiatives/traffic-the-wildlife-trade-monitoring-network
17. International Union for conservation of nature: https://www.iucn.org/
18. MSSRF- https://www.mssrf.org/
19. TERI-https://www.teriin.org/

COURSE TITLE: TECHNIQUES & INSTRUMENTATION IN BOTANY (THEORY)
w.e.f. June 2020
COURSE CODE: BOT-IV.E-6
MARKS: 100 (75 Theory+ 25 Practical)
CREDITS: 4 (3 Theory+ 1 Practical)
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

Objective of the course is to impart knowledge of principle, methodology and application of various techniques & instrumentation.

COURSE OUTCOMES:

Upon successful completion of the course, students will be able:

CO 1: To understand, define and explain the principle, instrumentation and working of techniques used in Botanical research.

CO 2:Analyze the research problem and formulate the methodology for carrying out research/experiment.

CO 3: To build a hypothetical methodology for analysis of biological samples.

CO 4: To compare and contrast the techniques used in Research fields.

Sr.No	**UNITS, TOPICS AND SUB-TOPICS**	**Hours**
	MODULEI: MICROSCOPY AND RADIOBIOLOGY (PRINCIPLE, METHODOLOGY AND APPLICATIONS)	**15**
1.1	Light microscopy (compound microscopy and Phase contrast microscopy)	
1.2	Fluorescence microscopy	
1.3	Transmission and Scanning electron microscopy (sample preparation for electron microscopy, cryofixation,)	
1.4	Microscopic measurements (Micrometry & cytometry) and photography (micro and macro)	
1.5	Radioactivity and its measurements (Geiger Muller andScintillationcounter and autoradiography)	

MODULEII : CENTRIFUGATION AND SPECTROPHOTOMETRY: PRINCIPLE, METHODOLOGY AND APPLICATIONS		**15**
2.1	Centrifugation: Low speed, high speed, cooling centrifuges and ultracentrifugation Analytical, preparatory and gradient centrifugation	
2.2	UV visual spectrophotometry	
2.3	Fluorescence spectrophotometry	
2.4	Flame (Atomic absorption) spectrophotometry	
2.5	Mass spectrophotometry	
MODULE III: CHROMATOGRAPHY, ELECTROPHORESIS & MOLECULAR TECHNIQUES: PRINCIPLE, METHODOLOGY AND APPLICATIONS		**15**
3.1	Adsorption and partition chromatography	
3.2	Column chromatography (isocratic and gradient)	
3.3	High Performance Liquid Chromatography& Gas Chromatography	
3.4	Electrophoresis: Agarose Gel Electrophoresis,Sodium Dodecyl Sulphate-Polyacrylamide Gel Electrophoresis , Iso-Electric Focussing and 2-Dimensional Electrophoresis	
3.5	Polymerase Chain Reaction, Real Time PCR	
	TOTAL	**45**

COURSE TITLE: TECHNIQUES & INSTRUMENTATION IN BOTANY (PRACTICAL)

COURSE CODE: BOT-IV.E-6

MARKS: 25

CREDITS: 1

SR.NO	Module 4- TOPICS	PRACTICAL
1	Preparation of Molar, Normal and ppm solutions	1
2	Determination of Lambda (λ) max of a given solution Verification of Beer's Law	2
3	Micrometric dimensions (cytometry and micrometry)	2
4	Demonstration of SDS- PAGE/ Agarose gel Electrophoresis	2
5	Preparation of TLC plate and Separation of biomolecules	2
6	Visit to Instrumentation Lab (NIO/College/ Goa University)	1
7.	Demonstration of Flame photometry	1
8	Mini project: 1. Comparison of data ofultra and gradient Centrifugation 2. Microscopy: Analysis of different photo micrographs 3. Photography: To submit a report of macro and micro photography 4. Preparation of column for column chromatography.	4
	Total	**15**

Suggested Reference Books:

1. Karp, G. (1999). Cell and molecular Biology, Concepts and experiments (John Wiley and Sons Inc) 2nd edition.USA.
2. Bajpai P. K. (2006). Biological instrumentation and methodology (S. Chand and Company. Ltd.Mumbai.
3. Plummer D.T. (2009). An Introduction to Practical Biochemistry. 3rd edition. Tata Mc Graw Hill Education Private Ltd. NewDelhi.
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6. vlab.amrita.edu,. (2011). Polyacrylamide Gel Electrophoresis. Retrieved 12 February 2020, from vlab.amrita.edu/?sub=3&brch=186&sim=319&cnt=1
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COURSE TITLE: ENZYMES AND THEIR METABOLIC PATHWAYS (THEORY) w.e.f June 2020.
COURSE CODE: BOT-III. E-3
MARKS: 100 (75 Theory+ 25 Practicals)
CREDITS: 4 (3 Theory+ 1 Practical)
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:
The objective of this course is to understand the importance and mechanisms of enzyme action. The course also discusses about enzymatic regulation & metabolic control of biochemical reactions.

COURSE OUTCOMES:
Upon successful completion of the course, students will be able to:
CO 1: To identify the role of enzymes in various biological processes.
CO 2: To relate the various mechanisms of enzyme action.
CO 3: To specify enzyme characteristics and their metabolism.

Sr.No	UNITS, TOPICS AND SUB-TOPICS	Hours
	MODULE I: BASIC CONCEPT AND CATALYSIS OF ENZYMES	**15**
1.1	Classifications & nomenclature (IUB system).	
1.2	Biological role of enzymes; Concept of holoenzymes, apoenzymes, prosthetic group, iso-enzymes, allosteric enzymes and Active sites.	
1.3	Chemical nature of enzymes, Enzyme activity. Characteristics of enzymes (Physico-chemical and biological properties).	
1.4	Role of co-factors (NAD, NADP+, FMN/FAD, Co-enzyme A, Pyridoxyl phosphate and metal ions).	
	MODULE II: ENZYME KINETICS	**15**
2.1	Factors affecting enzyme activity (concentration, substrate, pH, temperature, inhibitors).	
2.2	Michalis Menten equation and its significance.	
2.3	Fisher's lock and key module and Koschland (induced fit theory), Arrhenius plot.	
2.4	Enzyme action (competitive, noncompetitive and reversible)	

MODULE III: METABOLIC CONCEPTS OF ENZYMES		15
3.1 3.2 3.3 3.4	Glycolysis, Fate of pyruvate (Lactic acid & alcohol fermentation). Citric acid cycle, Respiratory substrate, Mitochondrial Electron transport, Cytochrome, Alternate oxidase pathway, Glycogen cycle. Biosynthesis and degradation of triglycerides. Pathway for amino acid catabolism (Nitrogenase enzyme complex **,** NIF and Nod genes).	
	TOTAL	**45**

COURSE TITLE: ENZYMES AND METABOLIC PATHWAYS (PRACTICALS)
COURSE CODE: BOT-III.E-3
MARKS: 25 MARKS
CREDITS: 1

Sr. No	TOPICS	PRACTICAL SESSIONS
1	Qualitative and quantitative determination for amylase enzyme in the given plant samples.	3
2	Effect of enzyme concentration, temperature, substrate, inhibitors and pH on the activity of α-amylases	5
3	To extract and determine the activity of catalase , lipase and peroxidase enzymes	3
4	a. Mini project on role of Nitrogen in plants b. Application of enzymes in industries (dairy/ pharmaceuticals/ sugar/ waste management/ food/ wine) c. Anaerobic respiration in germinating seeds.	4
	TOTAL	**15**

REFERENCES:

1. Bennett, T. P. and Frieden E. (1969). *Modern Topics in Biochemistry*. pg. 43-45, Macmillan, London
2. Breaker, Ronald R. (2000). Making Catalytic DNAs. *Science* 290: 2095–2096.
3. Campbell, N. A., Jane B. R., and Mitchell L. G. (1999). *Biology,* 5th ed. Menlo Park, CA: Benjamin/Cummings.
4. Deeth, R. J. (1997). Chemical Choreography. *New Scientist* 155: 24–27.
5. Harrow, B. and Mazur, A. (1958). Textbook of Biochemistry, 109, Philadelphia: Saunders
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10. Price C. N., Lewis S. (1999). Fundamentals of Enzymology. Oxford University Press.
11. Berg, J. M., Tymoczko, J. L., Gatto Jr., G. J., & Stryer, L. (2019). *Biochemistry* (9 ed.). New York: WH Freeman.
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13. Voet, D., & Voet, J. (2010). *Biochemistry* (4 ed.). New Jersey: John Wiley & Sons, Inc.

COURSE TITLE: HERBAL COSMETOLOGY (THEORY) w.e.f June 2020

COURSE CODE: BOT-III.E-4

MARKS: 100 (75 Theory +25 Practical)

CREDITS: 4 (3 Theory +1 Practical)

COURSE OBJECTIVES:

To impart knowledge about the different plants that play a very important role in enriching inner health and skin quality.

COURSE OUTCOMES:

Upon successful completion of the course, students will be able:

CO 1: To explain the basics of herbal cosmetology, skin, skin types.

CO 2: To outline the requirements for making herbal soaps, oils, shampoos, face packs, etc.

CO 3: To inculcate the technique of preparation of herbal products.

CO 4: To identify and describe the herbs used for cosmetic products.

CO 5: To understand future prospects of Herbal cosmetic industry.

	TOPICS	**Hours**
Module I: Introduction to Herbal cosmetology		
1.1	Definition, Collection and processing of herbal material, Natural and artificial drying of herbal material	**15 hours**
1.2	Herbal remedies for holistic health	
1.3	Current status of Herbal Cosmetic Industry in India	
1.4	Introduction Herbal edible churnas beneficial for skin and hair	
1.5	Herbs used in weight loss and weight gain: • Herbs for weight gain • Herbs for weight loss (For e.g. Ginseng, Cinnamon, Black Pepper, Dandelion, Yashtimadhu, Ashwagandha)	
1.6	Herbs that help in depression and anxiety Future prospects of herbal cosmetic industry	

Module II: Identification (botanical name and family), description and utilization of following plants with Cosmetic benefits & their cosmetic uses		**15** hours
2.1	i) *Curcuma longa* *ii) Aloe vera* *iii)Azadirachtaindica* *iv) Ocimum sp.* *v) Moringa sp.* *vi) Cymbopogonflexuosus* *vii) Murrayakoenigii* *viii) Citrus limon* *ix) Mentha sp.* *x) Tagetes sp.* *xi) Musa paradisica* *xii) Rosa sp.* *xiii) Manjistha*	
Module 3: Standardization of raw material and commonly used herbs in the herbal cosmetics		**15**
3.1	Importance of standardization	
3.2	Physical and chemical methods of standardization	
3.3	Quantitative and qualitative estimation of phyto-constitutes Herbs used in the following cosmetic product: o Herbal Shampoo o Herbal Conditioner	
3.4	o Herbal Hair Dye/ Herbal Hair Oil/Hair Cream/Hair Gel, o Herbal Face Mask o Herbal Bath Oil. Study of protocol for preparation of : o Different types of Herbal face masks- for dry skin, oily skin, o pigmented skin & wrinkled skin o Special Herbal masks for sensitive skin	

COURSE TITLE: Herbal Cosmetology (Practical)

COURSE CODE: BOT-III.E-4

MARKS: 25

CREDITS: 1

Sr. No.	Module 4- Topics	Practical
1.	Herbal face masks for dry skin, oily skin, pigmented skin, wrinkled skin.	02
2.	Preparation of Herbal Shampoo	02
3.	Demostration of Churna preparation	01
4.	Comparison of Herbal products to non-herbal products	01
5.	Visit to an Ayurvedic institute / local ayurvedic clinic.	02
6.	Extraction of plant pigments- *Lawsonia inermis* (mehndi) and *Curcuma longa* (turmeric),	02
7.	Mini project : • Study of herbal products for weight loss and weight gain • Study of various skin and hair care herbal products available in the market. • Study of locally available herbal Churnas. Local Survey to know about awareness about home remedies for cosmetic purpose.	05
	Total	**15**

REFERENCES:

1. Fuller, K.W. and Gallon, J.A. (1985)Plant Products and New Technology. Clarendon Press,Oxford, New York.
2. Kocchar, S.L. (1998) Economic Botany in Tropics, 'i.'d edition. Macmillan India Ltd., NewDelhi..
3. Simpson, B.B. and Conner-Ogorzaly, M. (1986) Economic Botany- Plants in Our World.McGraw Hill, New York.
4. Sachs, M. (2014)Ayurvedic Beauty Care: Ageless Techniques to Invoke Natural Beauty.ISBN: 9788120818804

5. Sharma, O.P. (1998) Hill's Economic Botany. Tata McGraw Hill Publishing Company Ltd., New
6. www.santulan.in
7. www.pvayurveda.com

COURSE TITLE: **PLANT MOLECULAR BIOLOGY (THEORY)**
COURSE: **BOT-V.C-7**
MARKS: **100 (75 Theory+25 Practicals)**
CREDITS: 4 (3 Theory +1 Practical)
COURSE DURATION: 45 HOURS

COURSE OBJECTIVE

At the end of the course student will able to **e**xplain life processes at the sub-cellular and molecular (gene) level and know general principles of gene organization and functions.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO 1: Outline, memorize and express process of central dogma.
CO 2: Estimate and evaluate methods of quantitation of macromolecules.
CO 3: Understand molecular basis of life.
CO 4: Learn and demonstrate basic molecular technique of DNA isolation and separation through electrophoresis.

Sr. No	UNITS, TOPICS AND SUB-TOPICS	Hours
MODULE-I: NATURE OF GENETIC MATERIAL AND DNA REPLICATION		**15**
1.1	Characteristics of genetic material, evidences to prove DNA & RNA as as genetic material, Watson and Crick's model of DNA; Polymorphism of DNA.	
1.2	Central dogma of molecular biology, Model organism for studying molecular biology; C-value paradox; Chargoff's Law, Franklin's and Wilkin's work	
1.3	General feature of DNA replication (replication eye, replication forks); Types of DNA replication, mechanism of DNA replication in Prokaryotes & in Eukaryotes (Dispersive, Conservative and Semi- conservative); enzymes of replication –DNA Primase; DNA polymerases.	

	Module II: DNA DAMAGE AND TRANSCRIPTION	**15**
2.1	Types of DNA damages and repair (direct reversal of damage, excision repair)	
2.2	Structure and functions of mRNA, tRNA and rRNA	
2.2	Transcription of mRNA in prokaryotes & eukaryotes	
2.3	Post transcriptional event; eukaryotes splicing & processing	
	MODULE III: GENE REGULATION, EXPRESSION & TRANSLATION (PROTEIN SYNTHESIS)	**15**
3.1	Units of gene (Cistron, recon, muton, enhancers, split genes, overlapping genes; transposons and its role in gene structure, promoters & terminators.	
3.2	Gene regulation in prokaryotes (Lac operon concept) & eukaryotes (tryptophan) ; Inducible and repressible mechanism.	
3.3	Secondary structure of mRNA and its functions	
3.4	Mechanism & factors of Translation; RNA polymerases	
3.5	Post translational modifications; Protein targeting	
	Total	**45**

COURSE TITLE: PLANT MOLECULAR BIOLOGY (PRACTICALS)
COURSE CODE: BOT-V. C-7
MARKS 25
CREDIT 1
COURSE DURATION: 15 SESSIONS (*inclusive of 3 PA*)

Sr. No	**TOPICS**	**Practical sessions**
1	Isolation of plant genomic-DNA	3
2	Quantification of DNA by DPA method.	2
3	Isolation and estimation of RNA from plant tissue (orcinol method).	2
4	Preparation of Agarose gel and running of DNA	3
5	Demonstration of DNA amplification by PCR	3
6	Mini Project 1. Spooling of DNA from different plant samples	2
	Total	**15**

REFERENCES:

1. Gupta P.K. (2018) Molecular Biology. Rastogi Publications.

2. Alberts Bruce, Johnson A. Lewis Julian., Raff Martin., Roberts Keith., and Walter Paul (2002). Molecular Biology of the Cell. 4th edition. Garland Publishing, Inc., New York.

3. Buchanan B., Gruissem Wilhelm and Jones Russell L.(2015) Biochemistry and molecular biology of plants. Wiley Blackwell pub Ltd.
4. Pal, J.K. and Ghaskadabi S.S. (2008) Fundamentals of Molecular Biology. Oxford.

5. James D. Watson (2007). Molecular Biology of the Gene (6th Edition) by, Tania A. Baker, Stephen P. Bell, and Alexander Gann.

6. Kleinsmith L.J and Kish V.M (1995). Principles of Cell and Molecular Biology (Second Edition). Happer Collins College Publishers, New York.

7. Lehninger (2008). Principles of Biochemistry by David L. Nelson and Michael M.
8. Dube, R.C. (2008). A Text Book of Biotechnology S. Chand pub.

9. Lewin B. (2000). Genes VII. Oxford University Press, New York.

10. Buchanan B.B, Gruissm W. and Jones R.L (2000). Biochemistry and Molecular biology.
11. Johnson Charlotte (2009) Plant molecular biology.Oxford Book company.

12 David Freifelder(1983) Jones & Bartlett publishers. 2ed Molecular biology. Reprint 1993. Narosa Publishing House.

COURSE TITLE: BIOINFORMATICS (THEORY) w.e.f June 2020
COURSECODE: BOT-V.E-9
MARKS: 100 (75 Theory +25 Practical)
CREDITS: 4 (3Theory +1 Practical)

COURSE OBJECTIVES:

The course will help the students to understand the fundamentals of bioinformatics and tools available.

COURSE OUTCOMES:

Upon successful completion of the course, students will be able to:

CO 1: Introduce, explain the basics of Bioinformatics and biological databases.

CO 2: Compare and contrast protein information resources and genome information resources, different biological databases and its role in molecular level sequencing

CO 3: Relate the theoretical knowledge with practical sessions. Enable data handling and analysis.

CO 4: To define the terminologies, types of biological databases and its applications

CO 5: Compare the homology between different biological species.

CO 6: To explore websites (online) and understand the need of Bioinformatics

	TOPICS	Hours
MODULE 1: INTRODUCTION TO BIOINFORMATICS AND INFORMATION NETWORKS		
1.1 1.2 1.3 1.4 1.5	Introduction to bio-informatics, The biological sequence / structure deficit. Genome projects, Pattern recognition and prediction, Levels of protein structure, Ramachandran Plot Role of Chaperons, Sequence analysis. Fields Related to Bioinformatics: Computational Biology, Genomics, Proteomics, Pharmacogenomics, Cheminformatics, Medical Informatics, Importance of Bioinformatics. Internet and the facilities available on it, computational biology, What is World Wide Web, Web browsers and Web Addresses. The National Centre for Biotechnology Information- NCBI, MMDb The European Molecular Biology Network- EMBnet Bioinformatics programme in India- BTISNet, BPI-2004, BOLD (Bar code of life database)	**15 hours**

MODULE II: INTRODUCTION TO BIOLOGICAL DATABASES AND SEQUENCE ALIGNMENT METHODS.		**15**
2.1	Introduction To Biological Database : GenBank, EMBL, SwissProt, PROSITE, EC-ENZYME, PDB, GDB, OMIM,PIR-PSD.	15 hours
2.2	Introduction and comparison of Homology, Analogy, Orthology And Paralogy. Alignment based methods and Hybrid method. Comparison of Computer Prediction Algorithms	
2.3	Introduction to pairwise and multiple sequence alignment; Comparison of sequences; Global alignment: The Needleman and Wunsch algorithm; Database interrogation, Alphabet and complexity; Pairwise database searching.	
2.4	BLAST; Databases of Multiple Alignments, Clustal Omega	
MODULE 3: PROTEIN AND GENOME INFORMATION RESOURCES		**15**
3.1	Introduction to Protein information resources, Primary Sequence Databases, Composite protein sequence databases, Secondary databases, Composite protein pattern databases; Structure classification databases.	
3.2	Introduction to genome information resources, DNA sequence databases, Specialised genomic resources, ORF (Open Reading Frame Finder), TIGR Genome Resources ,Genome comparison, Genome Annotation, Microarray image analysis	
	Total	**45**

COURSE TITLE: BIOINFORMATICS

COURSE CODE: BOT-V.E-9

MARKS: 25

CREDITS: 1

SR. NO	Module 4- TOPICS	PRACTICAL
1.	Biological databases and exploring various websites- NCBI, PUBMED and GenBank databases	3
2.	To explore EBI server and searching EMBL	2
3.	Exploring and querying UniProt KB	1
4.	Pairwise global alignment of protein and DNA using Needleman- Wunsh algorithm.	2
5.	Obtaining sequences for Pairwise alignment and to interpret the results to study the homology between the sequences.	2
6.	Database searching using different versions of BLAST and FASTA and Derivation of relationships of query sequences.	2
7.	Use of Clustal Omega for multiple sequence alignment	1
8.	MINI PROJECTS 1. Drug designing 2. Construction of phylogenetic trees/cladogram (comparison between different organisms)	2
	TOTAL	**15**

REFERENCES:

1. Attwood, D. J., Parry Smith D.J. and Phukan, S. (2011). Introduction to Bioinformatics; Pearson education.
2. Ignacimuthu, S. (2005). Basic Bioinformatics. Narosa PublishingHouse
3. Khan, I. A. and Khanum, A. (2003). Fundamentals of Bioinformatics –Ukaaz publications.
4. Mani, K. and Vijayaraj, K.A. (2002). Bioinformatics for Beginners. Aparnaa Publication.
5. Murthy, C. S. V. (2004). Bioinformatics. Himalaya Publishing House.

Web Resources

1. http://genes.mit.edu/GENSCAN.html
2. http://vmoc.museophile.org ComputerHistory
3. http://www.clcbio.com/index
4. http://www.genome.jp
5. http://www.genome.jp/dbget/LinkDB

6. http://www.ncbi.nlm.nih.gov/Structure/CN3D/cn3d.shtml

7. http://www.softberry.com/berry

8. http://www.studentworkzone.com/

9. www.ebi.ac.uk

10. www.fgcu.edu/support/office2000

11. www.learnthenet.com WebPrimer

12. www.clustawomega.org

14.www.embl.org

Research article:

1. Antre R.V *et al.,* Computer aided Drug Design: An Innovative Tool for Modeling, Open Journal of Medicinal Chemistry, 2012,2,pp139-148.
2. Surabhi et al, Computer aided drug designs: An overview, Journal of Drug Delivery and Therapeutics, 2018; 8(5);pp504-509. Available at http://jddtonline.info

Drug Design Softwares:

1. ArgusLab- https://www.arguslab.com
2. Schrodinger- https://www.schrodinger.com/
3. VlifeMDSTM- https://vlifesciences.com/
4. Accelrys
5. SYBYL
6. AutoDock- https://autodock.scripps.edu/
7. FlexX- https://www.biosolveit.de/FlexX
8. Vakser Lab
9. Ligplot: https://www.ebi.ac.uk/thornton-srv.software/LIGPLOT/
10. LiganScout- https:/www.intelligand.com

COURSE TITLE: SEED TECHNOLOGY (THEORY)
COURSE CODE: BOT-V. E-10
MARKS: 100 (75+25)
CREDITS: 4 (3+1)
DURATION: 75 HRS

COURSE OBJECTIVE

Characterize seeds based on their viability, know and apply the theoretical knowledge to conserve the germplasm .

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO 1: Review characteristics of good seeds and their role in germination.
CO 2: Know methods of seed testing and understand seed viability.
CO 3: Realize the role of seed banks, seed storage units and seed testing organizations.
CO 4: Apply knowledge of seed types to the field.

Sr. No	UNITS, TOPICS AND SUB-TOPICS	Hours
Module-I: PRINCIPLES OF SEED TECHNOLOGY AND SEED TESTING ORGANIZATIONS		**15**
1.1 1.2	Concepts and role of seed technology; Seed definition; types of seed (breeders seed, foundation seed, and certified seed); characteristics of good seeds. National seed corporation. International seed testing association ; central and state seed testing laboratory; Role of ICRISAT AND ICAR; Procedure, Equipments for seed testing; and importance of seed testing	
Module II: PLANT BREEDING IN RELATION TO SEED TECHNOLOGY		15
2.1 2.2	Maintenance of breeders seed methods in self and cross fertilized crops. Development trial and release of seed variety Germplasm and its conservation, seed banks and types of seed collections; Use of heterosis in crop improvement	
Module III: SEED PROTECTION, PROCESSING AND STORAGE		15
3.1 3.2 3.3	Importance of epidemic and seed borne diseases; Factors affecting seed infection Control of Seed borne pathogens; Pest problems and their treatment during storage Methods of seed drying and their advantages; Chemicals and equipments for seed treatments; Concept of seed marketing; Forecasting of seed.	
	Total	45

COURSE TITLE: SEED TECHNOLOGY (PRACTICALS)
COURSE CODE: BOT-V.E-10
MARKS: 25
CREDITS: 1
DURATION: 15 SESSIONS (*inclusive of 3 PA*)

Sr. No	TOPICS	Practical sessions
1	Physical and chemical properties of seed	3
2	Structure of dicot and monocot seeds from various plant species	3
3	To test seed viability (2,3,5-triphenyl tetrazolium chloride test)	2
4	**Mini Projects** 1. Breaking of seed dormancy methods (chemical, hormone & temperature) 2. Seeds and diseases 3. Seed moisture and germination 4. Preparation of seed balls	6
5	Visit to ICRISAT/ seed tech plant and report submission	1
	Total	15

REFERENCES:

1. Agrawal (2005). Seed Technology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Pandey (2010). A text book of Botany. S. Chand and Company Ltd., New Delhi.
3. Reddy (2008). Principles of crop production. Kalyani Publishers, New Delhi.
4. Santra and Chatterjee (2007).College Botany, New Central Book Agency (P) Ltd., Kolkata .
5. Umaraniet. A.L. (2006). Experimental Seed Science and Technology, Agrobios, Jodhpur.
6. Dutta (1983). A Class book of Botany, Oxford University Press, Calcutta.

COURSE TITLE: PLANT DRUG TECHNOLOGY AND PHARMACOGNOSY (THEORY)(w.e.f. June 2020)
COURSE CODE: BOT-V.E-11
MARKS: 100(75 Theory+ 25 Practicals)
CREDITS: 4 (3 Theory+ 1 Practical)
COURSE DURATION: 45 HOURS
COURSE OBJECTIVES:

To enable the students to learn and understand the fundamental knowledge, techniques & skills in plant drug industry, drug discovery and development.

COURSE OUTCOMES:
Upon successful completion of the course, students will be able to:

CO 1: Explain, discuss and classify medicinal plants, plant drug and technology
CO 2: Explain and illustrate, biosynthetic pathways, bioassays and working of instruments
CO 3: Discuss and compare methods of extraction and analysis of phytochemicals.

SR. NO.	TOPICS	HOURS
	MODULE I: INTRODUCTION	**15**
1.1	Introduction to plant drug technology and Pharmacognosy	
1.2	Classification of drugs: morphological, chemical and pharmacological.	
1.3	Identification of marker compounds in the formulations. Bioassays, Fingerprint and identification of plant drugs.	
1.4	Biosynthesis of alkaloids. Metabolic pathways of selected plants (from *Ocimum sanctum* and *Rauwolfia*).	
	MODULE II: CULTIVATION, COLLECTION AND CONSTITUENTS	**15**
2.1	ROOTS/ RHIZOME: *Rauwolfia* and *Curcuma*	
2.2	LEAVES: *Adathoda* and *Ocimum*	
2.3	SEEDS: Fenugreek and Nutmeg	
2.4	FRUITS: Coriander and Senna pod	
2.5	FLOWERS: Clove and Rose	
	MODULE III: PHYTOCHEMICALS (EXTRACTION AND ANALYSIS)	**15**
3.1	Extraction methods and principles. Traditional and modern techniques	
3.2	Methods of Characterization: NMR,MS,UV-Vis, GC-MS, LC-MS	
3.3	Analysis of Pigments, Phenolics, Flavonoids and Alkaloids.	

		TOTAL	45

COURSE TITLE: PLANT DRUG TECHNOLOGY AND PHARMACOGNOSY (PRACTICAL)
COURSE CODE: BOT-V.E-11
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

Sr. No.	MODULE IV: TOPICS	Practical
1.	Isolation of alkaloids and Phenolics	**02**
2.	Test for alkaloids: Mayer's, Wagner's, Dragendorffs' reagent	**01**
3.	Disc diffusion for antimicrobial assay	**02**
4.	MIC evaluation for antimicrobial assay	**02**
5.	Anatomical study of *Nux vomica* seeds, Ginger, Citronella leaf, Senna leaf & its medicinal properties	**04**
6.	Histochemical tests for Oils And Fats – Castor seed/ *Eucalyptus*Citrus	**01**
7.	Microchemical test of Arum / *Colocasia* leaves for observation of Calcium oxalate crystals.	**01**
8.	Mini project Adulteration of crude drugs	**02**
	TOTAL	**15**

<u>REFERENCES:</u>

1. Gokhale, S.B.&Kokate, C.K. (2009). *Pharmacognosy*. Maharashtra: NiraliPrakashan.

2. Khandelwal, K. R. (2008). *Practical Pharmacognosy*. Maharashtra: NiraliPrakashan.

3. Kokate, C. K. (2008). *Pharmacognosy*. Maharashtra: NiraliPrakashan.

4. Qadry, J.S. (2014). *A Textbook of Pharmacognosy, Theory and Practicals*. New Delhi:CBS Publishers & Distributors.

5. Trease, G.E. & Evans, W.C., (2002). *Pharmacognosy*. USA: Elsevier Science Publishers.

6. Wallis, T. E. (2005). *Textbook of Pharmacognosy*. New Delhi: CBS Publishers & Distributors.

7. Leland, J. C. (2006). *Natural Products from Plants*. New York:Taylor and Francis.

8.Harborne, J. B. (2010). *Phytochemical Methods*. New Delhi: Springer International edition.

9. Mammen, D. (1991). *Methods in Plant Chemistry and Economic Botany*. New Delhi: Kalyani publishers.

10. Kumar, G. S., & Jayaveera, K. N. (2014). *A Textbook of Pharmacognosy and Phytochemistry.* New Delhi: S. Chand & Company Pvt. Ltd.

11. McCreath, S. B., & Delgoda, R. (2017). *Pharmacognosy: Fundamentals, Applications and Strategies.* Amsterdam: Mica Haley.

12. Shah, B., & Seth, A. (2010). *Textbook of Pharmacognosy and Phytochemistry.* New Delhi: Elsevier Health Sciences.

13. What is Pharmacognosy. (2020, February 12). Retrieved from www.pharmacognosy.com: https://pharmacognosy.com/pharmacognosy-consulting-firm/

14. Pharmacognosy. (2020, February 12). Retrieved from www.phytojournal.com: http://www.phytojournal.com/pharmacognosy

15. Pharmacognosy Journal. (2020, February 12). Retrieved from www.scimagojr.com: https://www.scimagojr.com/journalsearch.php?q=19700175096&tip=sid

16. (2020, February 12). Retrieved from www.medicinalplants-pharmacognosy.com: https://www.medicinalplants-pharmacognosy.com/

COURSE TITLE: ORGANIC FARMING (THEORY)w.e.f June 2020
COURSE CODE:BOT-V.E-12
MARKS: 100 (75 Theory +25 Practical)
CREDITS: 4 (3Theory +1 Practical)
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

The course provides knowledge of principles and practices of organic agriculture and its role in sustainable crop production.

COURSE OUTCOMES:
Upon successful completion of the course, students will be able to:

CO 1: To understand the need and basics of Organic Farming, create awareness of the social, economic and environmental context for current and future organic agricultural production and management.
CO 2: Assess the importance of organic foods in today's World.
CO 3: Analyse and interpret the given problem in components of Organic Farming.
CO 4: Apply the knowledge in becoming an entrepreneur in Organic Farming to create own business plan.

Sr.No.	**UNITS, TOPICS AND SUB-TOPICS**	**HOURS**
MODULE 1: Concept of Organic farming, compost, manures and its application.		**15**
1.1	Introduction: Farming, organic farming, concept and development of organic farming. Principles of organic farming, Types of organic farming. Needs and benefits of organic farming. Agencies and institutions related to organic agriculture. Farm components for an organic farm	
1.2	Manure application: Composted vs. uncomposted manure Composting- principles, stages, types and factors Composting methods, Vermicomposting Bio-fertilizers, M.I., F.I.M., Neem cake, Mulching, Elley farming, Bioinoculation	
MODULE II:Soils, Soil Fertility Management and fertilizers		**15**

2.1 2.2 2.3 2.4 2.5 2.6	Soil types and Soil tillage Factors affecting soil fertility and productivity Land preparation Water management for good soil, Commercial fertilizers, composition Residual effects and fertilizer use efficiency Foliar application and its concept	
MODULEIII: Organic plant protection, Seed Certification and Entrepreneurship Development		**15**
3.1 3.2 3.3 3.4 3.5 3.6	Plant protection- cultural and mechanical Plant protection- bio pesticide and bio control agents. Allelopathic methods of weed control. Certification of organically produces seeds. Entrepreneurship – Concept, characteristics, approaches, need for entrepreneurship in Organic farming Popularization of organic farming. Marketing of organic produce. National and international scenario of organic farming	
	TOTAL	**45**

COURSE TITLE: ORGANIC FARMING (PRACTICAL)
COURSE CODE: BOT-V.E-12
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

Sr. No	Module IV- Topics	Practical sessions
8.	Comparative analysis of pH, EC, organic C, total N, available N, P, K and S from organic and inorganic data (obtained data).	01
9.	Survey of weeds in crop fields (Organic v/s inorganic farming)	01
10.	Study of soil types.	01
11.	Observation of Mycorrhizae	01
12.	Study of bio pesticide (Neem cake)	01
13.	Study of Mulching	01
14.	Study of nitrogen fixing bacteria in leguminous plants	01
15.	Visit to an organic farm	02
16.	Mini project: Preparation of Compost/ vermi-compost Effect of various manures on plant growth. Study of recycling of farm waste.	06
Total		**15**

REFERENCES:

1. Chakraverty, A. (1991). Post-harvest technology of cereal, pulses and oil seeds. Oxford IBH Publishing Co. Pvt Ltd.

2.Deshmukh, S.N. (2012). Organic Farming: Principles, Prospects and Problems, AgrobiosPublishers (India).

3. Gehlot, D. (2010). Organic Farming: Components and Management, Agrobios Publishers (India).

4. Gupta, O.P. (2010). Modern weed management. AgrobiosPublishers .

5. Israelsen, O.W. and Hansen, V.E. (2015). Irrigation Principles and Practices. John Wiley & Sons Inc.

6. Kanwar, J.S. (1978). Soil Fertility, Theory and Practice. Indian Council of Agricultural Research Publication.

7. Palaniappan, S.P. and Annadurai, K.A. (2010). Organic Farming: Theory and Practice. Indian Council of Agricultural Research, Scientific Publishers Journals Dept.

8. Rao, V.S. (2000). Principles of Weed science. Taylor & Francis Publishers.

9. Reddy, T.Y. and SankarReddi, G. H. (2015). Principles of Agronomy. Kalyani Publishers.

10. Sadhu, A.N. and Singh, A. (2014). Fundamentals of Agricultural Economics. Himalaya Publishing House.

11. Saraswat, V.N., Bhan, V. M. and Yaduraju, N.T. (2003). Weed management - (ICAR), Indian Council of Agricultural Research Publication.

12. Sharma, A.K. (2002). A hand book of Organic Farming. Agrobios Publishers.

13. Singh, B. D. (2006). Plant Breeding Principles and Methods. Kalyani Publishers.

14. Tisdale, S.L., Nelson, W.L., Beaton, J.D. and Havlin, J. L. (2013). Soil fertility and fertilizers. Pearson Publishers.

15. Yawalkar, K. S., Agrawal, J.P. and Bokde, S. (1962). Manures and Fertilizers. Agri-Horticulture Publishing House.

16.*Introduction to Organic Farming*. (n.d.). Retrieved February 13, 2020, from http://agritech.tnau.ac.in/: http://agritech.tnau.ac.in/

17. Reddy, J. (2017, February 19). *Organic Agriculture Information Guide*. Retrieved February 13, 2020, from AgriFarming: https://www.agrifarming.in/organic-agriculture.

COURSE TITLE: HORTICULTURE, FLORICULTURE AND LANDSCAPING (THEORY) w.e.f June 2020
COURSE CODE: BOT-VI.E-14
MARKS: 100 (75 Theory +25 Practical)
CREDITS: 4 (3 Theory +1 Practical

COURSE OBJECTIVES:
To provide entrepreneur opportunities.

COURSE OUTCOMES:
Upon successful completion of the course, students will be able to:

- To explain the basics of Horticulture, floriculture and landscaping.
- To outline the requirements for building up nurseries, garden, etc.
- To inculcate the technique of vegetative propagation of plants.
- To identify and relate the scope of these fields in building up career.

	TOPICS	**Hours**
Module I: Introduction to Horticulture		
1.1	Definition and importance; scope of PomocultureOlericulture, Floriculture	**15 hours**
1.2	Fertilizers: inorganic, Organic – biofertilizers: vermin composting, green manure, algal culture, FYM.	
1.3	Pots & potting:– Earthen, Fibre, Polythene bags, Potting mixture, Potting, Re-potting, Top dressing.	
1.4	Irrigation:- Surface, Sprinkle, Drip and Gravity irrigation	
1.5	Use of plant growth regulators in horticulture: Induction of rooting, flowering, fruit set, fruit development and control of fruit crops.	

Module II: Introduction to Floriculture and Propagation methods		**15 hours**
2.1	Knowledge of annual, biennials and perennials with reference to ornamental flowers.	
2.2	Cultivation of commercial flowers – Rose, Jasmine, Chrysanthemum., Crossandra& Orchid	
2.3	Nursery maintenance; Cut flowers ; flower arrangements (including ikebana); improving shelf life of cut flowers. Green house, Poly house, Moist chamber, Net frame	
2.4	Sexual methods (seed propagation) – Definition, Merits and Demerits, Criteria for selection of seeds.	
2.5	Asexual (Vegetative) propagation – Definition, and types- Cutting (root, stem, leaf), Layering (simple, air), Grafting (Whip, Approach) and Budding (T, patch), Stock –scion relationship in important horticultural crops.	
Module III: Introduction to Landscaping		**15**
3.1	Types of garden: Formal, informal and kitchen garden.	
3.2	Locations in the garden- edges, hedges, fence, lawn, flower beds, Avenue, water garden (with two examples of each). Focal point. Auto CAD in garden designing	
3.3	National parks, Botanical gardens, water garden, rockery plants, Bonsai techniques, Hydroponics.	
3.4	Lawn making: type of lawn grasses and maintenance. Plants suitable for hedges. Aftercare: Weeding, top dressing methods of pruning and topiary	
	Total	**45 hours**

COURSE TITLE: HORTICULTURE, FLORICULTURE AND LANDSCAPING

COURSE CODE: BOT-VI.E-14

MARKS: 25

CREDITS: 1

Sr. No.	Module 4- Topics	Practical
1.	Preparation of nursery bed and polybag filling	01
2.	Preparation of potting mixture – Potting, repotting.	02
3.	Field work in cutting, grafting, budding, layering	02
4.	Garden designing using Auto CAD software/any app	01
5.	Familiarizing gardening tools and implements	01
6.	Preparation of organic compost&vermicompost	02
7.	Establishment of vegetable garden using organic compost &vermi-compost	03
8.	Flower arrangement	01
9.	Visit to nurseries, gardens and Report.	01
10	Improving the shelf life of cut flowers using chemicals	01
	Total	**15**

REFERENCES:

1. Swarup V. (1997). Ornamental horticulture. MaMillan India Limited, NewDelhi.
2. Randhava, G.S, 1973 – Ornamental horticultural in India Today and Tomorrow Printers and Publishers, NewDelhi.
3. Trivedi TP (2007). Ornamental horticultural in India. Indian Council of Agricultural Research NewDelhi.
4. Nayak, K.C. South Indian fruits and their culture P.L. Varadaraj & Co.,& Lingichetti Street, Madras.
5. Edment Senn Andrews 1994 Fundamentals of Horticulture – Tata McGraw Hill Publishing Co., Ltd.,Delhi.
6. Richard B, 'Pruning, Training & Topiary', Lorenz Books.
7. Sara Oldfield, Botanic Garden, New Holland Publishers UK Ltd.
8. Alan Titchmarshs gardening guides (1984), Lawns, Hamlyn.

9. Alan Titchmarshs gardening guides(1984), Bush Roses, Hamlyn.
10. Alan Titchmarshs gardening guides(1984), Climbing Plants, Hamlyn.

Web links:

1. http://agritech.tnau.ac.in/horticulture/horti_index.html
2. http://agritech.tnau.ac.in/horticulture/horti_flower%20crops.html
3. http://agritech.tnau.ac.in/horticulture/horti_nursery%20techniques.html

COURSE TITLE: BASICS IN HORTICULTURE (THEORY)w.e.f June 2020
SKILL ENHANCEMENT COURSE

MARKS: 60

CREDITS: 3

COURSE OBJECTIVES:

Is to provide entrepreneur opportunities.

COURSE OUTCOMES:

Upon successful completion of the course, students will be able to:

CO 1: Explain the basics of Horticulture, floriculture and landscaping
CO 2: Outline the requirements for building up nurseries, garden, etc.
CO3: Inculcate the technique of vegetative propagation of plants.
CO 4: Identify and relate the scope of these fields in building up career

Sr.No	Topics	Hours
Module I: Tools and Techniques in Horticulture, floriculture		**15**
1.1	**Theory sessions:** Definition and importance; Pomoculture, Olericulture, Floriculture. **Fertilizers**: inorganic, Organic – biofertilizers: vermicomposting, green manure, algal culture, FYM. Knowledge of annual, biennials and perennials with reference to ornamental flowers Irrigation:- Surface, Sprinkle, Drip and Gravity irrigation Introduction to Green house, Poly house, Moist chamber, Net frame, Introduction to Hydroponics.	
1.2	**Practice sessions:** i) Local visits to nurseries, home gardens to know about different pots and its potting system ii) Preparation of potting mixture – Potting, repotting iii) Preparation of organic compost &vermicompost iv) Familiarizing gardening tools and implements v) Improving the shelf life of cut flowers using chemicals vi) Study of Hydroponics vii) Local visit to an established green house/polyhouse and report making.	

Module II: Propagation Methods		15
2.1 2.2	**Theory sessions:** Introduction to sexual methods (seed propagation) – Definition, Merits and Demerits, Criteria for selection of seeds. Asexual (Vegetative) propagation – Definition, and types- Cutting (root, stem, leaf), Layering (simple, air), Grafting (Whip, Approach) and Budding (T, patch), Stock –scion relationship in important horticultural crops. Use of plant growth regulators in horticulture Practice sessions: i) Field work in cutting, grafting, budding, layering ii) To design experiments for induction of rooting, flowering, fruit set, fruit development and control of fruit crops iii) To study the cultivation practices of local commercial flowers iv) Field work in Nursery management; Cut flowers; to improve shelf life of cut flowers. v) Visit to a local florist for learning different forms of flower-arrangement and live tutorials in classroom on various examples of flower arrangement all around the world	
Module III: Landscaping		**15**

3.1	**Theory sessions:** Types of garden: Formal, informal and kitchen garden Locations in the garden- edges, hedges, fence, lawn, flower beds, Avenue, water garden (with two examples of each). Focal point. Auto CAD in garden designing.Bonsai techniques	
3.2	**Practice session:** i) Visit to local gardens and giving comparative account of types of garden ii) Listing of plants used for edges, fence, lawn, flower beds, water gardens, etc. iii) Visit to a botanical gardens/ water garden iv) To learn different styles of Bonsai techniques v) Lawn making: type of lawn grasses and maintenance. Plants suitable for hedges. Aftercare: Weeding, top dressing methods of pruning and topiary vi) Garden designing using (preferably Auto CAD) software	

Module 4: Applications of Horticulture, Floriculture and Landscaping		**15**
4.1	Theory sessions: Entrepreneurship skills, Invited lecture by Guests (Spice Farm owner, Ecotourism sector, Organic farmer/ Organic products outlet owner, Nursery manager/ Landscaper, Krishivigyan Kendra, Agriculture dept, Forest Dept, etc) Latest schemes in horticulture, floriculture, agriculture in Goa.	
4.2	**Practice sessions:** Preparation of garden design (area of the campus) Innovative ideas for beautification of the campus and preparation of the same. Establishment of vegetable garden using organic compost &vermi-compost Or Internship at any firm related to Horticulture.	
	Total	**60**

REFERENCES:

11. Swarup V. (1997). Ornamental horticulture. MacMillan India Limited, New Delhi.
12. Randhava, G.S, (1973) – Ornamental horticultural in India Today and Tomorrow Printers and Publishers, NewDelhi.
13. Trivedi TP (2007). Ornamental horticultural in India. Indian Council of Agricultural Research NewDelhi.
14. Nayak, K.C. South Indian fruits and their culture P.L. Varadaraj & Co. ,& Lingichetti Street, Madras.
15. Edment Senn Andrews (1994) Fundamentals of Horticulture – Tata McGraw Hill Publishing Co., Ltd., Delhi.

<u>Weblink</u>

1. http://agritech.tnau.ac.in/horticulture/horti_index.html

Parvatibai Chowgule College of Arts & Science
(Autonomous)
Margao –Goa
Department of Botany

Certificate course in Herbal Cosmetology

SYLLABUS

Sr.no	Topics	Time (hour)
1	Introduction to herbal cosmetology.	1
2	Concept of Skin, skin types and metabolism.	2
3	Ayurvedic guidelines about diet and nutrition for healthy skin and hair.	2
4	Hair and its types,	1
5	Hair growth and metabolism in body.	2
6	Ayurvedic management of hairfall, dandruff and premature greying.	2
7	Benefits of tulsi, neem, *Aloevera*, fenugreek seeds, ragietc in herbal Cosmetology.	2
8	Scope of herbal cosmetology	1
9	Assignment	3
10	Written exam	2
11	Practical exam	2
	Total	**20**

Sr.no	Practicals	Sessions
1	Preparation of herbal soaps and lipbalms.	2
2	Preparation of herbal oil, shampoos etc	2
3	Preparation of facepacks,body massage powder etc	2
4	Practice sessions- skin products	2
5	Practice sessions- hair products	2
	Total	**10**

ANNEXURE A

(Summary of changes incorporated in the syllabus)

Semester	Course Title	Existing (Indicate only the unit where the change is proposed)	Changes Proposed	Specify the reason for the change
Sem I	**BOT-I.C-1** Plant Diversity	**Module 2:** **4.1**	Added Stelar Evolution	Questions based on the said topic are common at entrance exams
	BOT-I.C-2 Cell Biology and Biomolecules	No changes made	The course syllabus is modified into 4 module system (3 theory and one practical)	As it was proposed
Sem III	**BOT-III.C-5** Plant Physiology	Practical component	➢ Practical no. 3 was specified as paper **chromatography** No change in title ➢ Addition of Hydroponics and plant growth as Mini project. Latest book references are along with existing ones.	The course syllbabus was modified into 4 modules (3 theory and 1 practical) as per **college requirement**. Earlier units were merged to make to 3 modules even though they are independent units and had no connection to each other.
	BOT-III.E-1 Ecology and	Module 1 1.1	The course syllabus is modified into 4 module	The BoS members felt the need of

	Conservation	1.2 Module II 2.3 Module III 3.5 Module IV-Practical 1. 3..	system (3 theory and one practical) Addition of Shelford's law of tolerance; Introduction to Species diversity indices (Simpson's & Shannon-Weiner) of herbaceous vegetation. 1.2 Land bridge theory is incorporated Title of the module is renamed to Ecological factors and community relationships Community relationships: Addition of Biotic interactions, Gaia Hypothesis, Optimal foraging theory POLLUTION, LAWS AND ORGANISATION S. Addition of Organizations (National & International) working for conservation (NERI, TERI, MSSRF, IUCN, TRAFFIC) To study the physical and chemical characters (moisture, texture and pH) of Sand, Loam and Clay. Visual interpretation of remotely sensed image for vegetation types (Land use land cover, NDVI) Anatomical study of Hydrophytes (leaf), Xerophytes (succulents) and Halophytes (leaf). New references added.	removing Food chain, food web, ecological pyramids as they study the same under environmenta l studies. The addition of topics are done according to NET /SET Life Science syllabus. The soil types should be mentioned. BoS member suggested the inclusion of study and calculation of vegetation

				cover, Land use Land Cover and NDVI was added.
	BOT-III.E-2 Systematics of Flowering plants and Phylogeny	**The course is interchanged with Techniques and Instrumentation in Botany**	The semester in which it will be offered and course code is changed.	The BoS members felt the need of floating this paper earlier than applied courses. Availability of plants is the best in the Monsoon season.
	BOT-III.E-3 ENZYMES AND THEIR METABOLIC PATHWAYS	**All Modules** **Module 1** **1.2** **1.3** **1.4** **Module 2**	Matter rearranged into 4 sub units Renamed as "Basic concept and catalysis of enzymes" 1.2 and 1.3 combined together Added Active sites 1.4 and 1.5 combined together. Renamed as "Chemical nature of enzymes, Enzyme activity. Characteristics of enzymes (Physico-chemical and biological properties)." Added new & Renamed as: Role of co-factors (NAD, NADP+, FMN/FAD, Co-enzyme A, Pyridoxyl phosphate and metal ions). Renamed as "Enzyme Kinetics" Entire module rearranged	To bring about uniformity To suit the contents Important aspect of enzymes To suit the contents

			and modified	
		2.1	Added new & Renamed as: Factors affecting enzyme activity (concentration, substrate, pH, temperature, inhibitors).	
		2.2	Renamed as: Michalis Menten equation and its significance.	Important for NET-SET examinations
		2.3	Renamed as: Fisher's lock and key module and Koschland (induced fit theory), Arrhenius plot. Added new: Arrhenius plot.	Important for NET-SET examinations
		2.4	Renamed as: Enzyme action (competitive, non-competitive and reversible)	Basic concepts of enzyme action
		Module 3	Renamed as "Metabolic concepts of enzymes" Entire module rearranged and modified	To suit the contents
		3.1	Renamed as: Glycolysis, Fate of pyruvate (Lactic acid & alcohol fermentation) Renamed as: Citric acid cycle, Respiratory	

		3.2 **3.3** **3.4** **Practicals** **Sr. No. 3**	substrate, Mitochondrial Electron transport, Cytochrome, Alternate oxidase pathway, Glycogen cycle. Added new: Cytochrome, Alternate oxidase pathway Added new & Renamed as: Biosynthesis and degradation of triglycerides. 3.4 and 3.5 combined together: Pathway for amino acid catabolism (Nitrogenase enzyme complex**,** NIF and Nod genes). To demonstrate anaerobic respiration in germinating seeds- Removed as an experiment and added in the mini project list. Renamed as: Anaerobic respiration in germinating seeds. New references added.	Important pathways
	BOT-III.E-4 Herbal Cosmetology	Module	This course is revised into four module system. New references added.	Revised according to the guidelines by the Dean into for module system.
Sem V	**BOT-V.C-7** Plant Molecular Biology	Module I	➢ **Comparison of DNA and RNA was eliminated** as per BOS suggestion. The concept will be covered under	The course syllbabus was modified into 4 modules (3 theory and 1

		Module III	polymorphism of DNA & RNA ➢ Sr. No 1.3 **word replication enzymes** is replaced with Enzymes of replication ➢ Module III Sr. 3.2, Gene regulation in eukaryotes: **Tryptophan** e.g is incorporated. Practicals: ➢ 2nd practical on Spooling of DNA changed to **Mini project as Spooling of DNA from different plant samples** ➢ 4th Practical on RNA estimation, method specified by **Orcinol reagent** ➢ 5th practical word **demonstration is removed** **Latest book references are added** along with existing ones	practical) as per **college requirement**. Earlier units were merged to make to 3 modules even though they had no connection to each other
	BOT-V.E-9 Bioinformatics	Module 1 1.2 1.5 Module II 2.4 Module 4 9	 Inclusion of Ramachandran Plot. Addition of MMDb The European Molecular Biology Network- EMBnet INTRODUCTION TO BIOLOGICAL DATABASES AND SEQUENCE ALIGNMENT METHODS BLAST; Databases of Multiple Alignments, Clustal Omega Addition of mini projects 1. Drug designing	BoS members felt the need to understand ramachandran plot wrt understanding protein structures.

			2. Construction of phylogenetic trees/cladogram (comparison between different organisms). New references added.	
	BOT-V.E-10	Practical Module	Mini projects: ➢ **Preparation of seed balls** is added as mini project. **Latest book references are added** along with existing ones	The course syllbabus was modified into 4 modules (3 theory and 1 practical) **as per college requirement**. Earlier units were merged to make to 3 modules even though they had no connection to each other
	BOT-V.E-11 Plant Drug Technology and Pharmacognosy	1.1 Module II Module IV-Practicals Expt. No. 6.	Renamed as Introduction to Plant Drug Technology and Pharmacognosy. Renamed as Cultivation, Collection and Constituents Experiments 1 & 2 are interchanged. Addition of Eucalyptus	To simplify the unit name. To simplify the module name. To have a sequencial flow As a source of oils
	BOT-V.E-12 Organic farming	Module: III 3.6	Renamed as National and international scenario of organic farming. New references added.	The suggestion was given by BoS members
Sem IV	**BOT-IV.E-6 Techniques and instrumentation in Botany**	This course is interchanged with BOT-III.E-2 of semester III to semester IV Module I	The semester in which it will be offered and course code is changed Title changed to Microscopy and Radiobiology (Principle, Methodology and	The BoS members felt the need of floating this paper earlier than applied courses. Availability of plants is

		 1.4 2.1 2.2 3.3 3.4 Module 4 1 5 7 8	applications) Addition of micro and macro photography. 2.1, 2.2 merged to form 2.1 Ultraviolet –Visual Spectrophotometry High Performance Liquid Chromatography and Gas Chromatography Agarose Gel Electrophoresis(AGE) Sodium Dodecyl Polyacrylamide gel electrophoresis(SDS-PAGE), Isoelectric focusing(IEF), Two dimensional electrophoresis (2D-Electrophoresis) Changed to Preparation of Molar, Normal and ppm solutions Preparation of Thin Layer Chromatographic plate and separation of biomolecules Demonstration of Flame photometry Mini Project: Comparison of data of ultra and gradient Centrifugation Microscopy: Analysis of different photo micrographs Photography: To submit a report of macro and micro photography Preparation of column for column chromatography. New references added.	the best in the Monsoon season. Full forms of techniques is mandatory.
SEM VI	**BOT-VI.E-14 Horticulture, Floriculture and Landscaping**	Module 1 1.5	The course is restructured back to elective in semester VI for the Third year in B.Sc. Botany. This course is in four module system. 1.5 is shifted to Module 1 from unit II of earlier	Change was proposed to the BoS members and it was accepted.

			syllabus. New references added.	
SEM IV	**Skill Enhancement course Basics in Horticulture**	Four module course	The title of the SEC course is changed from 'Horticulture, Floriculture and Landscaping' to 'Basics in Horticulture'.	To differentiate between the Elective and the SEC course.

ANNEXURE II

DEPARTMENT OF BOTANY

List of SWAYAM / NPTEL courses identified by the Botany department:

Sr.No.	Title of the SWAYAM course	Duration
1	Post Harvest Management of Fruits and Vegetables	**12 weeks**
2	Food Microbiology and Food Safety	**15 weeks**
3	Applied Environmental Microbiology	**12 weeks**

List of SWAYAM / NPTEL courses identified by the Botany department:

1. Post Harvest Management of Fruits And Vegetables

Course Status :	Upcoming
Course Type :	Core
Duration :	12 weeks
Start Date :	20 Jan 2020
End Date :	20 Apr 2020
Exam Date :	09 May 2020
Enrollment Ends :	28 Feb 2020
Category :	Agricultural and Food Engineering
Level :	Undergraduate

Description:
Post-harvest technologies constitute an inter-disciplinary science and techniques applied to agricultural commodities after harvest for the purpose of preservation, conservation, quality control, processing, packaging, storage, distribution, marketing and utilization to meet the food and nutritional requirements of consumers in relation to their needs. Fruits and vegetables are highly perishable commodities and the ambient high temperatures in tropical countries make them more susceptible for rapid development of senescence, decay and rotting. Both respiratory and transpiratory rates are proportional to temperature increases and the produce quickly dries, wilts and spoils unless properly preserved.
In this course, the various changes that take place in the fruit or vegetable after harvesting as

well as the maturity indices for harvesting a particular crop will be discussed. The students will learn about post harvest handling of the crops so as to enhance the shelf life of the crops. The course will also discuss on the various principles involved in preservation of fruits and vegetables along with the various techniques used in the preservation of fruits and vegetables. Dr.NongalleiPebam, Food Safety Administration, Department Of Health, Government of Manipur is the course coordinator.

2. Food Microbiology and Food Safety

Course Status :	Upcoming
Course Type :	Core
Duration :	15 weeks
Start Date :	06 Jan 2020
End Date :	30 Apr 2020
Exam Date :	09 May 2020
Enrollment Ends :	28 Feb 2020
Category :	Agricultural and Food Engineering
Level :	Postgraduate

Food microbiology is about the understanding of microorganisms that grow or multiply in or contaminate the food which we consume. Food microorganisms could be either beneficial or harmful. The key aspect of food microbiology is food safety which focuses on the disease-causing microorganism and their toxins which may contaminate the food. That is why it becomes essential to recognise the possible role of microorganisms to ensure the public safety. The major learning objectives of this course will be to study: the scope of food microbiology and food safety; to obtain the knowledge about important genera of microorganisms associated with food and their characteristics; to learn various techniques for enumeration and control of microorganisms in food; to gain the essential knowledge and applications of various techniques (traditional to advanced) for preserving food; to understand the role of different microorganisms in food spoilage, food fermentation and food-borne diseases; to comprehend the microbiological quality control and food-borne illnesses investigation procedures for ensuring food safety and hygiene; to understand current national and international food safety rules and regulations; to know the requirements and components of food safety management system (FSMS) and use of microbiological risk assessment (MRA) tools for assessing microbiological risks in food sector.

Course coordinator: Dr.TejpalDhewa | Central University of Haryana

3. Applied Environmental Microbiology

Course Status :	Upcoming
Course Type :	Elective
Duration :	12 weeks
Start Date :	27 Jan 2020
End Date :	17 Apr 2020
Exam Date :	25 Apr 2020
Enrollment Ends :	03 Feb 2020
Category :	Civil Engineering
Level :	Postgraduate

CHEMISTRY

Parvatibai Chowgule College of Arts and Science

(AUTONOMOUS)

DEPARTMENT OF CHEMISTRY

SYLLABUS
FOR THE UNDERGRADUATE COURSE
IN
CHEMISTRY
AT
F.Y. B. Sc.
SEMESTER- I AND SEMESTER- II
ACADEMIC YEAR: 2015-2016

SEMESTER- I

CORE COMPULSORY MAJOR PAPER

THEORY

Paper Title: General Physical and Inorganic Chemistry + Laboratory Course-1

Paper Code: CHE- I. C-1

Name of Faculty: Mrs. Manjita R. Porob and Dr. L.R. Gonsalves

Marks: 75

Credits: 3

Course Objectives:
1. To provide a basic understanding of the core areas of Physical Chemistry based on the theme of systems, states and processes.
2. To obtain a comprehensive understanding of the basic concepts in Inorganic Chemistry.
3. To generally provide practical skills to correlate with the theory.

Learning outcome:
1. Will have a working knowledge of the main areas of Physical Chemistry, will develop critical thinking abilities and be able to work in chemical or related fields.
2. Will help to get better understanding about the basics of Physical and Inorganic Chemistry.
3. Will be able to carry out experiments with required skills.

SECTION- I (PHYSICAL CHEMISTRY)

1. Mathematical Preparations for Chemists **06 L**

Logarithmic relations curve sketching: linear graphs, and calculation of slopes. Differentiation of functions: Kx, e^x (exponential), sin x, log x, maxima and minima. Integration of some useful functions.

2. Chemical Kinetics **08 L**

Rate of reaction, factors influencing rate of the reaction- concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates. Zero, first, second order kinetics. Half life and average life. Determination of order of reaction: Integrated rate equation method, graphical method, differential method, half-life method and isolation method. Effect of temperature on the rate of the reaction, Arrhenius equation and concept of activation energy.
(Numerical expected)

3. Solid State **08 L**

Introduction, difference between crystalline and amorphous solids, laws of crystallography: law of constancy of interfacial angles, law of symmetry and law of rationality of indices, Symmetry and crystal systems, elements of symmetry, introduction to point groups, lattice and unit cells, The Bravais lattices, the seven crystal systems, Miller and Weiss indices. Bragg's equation, Inter planar distance.
(Numerical expected)

4. Gaseous State **08 L**

Gas laws (to introduce), Ideal gas equation, compressibility factor, PV isotherms of real gases. kinetic molecular theory of gases, its postulates and derivation of kinetic gas equation. the van der Waal's equation of state. Berthelot Equation (derivation not expected). qualitative discussion of the Maxwell's distribution of molecular velocities. Critical phenomena: relationship between critical constants and van der Waal's constants, the law of corresponding states and reduced equation of state, Joule-Thomson effect . Liquefaction of gases (Linde's method).
(Numerical expected)

SECTION- II (INORGANIC CHEMISTRY)

1. Atomic Structure and the Periodic Table **05 L**

Atomic spectra of hydrogen, Bohr's model of hydrogen atom, probability picture of electron, dual nature of electrons, Heisenberg uncertainty principle, Schrodinger wave equation, quantum numbers, shapes of s, p, d, orbitals, Aufbau and Pauli exclusion principles, Hund's rule of maximum multiplicity, sequence of energy levels and arrangement of elements in groups in the periodic table, periodic trends and effective nuclear charge.

2. Covalent Bonding **10 L**

Covalent bond: Valence Bond Theory (VBT) and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions, Valence Shell Electron Pair Repulsion Theory (VSEPR) applied to NH_3, H_3O^+, SF_4, ClF_3, ICl_2^- and H_2O, Molecular Orbital Theory, homonuclear and heteronuclear diatomic molecules(CO and NO), multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

PRACTICALS

Paper Title: General Physical and Inorganic Chemistry + Laboratory Course-1

Paper Code: CHE- I. C-1

Name of Faculty: Dr. Sachin B. Kakodkar and Dr. L. R. Gonsalves

Marks: 25

Credits: 1

PHYSICAL CHEMISTRY

1. Preparation of standard solutions based on normality, molarity, molality. Also further dilutions from a standard solution to a volume of 50 mL.
2. To investigate the order of the reaction between $K_2S_2O_8$ and KI using equal initial concentrations of both the reactants.
3. To study hydrolysis of Methyl acetate using two different initial concentrations in presence of mineral acid (HCl) as catalyst
4. To determine the relative strength of two acids i.e. HCl and H_2SO_4 by using them as catalysts for the hydrolysis of methyl acetate.
5. To study the solubility of benzoic acid at room and below room temperature by volumetric method.

INORGANIC CHEMISTRY

1. Preparation of standard 0.1M $K_2Cr_2O_7$ solution and carry out the dilution to 0.05, 0.01, 0.001 M in 50 mL standard volumetric flask
2. To prepare 100 ppm of Manganese solution using $KMnO_4$ and carry out the further dilutions like 5, 10, 20 ppm in 50 mL standard volumetric flasks
3. To prepare 0.1 N $Na_2C_2O_4$ solution and use it to standardize the given $KMnO_4$ solution.

CORE COMPULSORY MAJOR PAPER

THEORY

Paper Title: General Organic and Inorganic Chemistry + Laboratory Course-2

Paper Code: CHE-I. C-2

Name of Faculty: Shri. N.G. Rivonkar; Mrs. Padmini C. Panjikar; Sandesh T. Bugde and Dr. R. K. Kunkalekar

Marks: 75

Credits: 3

Course Objectives:

1. The main objective of this course is to study the basics of Organic Chemistry, which includes the study of structure and reactivity of organic molecules. Also this course focuses on the detail study of alkanes and alkenes with respect to their method of formation and chemical reaction. The special unit has been included to study IUPAC nomenclature of organic compounds.
2. To study the chemistry related to molecular structure in three dimensions (Stereochemistry), which includes the detail study representing stereo isomers on a 2 D surfaces
3. To provide a basic knowledge of the elements in the periodic table and their General Chemistry.

Learning outcome:

1. Students will learn about the basic concepts in Organic Chemistry like the hybridisation in organic molecules, molecular interaction.
2. Students will briefly learn about the types of reaction, reactive intermediates and reaction mechanism in organic chemistry.
3. Students will learn how to name different classes of organic compounds using IUPAC nomenclature.
4. Students will learn how to represent 3 D of organic molecule on 2 D surfaces. Also how the orientation of a molecule in space can give a compound different reactivity.
5. Students will learn two important classes of organic compounds like alkanes and alkenes.
6. Develop skills to carry out related experiments.

SECTION- I (ORGANIC CHEMISTRY)

1. IUPAC Nomenclature of Organic Compounds **02 L**

Basic rules of IUPAC nomenclature, nomenclature of the compounds- alkanes, cycloalkanes, alkenes, alkynes, haloalkanes, acids, alcohols, ethers, aldehydes, ketones, nitriles, acid halides, esters, anhydrides, amides.

Nomenclature of aromatic compounds, mono and di substituted benzene with two functional groups, bridged cycloalkanes.

2. Structural Theories and Reactivities of Organic Compounds **10 L**

Bond formation in organic compounds; sp sp^2, sp^3 with respect to methane, ethene and acetylene (hybridisation concept), discussion on shape, bond length, bond angles of organic molecules.

Polar covalent bonds, electronegativity and bond dipoles in organic molecules, introduction and examples of Van der Waal's forces, inductive effect, field effect, hyperconjugation and resonance, hydrogen bonding.

Curved arrows in organic chemistry, homolytic and heterolytic bond breaking, types of reagents, electrophiles and nucleophiles, types of organic reactions: addition, elimination, substitution, oxidation, reduction and rearrangement with examples. Introduction to reactive intermediates: carbocations, carbanions, free radicals, carbenes, arynes and nitrenes with shape, stabilities, methods of formation and reaction. Methods of determination of reaction mechanisms: Determination of structure, intermediates, isotope effects, kinetic and stereochemical studies.

3. Stereochemistry **08 L**

Isomerism, types of isomers: constitutional, conformational and configurational isomerism. Chirality, chiral centre, enantiomers and diastereomers (with example of threo and erythro diastereomers, meso compounds). Representation of configuration by- 3D Projection (Wedge and dotted projection), Fischer projection, Newmann projection and Saw horse projection. R/S configuration (Can-Ingold-Prelog sequence rules to be exalined). E/Z nomenclature.

4. Study of alkanes, cycloalkanes and alkenes **10 L**

Alkanes and Cycloalkanes**:** Physical properties of alkanes and cycloalkanes, sources of alkanes and cycloalkanes, chemical properties: combustion and pyrolysis of alkanes, methods of preparation: Corey-House reaction, Wurtz reaction.

Alkenes: Physical properties and relative stabilities of alkenes, preparation of alkenes, elimination reactions, dehydration of alcohols, regioselectivity in alcohol dehydration: The Zaitsev rule, rearrangement in alcohol dehydration, dehydrohalogenation: E1 and E2 mechanisms, reactions of alkenes: hydrogenation, addition of halides and hydrogen halides, regioselectivity of hydrogen halide addition, hydroboration and oxidation reactions, oxymercuration- demercuration reactions, epoxidation of alkenes, ozonolysis of alkenes.

SECTION- II (INORGANIC CHEMISTRY)

1. Chemistry of s- block elements **05 L**

General properties, comparative study within groups, diagonal relationship, salient features of hydrides, solvation and complexation tendencies and biological importance, introduction to alkyls and aryls

2. Chemistry of p- block Elements **10 L**

Comparative study within group and diagonal relationship of groups 13, 14, 15, 16, 17, Hydrides of Boron, diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), phosphazenes, tetra sulfur tetranitride, basic properties of halogens, inter halogens and polyhalides.

PRACTICALS

Paper Title: General Organic and Inorganic Chemistry + Laboratory Course-2

Paper Code: CHE- I. C-2

Name of Faculty: Shri. N.G. Rivonkar; Sandesh T. Bugde; Dr. L. R. Gonsalves

Marks: 25

Credits: 1

ORGANIC CHEMISTRY

1. Purification techniques for organic solid compounds

A. **Crystallization:** a. Benzoic acid from water
b. m-Dinitrobenzene from ethanol
B. **Sublimations:** a. Naphthalene b. Anthracene c. Camphor

3. **Organic synthesis:** a. Benzoylation of β-naphthol and aniline.
b.Bromination of phenol and aniline
c. Anthraquinone from anthracene (Oxidation reaction)

4. **Qualitative Analysis (Solids)**
Acids: Benzoic, salicylic, phthalic
Phenols: α-Naphthol, β-naphthol
Bases: p-Toluidine, diphenylamine, o-, m- and p-nitroanilines
Anilides: Acetanilide, benzanilide
Hydrocarbons: Naphthalene, anthracene
Amides: Benzamide, urea
Haloarenes: p-Dichlorobenzene
Nitro Compounds: m-Dinitrobenzene, p-nitrotoluene
Carbohydrates: Glucose, fructose, mannose

INORGANIC CHEMISTRY

1. To prepare 0.001 M EDTA and separately estimate the amount of Zn^{2+} ion from $ZnCO_3$, Mg^{2+} ion from MgO.
2. Volumetric estimation of Fe^{2+} using internal indicator by potassium dichromate method
3. Determination of alkali content in antacid tablet using Standard HCl solution

SEMESTER- II

CORE COMPULSORY MAJOR PAPER

THEORY

Paper Title: Concepts in Physical and Analytical Chemistry + Laboratory Course-3

Paper Code: CHE-II. C-3

Name of Faculty: Mrs. Manjita R. Porob and Dr. G. K. Naik

Marks: 75

Credits: 3

Course Objectives:
1. To provide an understanding of some important topics in Physical Chemistry
2. To provide an understanding of titrimetric methods of analysis.

Learning Outcome:
1. Will have knowledge of the main areas of Physical Chemistry, will develop critical thinking abilities and be able to work in chemical or related fields.
2. Will be able to understand the principles of titrimetric methods.
3. Attain practical skills.

SECTION- I (PHYSICAL CHEMISTRY)

1. Thermodynamics **10 L**

Thermodynamic terms: system, surrounding, types of systems, intensive and extensive properties, State and path functions and their differentials, Thermodynamic process, Concept of work and heat, First law of thermodynamics: Definition and statements of internal energy and enthalpy, Heat capacities at constant volume and pressure and their relationships, Joule's law, Joule Thomson coefficient and inversion temperature, Calculation of w, q, dU, dH, for the expansion of ideal gases under isothermal and adiabatic conditions for reversible processes Thermochemistry: Standard state, standard enthalpy of formation, Hess's law of heat summation and its applications, Heat of reaction at constant pressure and at constant volume, Enthalpy of neutralisation, bond dissociation energy and its calculation from thermodynamical data, Temperature dependence of enthalpy, Kirchoff's equation.
(Numerical expected)

2. Liquid State and Applications **07 L**

The Intermolecular forces, structure of liquids (qualitative description), structural differences between solids, liquids and gases, Physical properties of liquids: vapour pressure, surface tension, surface tension by capillary rise method, drop number method using stalagmometer, Viscosity of liquids, Poiseuille equation, determination of viscosity using Ostwald's viscometer, Introduction to l iquid crystals.
(Numerical expected)

3. Phase Equilibria **06 L**

Statement, meaning of terms: phase, components, degrees of freedom, Gibbs phase rule, derivation of Gibbs phase rule, Phase equilibria of one component system: water system, sulphur system, Phase equilibria of two component system, simple eutectic system, Pb/Ag system. Nernst distribution law, deviations from Nernst distribution law, applications of the law.

SECTION- II (ANALYTICAL CHEMISTRY)

1. Introduction to Analytical Chemistry and some basic concepts **04 L**

Analytical Chemistry and its role in sciences. some important units of measurement, solutions and their concentrations, stoichiometric calculations.
(Numericals expected)

2. Titrimetric methods of analysis **05 L**

Some general aspects of volumetric titrimetry, standard solutions, volumetric calculations. Variables that influence the magnitude of salt effect, activity coefficients, titration curves in titrimetric methods.
(Numericals expected)

3. Theory and applications of neutralization titrations **05 L**

Solutions and indicators for acid/base titrations, titration curves for strong acids and strong bases, buffer solutions, titration curves for weak acids, titration curves for weak bases, composition of buffer solutions as a function of pH. Reagents for neutralization titrations, applications of neutralization titrations.
(Numericals expected)

4. Titration curves for polyfunctional acids and polyfunctional bases **04 L**

Polyfunctional acids and polyfunctional bases, titration curves for polyfunctional acids, titration curves for polyfunctional bases, composition of solutions of a polyprotic acid as a function of pH.
(Numericals expected)

5. Precipitation and Complex formation titrations **04 L**

Titration curves, end points for argentometric titrations, applications of standard silver nitrate solutions. Complex formation reactions, titrations with aminopolycarboxylic acids.
(Numericals expected)

PRACTICAL

Paper Title: Concepts in Physical and Analytical Chemistry + Laboratory Course-3

Paper Code: CHE- II. C-3

Name of Faculty: Dr. Sachin B. Kakodkar

Marks: 25

Credits: 1

PHYSICAL CHEMISTRY
1. To determine the partition coefficient of I_2 between $C_2H_4Cl_2$ and H_2O.
2. To determine the amount of strong acid (HCl) present in the given solution by conductometric titration using standard NaOH solution.
3. To determine the amount of weak acid (CH_3COOH) present in the given solution by conductometric titration using standard NaOH solution.
4. To determine viscosity of a given liquid using Ostwald's Viscometer.

ANALYTICAL CHEMISTRY
1. To standardize hydrochloric acid against sodium carbonate.
2. To standardize sodium hydroxide against potassium hydrogen phthalate.
3. To determine hardness in water.
4. To standardize sodium thiosulphate solution against copper.

CORE COMPULSORY MAJOR PAPER

THEORY

Paper Title: Concepts in Organic and Inorganic Chemistry + Laboratory Course-4

Paper Code: CHE-II. C-4

Name of Faculty: Shri. N.G. Rivonkar; Mrs. Padmini C. Panjikar and Dr. L.R. Gonsalves

Marks: 75

Credits: 3

Course Objectives:

1. The main objective of this course is to detail study on alkynes with respect to their properties, method of formation and chemical reaction. Also this course focuses on the learning on arenes, aromaticity, alcohols and aryl halides with respect to their classification, method of formation and chemical reactions.
2. Intends to provide, both theoretical as well as a practical understanding of the structure and bonding in ionic solids and the various defects which leads to a perfect or imperfect crystal structure.
3. To provide a simple framework in order to fit the factual knowledge and extrapolate from this to predict unknown facts.

Learning Outcome:

1. Students will learn a important classes of organic compound: Alkynes.
2. Students will briefly learn about the aromatic chemistry involving different types of reaction can aromatic compounds undergoes. Also they will learn about the mechanism involve in reactions having aromatic compounds.
3. Students will also learn chemistry of alcohols and alkyl halides
4. Will have an understanding of crystalline solids in terms of their structure, ionic radii and coordination there by able to predict crystal structure.

SECTION- I (ORGANIC CHEMISTRY)

1. Study of alkynes **03 L**

Alkynes: Sources of alkynes, physical properties of alkynes, acidity of acetylene and terminal alkynes, preparation of alkynes by elimination reactions, alkylation of acetylene and terminal alkynes, reactions of alkynes: hydrogenation, metal-ammonia reduction, addition of hydrogen halides, hydration of alkynes.

2. Arenes and Aromaticity **08 L**

The aryl group, structure of benzene: Molecular formula and Kekule structure, stability and carbon-carbon bond lengths of benzene, resonance structure, molecular orbital picture, Huckel's rule, polycyclic aromatic hydrocarbons, physical properties of arenes, electrophilic aromatic substitution reactions- reactions and mechanisms of nitration, halogenations, sulphonation and Friedel Craft's reactions, activating and deactivating substituents, orientation and ortho/para ratio, side chain reactions of benzene derivatives, Birch reduction.

3. Study of Alcohols and Alkyl Halides **12 L**

Alcohols: Classification, structure and bonding, physical properties, methods of preparation- catalytic hydrogenation, metal hydride reduction, Grignard reaction (using formaldehyde, other aldehydes, ketones, esters, nitriles and epoxides), reactions of alcohols- oxidation reactions using chromic acid, $KMnO_4$, PCC and PDC (structures of PCC and PDC), conversion of alcohols to ethers, Fischer Esterification.

Diols: Classification, methods of preparation (syn and anti diols), reactions of vicinal diols- Pinacol-Pinacolone rearrangement and periodic oxidative cleavage.

Alkyl Halides: Classification, structure and bonding, physical properties, methods of preparation-using alcohols and hydrogen halides, $SOCl_2$, PCl_3, halogenation of alkanes, mechanism for chlorination of methane, relative reactivity and selectivity with respect to chlorination and bromination, mechanisms of nucleophilic substitution reactions of alkyl halides, S_N1 and S_N2 reactions with energy profile diagrams.

SECTION- II (INORGANIC CHEMISTRY)

1. Chemistry of transition elements **12 L**

Chemistry of elements of the first transition series: properties, their binary compounds, oxidation states and their stability, coordination number and geometry, comparative study with 4d and 5d analogues with respect to their ionic radii, magnetic behaviour, oxidation states and spectral properties.

2. Ionic Solids: Structure and Bonding **10 L**

Introduction to bonding in solids, types of bonds, properties of ionic substances, structure of ionic solids (NaCl, CsCl, ZnS, CaF_2, TiO_2-rutile), lattice energy and Born-Haber's Cycle, factors affecting radii of ions, packing efficiency, radius ratio and coordination number, limitations of radius ratio, Fajan's rules, defects in solids: point defects, color centres, extended defects, non-stoichiometric defects, conductivity in ionic solids;

PRACTICALS

Paper Title: Concepts in Organic and Inorganic Chemistry + Laboratory Course-4

Paper Code: CHE- II. C-4

Name of Faculty: Dr. L.R. Gonsalves; Shri. N.G. Rivonkar; Sandesh T. Bugde;

Marks: 25

Credits: 1

ORGANIC CHEMISTRY

1. Purification techniques for organic compounds (Liquids) and determination of physical constant.
   Distillation: a. Separation of acetone and toluene
   b. Separation of ethyl acetate and nitrobenzene
2. Organic synthesis: a. p-Bromo acetanilide from aniline
   b. oxidising agent PCC (Pyridinium Chlorochromate)
   c. Oxime from cyclohexanone
3. Qualitative Analysis (Liquids)
   Haloalkane and haloarene: Chloroform, carbon tetrachloride, chlorobenzene, bromobenzene
   Nitro Compounds: Nitrobenzene
   Alcohols: Methanol, ethanol, 2-propanol, cyclohexanol
   Phenols: Phenol
   Carbonyl compounds (Neutral compounds): Benzaldehyde, acetone
   Esters: Methyl acetate, ethyl acetate, ethyl benzoate, methyl salicylate
   Bases: Aniline, N-methylaniline

INORGANIC CHEMISTRY

1. Semi-micro qualitative analysis: To analyse 2-3 inorganic mixtures containing four ions only (two cations and two anions).

Cations : Pb^{2+}, Cu^{2+}, Cd^{2+}, Sn^{2+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Ni^{2+}, Co^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, $(NH4)^+$, K^+

Anions: Cl^-, Br^-, I^-, NO_2^-, NO_3^-, SO_3^{2-}, CO_3^{2-}, SO_4^{2-}, PO_4^{3-}

2. Gravimetric estimation of Ba as $BaSO_4$
3. Gravimetric estimation of Fe as Fe_2O_3

SEMESTER- I

CORE COMPULSORY MINOR PAPER

THEORY

Paper Title: General Physical and Inorganic Chemistry + Laboratory Course-1

Paper Code: CHE- I. C-1

Name of Faculty: Mrs. Manjita R. Porob and Dr. L.R. Gonsalves

Marks: 75

Credits: 3

Course Objectives:
1. To provide a basic understanding of the core areas of Physical Chemistry based on the theme of systems, states and processes.
2. To obtain a comprehensive understanding of the basic concepts in Inorganic Chemistry.
3. To generally provide practical skills to correlate with the theory.

Learning outcome:
1. Will have a working knowledge of the main areas of Physical Chemistry, will develop critical thinking abilities and be able to work in chemical or related fields.
2. Will help to get better understanding about the basics of Physical and Inorganic Chemistry.
3. Will be able to carry out experiments with required skills.

SECTION- I (PHYSICAL CHEMISTRY)

1. Mathematical Preparations for Chemists **06 L**

Logarithmic relations curve sketching: linear graphs, and calculation of slopes. Differentiation of functions: Kx, e^x (exponential), sin x, log x, maxima and minima. Integration of some useful functions.

2. Chemical Kinetics **08 L**

Rate of reaction, factors influencing rate of the reaction- concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates. Zero, first, second order kinetics. Half life and average life. Determination of order of reaction: Integrated rate equation method, graphical method, differential method, half-life method and isolation method. Effect of temperature on the rate of the reaction, Arrhenius equation and concept of activation energy.
(Numerical expected)

3. Solid State **08 L**

Introduction, difference between crystalline and amorphous solids, laws of crystallography: law of constancy of interfacial angles, law of symmetry and law of rationality of indices, Symmetry and crystal systems, elements of symmetry, introduction to point groups, lattice and unit cells, The Bravais lattices, the seven crystal systems, Miller and Weiss indices. Bragg's equation, Inter planar distance.
(Numerical expected)

4. Gaseous State **08 L**

Gas laws (to introduce), Ideal gas equation, compressibility factor, PV isotherms of real gases. kinetic molecular theory of gases, its postulates and derivation of kinetic gas equation. the van der Waal's equation of state. Berthelot Equation (derivation not expected). qualitative discussion of the Maxwell's distribution of molecular velocities. Critical phenomena: relationship between critical constants and van der Waal's constants, the law of corresponding states and reduced equation of state, Joule-Thomson effect. Liquefaction of gases (Clarke's method).
(Numerical expected)

SECTION- II (INORGANIC CHEMISTRY)

1. Atomic Structure and the Periodic Table **05 L**

Atomic spectra of hydrogen, Bohr's model of hydrogen atom, probability picture of electron, dual nature of electrons, Heisenberg uncertainty principle, Schrodinger wave equation, quantum numbers, shapes of s, p, d, orbitals, Aufbau and Pauli exclusion principles, Hund's rule of maximum multiplicity, sequence of energy levels and arrangement of elements in groups in the periodic table, periodic trends and effective nuclear charge.

2. Covalent Bonding **10 L**

Covalent bond: Valence Bond Theory (VBT) and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions, Valence Shell Electron Pair Repulsion Theory (VSEPR) applied to NH_3, H_3O^+, SF_4, ClF_3, ICl_2^- and H_2O, Molecular Orbital Theory, homonuclear and heteronuclear diatomic molecules(CO and NO), multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

PRACTICALS

Paper Title: General Physical and Inorganic Chemistry + Laboratory Course-1

Paper Code: CHE- I. C-1

Name of Faculty: Dr. Sachin B. Kakodkar and Dr. L. R. Gonsalves

Marks: 25

Credits: 1

PHYSICAL CHEMISTRY

6. Preparation of standard solutions based on normality, molarity, molality. Also further dilutions from a standard solution to a volume of 50 mL.
7. To investigate the order of the reaction between $K_2S_2O_8$ and KI using equal initial concentrations of both the reactants.
8. To study hydrolysis of Methyl acetate using two different initial concentrations in presence of mineral acid (HCl) as catalyst
9. To determine the relative strength of two acids i.e. HCl and H_2SO_4 by using them as catalysts for the hydrolysis of methyl acetate.
10. To study the solubility of benzoic acid at room and below room temperature by volumetric method.

INORGANIC CHEMISTRY

1. Preparation of standard 0.1M $K_2Cr_2O_7$ solution and carry out the dilution to 0.05, 0.01, 0.001 M in 50 mL standard volumetric flask
2. To prepare 100 ppm of Manganese solution using $KMnO_4$ and carry out the further dilutions like 5, 10, 20 ppm in 50 mL standard volumetric flasks
3. To prepare 0.1 N $Na_2C_2O_4$ solution and use it to standardize the given $KMnO_4$ solution.

SEMESTER- II

COMPULSORY CORE MINOR PAPER

THEORY

THEORY

Paper Title: General Organic and Inorganic Chemistry + Laboratory Course-2

Paper Code: CHE-I. C-2

Name of Faculty: Shri. N.G. Rivonkar; Mrs. Padmini C. Panjikar; Sandesh T. Bugde and Dr. R. K. Kunkalekar

Marks: 75

Credits: 3

Course Objectives:

1. The main objective of this course is to study the basics of Organic Chemistry, which includes the study of structure and reactivity of organic molecules. Also this course focuses on the detail study of alkanes and alkenes with respect to their method of formation and chemical reaction. The special unit has been included to study IUPAC nomenclature of organic compounds.
2. To study the chemistry related to molecular structure in three dimensions (Stereochemistry), which includes the detail study representing stereo isomers on a 2 D surfaces
3. To provide a basic knowledge of the elements in the periodic table and their General Chemistry.

Learning outcome:

1. Students will learn about the basic concepts in Organic Chemistry like the hybridisation in organic molecules, molecular interaction.
2. Students will briefly learn about the types of reaction, reactive intermediates and reaction mechanism in organic chemistry.
3. Students will learn how to name different classes of organic compounds using IUPAC nomenclature.
4. Students will learn how to represent 3 D of organic molecule on 2 D surfaces. Also how the orientation of a molecule in space can give a compound different reactivity.
5. Students will learn two important classes of organic compounds like alkanes and alkenes.
6. Develop skills to carry out related experiments.

SECTION- I (ORGANIC CHEMISTRY)

1. IUPAC Nomenclature of Organic Compounds **02 L**

Basic rules of IUPAC nomenclature, nomenclature of the compounds- alkanes, cycloalkanes, alkenes, alkynes, haloalkanes, acids, alcohols, ethers, aldehydes, ketones, nitriles, acid halides, esters, anhydrides, amides.

Nomenclature of aromatic compounds, mono and di substituted benzene with two functional groups, bridged cycloalkanes.

2. Structural Theories and Reactivities of Organic Compounds **10 L**

Bond formation in organic compounds; sp sp^2, sp^3 with respect to methane, ethene and acetylene (hybridisation concept), discussion on shape, bond length, bond angles of organic molecules.

Polar covalent bonds, electronegativity and bond dipoles in organic molecules, introduction and examples of Van der Waal's forces, inductive effect, field effect, hyperconjugation and resonance, hydrogen bonding.

Curved arrows in organic chemistry, homolytic and heterolytic bond breaking, types of reagents, electrophiles and nucleophiles, types of organic reactions: addition, elimination, substitution, oxidation, reduction and rearrangement with examples. Introduction to reactive intermediates: carbocations, carbanions, free radicals, carbenes, arynes and nitrenes with shape, stabilities, methods of formation and reaction. Methods of determination of reaction mechanisms: Determination of structure, intermediates, isotope effects, kinetic and stereochemical studies.

3. Stereochemistry **08 L**

Isomerism, types of isomers: constitutional, conformational and configurational isomerism. Chirality, chiral centre, enantiomers and diastereomers (with example of threo and erythro diastereomers, meso compounds). Representation of configuration by- 3D Projection (Wedge and dotted projection), Fischer projection, Newmann projection and Saw horse projection. R/S configuration (Can-Ingold-Prelog sequence rules to be exlained). E/Z nomenclature.

4. Study of alkanes, cycloalkanes and alkenes **10 L**

Alkanes and Cycloalkanes**:** Physical properties of alkanes and cycloalkanes, sources of alkanes and cycloalkanes, chemical properties: combustion and pyrolysis of alkanes, methods of preparation: Corey-House reaction, Wurtz reaction.

Alkenes: Physical properties and relative stabilities of alkenes, preparation of alkenes, elimination reactions, dehydration of alcohols, regioselectivity in alcohol dehydration: The Zaitsev rule, rearrangement in alcohol dehydration, dehydrohalogenation: E1 and E2 mechanisms, reactions of alkenes: hydrogenation, addition of halides and hydrogen halides, regioselectivity of hydrogen halide addition, hydroboration and oxidation reactions, oxymercuration- demercuration reactions, epoxidation of alkenes, ozonolysis of alkenes.

SECTION- II (INORGANIC CHEMISTRY)

1. Chemistry of s- block elements **05 L**

General properties, comparative study within groups, diagonal relationship, salient features of hydrides, solvation and complexation tendencies and biological importance, introduction to alkyls and aryls

2. Chemistry of p- block Elements **10 L**

Comparative study within group and diagonal relationship of groups 13, 14, 15, 16, 17, Hydrides of Boron, diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), phosphazenes, tetra sulfur tetranitride, basic properties of halogens, inter halogens and polyhalides.

PRACTICALS

Paper Title: General organic and Inorganic Chemistry + Laboratory Course-2

Paper Code: CHE- I. C-2

Name of Faculty: Dr. L. R. Gonsalves; Shri. N.G. Rivonkar; Sandesh T. Bugde

Marks: 25

Credits: 1

ORGANIC CHEMISTRY

1. Purification techniques for organic solid compounds

A. **Crystallization:** a. Benzoic acid from water
b. m-Dinitrobenzene from ethanol
B. **Sublimations:** a. Naphthalene b. Anthracene c. Camphor

3. **Organic synthesis:** a. Benzoylation of β-naphthol and aniline.
b.Bromination of phenol and aniline
c. Anthraquinone from anthracene (Oxidation reaction)

4. **Qualitative Analysis (Solids)**
Acids: Benzoic, salicylic, phthalic
Phenols: α-Naphthol, β-naphthol
Bases: p-Toluidine, diphenylamine, o-, m- and p-nitroanilines
Anilides: Acetanilide, benzanilide
Hydrocarbons: Naphthalene, anthracene

Amides: Benzamide, urea
Haloarenes: p-Dichlorobenzene
Nitro Compounds: m-Dinitrobenzene, p-nitrotoluene
Carbohydrates: Glucose, fructose, mannose

INORGANIC CHEMISTRY

1. To prepare 0.001 M EDTA and separately estimate the amount of Zn^{2+} ion from $ZnCO_3$, Mg^{2+} ion from MgO.
2. Volumetric estimation of Fe^{2+} using internal indicator by potassium dichromate method
3. Determination of alkali content in antacid tablet using Standard HCl solution

REFERENCES

PHYSICAL CHEMISTRY
TEXTB OOKS

1. Atkins, P., Paula, J. D. *Atkin's Physical Chemistry*, Oxford University Press.

ADDITIONAL READING

1. Bahl A., Bahl B.S. and Tuli, G.D. *Essentials of Physical Chemistry*, S. Chand & Company Ltd., New Delhi.
2. Puri B.R., Sharma L. R. and Pathania M. S. *Principles of Physical Chemistry*, Vishal Publishing Co.
3. Raj G. *Advanced Physical Chemistry*, Goel Publishing House, Meerut.

ORGANIC CHEMISTRY
TEXT BOOK

1. Morrison, R. T., Boyd, R. N. and Bhattacharjee, S. K. *Organic Chemistry,* Pearson India.

ADDITIONAL READING

1. Bruice, P. Y. *Organic Chemistry*, Pearson India.
2. Carey, F. C. and Giuliano, R. M. *Organic Chemistry*, Tata McGraw-Hill India.
3. Finar, I. L. *Organic Chemistry*, Pearson India.

INORGANIC CHEMISTRY
TEXT BOOKS

1. Lee, J. D. Concise Inorganic Chemistry, ELBS Publications.
2. Atkins, P., Overton, T., Rourke, J., Weller, M., Armstrong, F. *Shriver & Atkins' Inorganic Chemistry*, Oxford University Press.

ADDITIONAL READING

1. Greenwood, N. N., Earnshaw, A. *Chemistry of Elements,* Pergamon, Oxford.
2. Huheey, J. E., Keiter, E. A., Keiter, R. L., Medhi, O. K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson.
3. Cotton, F. A., Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley Publications.
4. Puri, B. R., Sharma, L. R., Kale, K. C. *Principles of Inorganic Chemistry*, Vallabh Publications.
5. Sharpe and Emilus, Inorganic Chemistry.
6. Housecroft, C. E. and Sharpe, A. G. *Inorganic Chemistry*, Prentice Hall.

ANALYTICAL CHEMISTRY
TEXT BOOK

1. Skoog, D. A., West D.M. and Holler, F. J. *Analytical Chemistry An Introduction*, Saunders College Publishing

BOOKS SUGGESTED FOR LABORATORY COURSE

1. Yadav, J. B. *Advanced Practical Physical Chemistry*, Krishna Prakashan Media (P) Ltd. Meerut.
2. Chondhekar, T. K. and Rajbhoj, S.W. *Systematic Experimental Physical Chemistry*, Anjali Publication, Aurangabad.
3. Furniss, B. Brian, S. *Vogel's textbook of practical organic chemistry*, Pearson education.
4. Vishnoi, N. K. *Advanced Practical Organic Chemistry*, Vikas Publishing House Pvt Ltd.
5. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Orient Longman.
6. Jeffery, G. H. Bassett, J. *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley & Sons Inc.

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Parvatibai Chowgule College of Arts and Science
(Autonomous)

DEPARTMENT OF CHEMISTRY

COURSE STRUCTURE

THREE YEAR B.Sc. DEGREE COURSE IN CHEMISTRY

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	CHE-I. C-1 General Physical and Inorganic Chemistry	CHE-I. C-2 General Organic and Inorganic Chemistry	---	---	---	---
II	CHE-II. C-3 Concepts in Physical and Analytical Chemistry	CHE-II. C-4 Concepts in Organic and Inorganic Chemistry	---	---	---	---
III	CHE-III. C-5 Comprehensive Chemistry –I	---	CHE-III. E-1 Name Reactions and Synthetic Methodologies	CHE-III. E-2 Industrial Chemistry	CHE-III. E-3 Surface Chemistry and Catalysis	CHE-III. E-4 Bioinorganic Chemistry
IV	CHE-IV. C-6 Comprehensive Chemistry -II	---	CHE-IV. E-5 Pharmaceutical Chemistry	CHE-IV. E-6 Polymer and Colloid Science	CHE-IV. E-7 Spectroscopic Techniques	CHE-IV. E-8 Chemistry of Natural Products
V	CHE-V. C-7 Advanced Chemistry - I	---	CHE-V. E-9 Heterocyclic Chemistry	CHE-V. E-10 Organometallic Chemistry	CHE-V. E-11 Electroanalytical Techniques	CHE-V. E-12 Chemistry of main group elements
VI	CHE-VI. C-8 Advanced Chemistry - II	---	CHE-VI. E-13 Applied Electrochemistry	CHE-VI. E-14 Instrumental Methods in Analytical Chemistry	CHE-VI. E-15 Introduction to Nanomaterials	CHE-VI. E-16 Solid State Chemistry

CCMINOR

SEMESTER	CORE COMPULSORY MINOR
I	General Physical and Inorganic Chemistry
II	General Organic and Inorganic Chemistry
III	Concepts in Physical and Analytical Chemistry
IV	Concepts in Organic and Inorganic Chemistry
V	Comprehensive Chemistry –I
VI	Comprehensive Chemistry -II

Parvatibai Chowgule College of Arts and Science

AUTONOMOUS

DEPARTMENT OF CHEMISTRY

DRAFT SYLLABUS
FOR THE UNDERGRADUATE COURSE IN CHEMISTRY
AT
S. Y. B. Sc. SEMESTER – III
FOR THE
ACADEMIC YEAR: 2016-2017

SEMESTER III

CORE COURSE
THEORY
Course Title: Comprehensive Chemistry - I
Course Code: CHE- III. C-5
Name of Faculty: Dr. S. B. Kakodkar and Dr. L. R. Gonsalves
Maximum Marks: 75
Credits: 3

Course Objectives:

1. To understand some important core topics in Physical Chemistry.
2. The topics in Inorganic Chemistry mainly deal with chemistry of the f-block elements, i.e the lanthanides and actinides and its compounds. It also involves a brief introduction to coordination compounds. The course also provides basic understanding of different types of ionic solids and the different types of defects that can occur in a crystal.
3. To understand the topics in the theory with practical knowledge.

Learning Outcome:

1. Will learn principles of Physical Chemistry and its applications in various processes.
2. Will obtain a comprehensive and detail understanding of the properties and compounds of the f-block elements i.e. the lanthanides and actinides.
3. Will gain a basic understanding of coordination compounds, their nomenclature and the types of coordination compounds.
4. Will be able to describe different crystal structures of ionic solids and the types of defects which can occur in a crystal.
5. Will be able to get a deeper understanding of the theory with practical knowledge.

SECTION –I (PHYSICAL CHEMISTRY)

1. Thermodynamics **10 L**

Second law of thermodynamics: Different statements of the law; Carnot cycle and its efficiency, Carnot theorem; Thermodynamic scale of temperature; Concept of entropy: entropy as a state function, entropy as a function of V and T, entropy as a function of P and T, entropy change in physical processes, entropy as a criteria of spontaneity and equilibrium; Entropy change for ideal gases. Third law of thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data; Gibbs and Helmholtz functions; A and G as criteria for thermodynamic equilibrium and spontaneity, their advantages over entropy change; Variation of G and A with P, V and T.

2. Chemical Equilibrium **05 L**

Reversible reactions, equilibrium constant, Equilibrium constant and free energy; Thermodynamic derivation of law of mass action; Reaction isotherm and reaction isochore - Clapeyron equation and Clausius - Clapeyron equation; Le Chatelier's principle and its applications to some industrial processes.

3. Electrochemistry **08 L**

Electrical transport-conduction in metals and in electrolyte solutions, weak and strong electrolytes; conductance, specific conductance and equivalent conductance and measurements; variation of specific and equivalent conductance with dilution; Arrhenius theory of electrolyte dissociation and its limitations; Ostwald's dilution law, its uses and limitations; Migration of ions and Kohlrausch law; Debye-Huckel-Onsager's equation for electrolytes; Transport number, determination of transport number by Hittorf's method, Applications of conductance measurements: degree of dissociation, dissociation constant of acids; Solubility and solubility product of a sparingly soluble salts; Conductometric titrations (e.g. Strong acid and strong base).

SECTION –II (INORGANIC CHEMISTRY)

1. Chemistry of f-block elements **09 L**

Electronic structure, oxidation states and ionic radii; physical and chemical properties; occurrence and isolation of lanthanides from monazite ore; Lanthanide compounds; General properties and chemistry of actinides; Chemistry of extraction of Thorium and Uranium from its ore; Compounds of Th and U; comparison between lanthanides and actinides

2. Introduction to Coordination Compounds **08 L**

Werner's coordination theory; effective atomic number concept; nomenclature of coordination compounds; constitution and geometry; Isomerism and chirality in coordination compounds; chelates and macrocyclic effect

3. Acids, Bases and Non-aqueous solvents **05 L**

Arrhenius concept and Bronsted theory; Lewis concept of acid and bases; Physical properties of a solvent; Solvents and their general characteristics; Reactions in non aqueous solvent with respect to NH_3

PRACTICALS:
Course Title: Comprehensive Chemistry - I
Course Code: CHE- III. C-5
Name of Faculty: Dr. S. B. Kakodkar and Dr. L. R. Gonsalves
Maximum Marks: 25
Credit: 1

PHYSICAL CHEMISTRY EXPERIMENTS

1. To verify Ostwald's dilution law by determining the equivalent conductance of a weak monobasic acid at different concentrations
2. To determine the equivalent conductance of a strong electrolyte at several concentrations and hence verify Onsager's equation
3. To determine solubility product of sparingly soluble salt by conductometric method
4. To determine hydrolysis constant of sodium acetate by conductometric method
5. To determine ΔG, ΔH and ΔS of silver benzoate by solubility product method conductomtrically
6. To study the molecular condition of benzoic acid between toluene and water at room temperature by partition method
7. To study the solubility of benzoic acid in water at different temperatures and to calculate the heat of solution
8. To determine energy of activation for acid catalysed hydrolysis of methyl acetate

INORGANIC CHEMISTRY EXPERIMENTS

1. Preparation of Tetraamine copper (II) sulphate monohydrate
2. Estimation of Copper (II) from teraamine copper (II) sulphate by iodometry
3. Preparation of Hexamine nickel (II) chloride complex
4. Estimation of Nickel in hexamine nickel (II) chloride by EDTA method
5. Gravimetric estimation of Nickel as Ni-DMG
6. Volumetric Estimation of Calcium by EDTA method
7. Volumetric Estimation of dissolved oxygen in water sample

TEXT BOOK (PHYSICAL CHEMISTRY)**:**

Raj Gurdeep, Advanced Physical Chemistry; Goel Publishing House, Meerut, 27th Edition

REFERENCE BOOK:

Puri B.R., Sharma L.R., Pathania M. S., Principles of Physical Chemistry

TEXT BOOK (INORGANIC CHEMISTRY)**:**

Shriver D.F. and Atkins P. W., Inorganic Chemistry, 5th Edition, Oxford University Press

REFERENCE BOOKS (INORGANIC CHEMISTRY):

1. Cotton F. A. and Wilkinson G, Advanced Inorganic Chemistry, 5th Edition, John Wiley
2. Lee, J. D. Concise Inorganic Chemistry, 5th Edition, Wiley Blackwell Science Publications

SEMESTER III

ELECTIVE COURSES
THEORY
Course Title: Name reactions and Synthetic methodologies
Course Code: CHE-III. E-1
Name of Faculty: Padmini Panjikar
Maximum Marks: 75
Credits: 3

Course Objectives:

1. The main objective of this course is to study the organic chemistry through name reactions.
2. This course includes important name reactions involved in different categories of organic reactions such as addition, substitution, rearrangement reactions.
3. This course also includes name reaction concerned with oxidation and reduction reaction.

Learning outcome:

1. Students will learn importance of name reactions in organic chemistry.
2. Students will learn different types of reactions in organic chemistry through name reactions.

1. Name reactions involving nucleophilic addition to carbonyl compounds 17 L

Structure and reactivity of carbonyl group; General mechanism of nucleophilic addition to carbonyl group; Introduction to condensation reactions; Reactions and mechanisms of: Aldol condensation, Claisen-Schmidt condensation, Claisen condensation, Dieckmann condensation, Perkin condensation, Knoevenagel condensation, Doebner modification, Stobbe condensation, Benzoin condensation, Michael addition.

2. Name reactions involving electrophilic aromatic substitutions 10 L

Introduction to general mechanism involved, reactivity of arenes, product distribution, ipso-attack and orientation in benzene with more than one substituent

Reactions and mechanisms of: Friedel-Crafts alkylation and acylation, Vilsmeier-Haack reaction, Gattermann-Koch reaction, Reimer-Tiemann reaction and Kolbe-Schmitt reaction.

3. Name reactions involving rearrangement 06 L

Reactions and mechanisms of: Beckmann rearrangement, Curtius rearrangement, Hofmann rearrangement, Pinacol-Pinacolone rearrangement, Wagner-Meerwin rearrangement, Claisen rearrangement.

4. Oxidation reactions 06 L

Oppenauer oxidation (with mechanism), aromatisation and dehydrogenation; Chromium and manganese compounds as oxidising agents: Preparation and applications of PCC and PDC, oxidation of alcohols, aldehydes, C-C double bonds and C-H bonds in hydrocarbons.

5. Reduction reactions 06 L

Catalytic hydrogenation: Different catalysts, solvents and equipments; functional group reductions and homogeneous catalytic hydrogenation; Reductions by hydride transfer reagents and related reactions: $NaBH_4$ and LAH reduction (with mechanism); reductions with borane and dialkylboranes; Other methods of reductions: Clemmensen's reduction, Wolff-Kishner reduction (with mechanism).

PRACTICALS
Course Title: Name reactions and Synthetic methodologies
Course Code: CHE-I. E-1
Name of Faculty: Padmini Panjikar
Maximum Marks: 75
Credit: 1

1. Preparation of chalcone using benzaldehyde and acetophenone.
2. Preparation of dibenzalacetone.
3. Preparation of nitrostyrene using nitromethane and benzaldehyde.
4. Preparation of benzoin using benzaldehyde and thiamine hydrochloride.
5. Oxidation of benzoin to benzil.
6. Preparation of 2,4-DNP derivatives
7. Preparation of oxime derivatives
8. Preparation of PCC and PDC
9. Reduction of m-dinitrobenzene to m-nitroaniline
10. Nitration of nitrobenzene
11. Nitration of acetanilide
12. Preparation of Cinnamic acid
13. Preparation of Michael adduct between cyclohexanone and nitrostyrenes
14. Oxidation of alcohols using PCC
15. Oxidation of alcohol using PDC

TEXT BOOK:

1. Morrison, R. T., Boyd, R. N. and Bhattacharjee, S. K. Organic Chemistry, Pearson India.

REFERENCE BOOKS:

1. Bruice, P. Y. Organic Chemistry, Pearson India.
2. Carey, F. C. and Giuliano, R. M. Organic Chemistry, Tata McGraw-Hill India.
3. Finar, I. L. Organic Chemistry, Pearson India.
4. March Jerry, Advanced Organic Chemistry Reaction, Mechanism and Structure, 4th Edition, Wiley Publications.

PRACTICAL TEXT BOOK

Furniss, B. Brian, S. Vogel's Textbook of Practical Organic Chemistry, Pearson education

THEORY
Course Title: Industrial Chemistry
Course Code: CHE-III. E-2
Name of Faculty: Dr. Rohan K. Kunkalekar, Dr. Roopa Belurkar
Maximum Marks: 75
Credits: 3

Course Objectives: The main objective of this course is to study the industrial processes, pollution caused due to industries, some pharmaceutical preparations and preparation and properties of solid materials.

Learning outcome: students will learn about industrial processes, preparation and properties of solid materials, they will learn about the different types of pollutions caused by industries. Students will develop the laboratory skills about the synthesis and analysis of industrially important materials.

1. Pollution **12 L**

A. Segments of environment
   Air, Oxygen, nitrogen cycle, water, Biosphere, Flora and Fauna, Soil
B. Types of Pollution (i) Air Pollution: Introduction, classification of pollutants, sources, control, effect with respect to oxides of Nitrogen, Carbon and Sulphur, Photochemical smog, acid rain and Green House Effect. (ii) Water pollution: Organic /inorganic pollutants Sewage analysis (iii) Noise pollution.
C. Effluent treatment and waste management
   Principles and equipments for aerobic, anaerobic treatment, adsorption, filtration, sedimentation, Bag filters, electrostatic precipitators, mist eliminators, wet scrubbers, Absorbers, Solid Waste Management.
D. Pollution evaluation methods, Pollutants and their statutory limits.

2. Materials Science **15 L**

A. Mechanical properties of materials and change with respect to temperature
B. Metals and alloys – important metals and alloys
C. Corrosion – various types of corrosion relevant to chemical industry – Mechanism, Preventive methods.
D. Cement – Types of cement, composition, manufacturing processes, setting of cement.
E. Ceramics – Introduction, Types, Manufacturing processes, Applications, Refractories.
F. Glass – types, composition, manufacture, physical and chemical properties applications.

3. Pharmaceutical Drugs **10 L**

Classification of various types of drugs with examples; Raw materials, process of manufacture, effluent handling etc of the following bulk drugs:

A. Antimicrobial – chloramphenicol, furazolidone, isoniazid, Ethambutol
B. Analgesic/Anti-inflammatory / salicylic acid and its derivatives, Ibuprofen

4. Industrial fuels and chemicals **08 L**

A. Industrial fuels like coal gas, producer gas and water gas.
B. Physico chemical principles involved in the manufacture of HNO_3 (Ostwald's method) and NH_3 (Haber's method).

PRACTICALS
Course Title: Industrial Chemistry
Course Code: CHE-III. E-2
Name of Faculty: Dr. Rohan K. Kunkalekar, Dr. Roopa Belurkar
Maximum Marks: 25
Credit: 1

1. Volumetric estimation of amount of chloride present in given sample
2. To prepare crystals of potash alum, K_2SO_4. $Al_2(SO_4)_3$. 24 H_2O, from Aluminium foil
3. To estimate the amount of copper present in brass by colourimetric method
4. To separate and estimate the amount of magnesium ion and zinc ion present in the given magnesium-zinc mixture, using an anion exchange resin column (minimum 4 hours)
5. To estimate amount of zinc present in brass by complexometric titration (minimum 4 hours)
6. Ore analysis: Ca from Limestone (minimum 4 hours)
7. Ore analysis: Mn from Manganese ore (minimum 4 hours)
8. Synthesis of common industrial compounds involving two step reactions: Phthalic acid to Phthalic anhydride. (minimum 4 hours)
9. Complete pharmacopeia analysis of drugs: a) Paracetamol OR b) Ibuprofen (minimum 4 hours)

TEXT BOOK:
Sharma B. K., Industrial Chemistry, 6th Edition, Goel Publishing House, Meerut

REFERENCE BOOKS:

1. Lee, J. D., Concise Inorganic Chemistry, 5th Edition, Wiley Blackwell Science Publications
2. Cotton F. A., and G. Wilkinson G., Basic Inorganic Chemistry, 2nd Edition, Wiley Eastern Ltd,.
3. Iqbal S. A., and Mido,Y., Chemistry of Air and Air Pollution, Discovery Publishing House, New Delhi
4. Tyagi O. D. and Mehra M., A Text Book Of Environmental Chemistry, Anmol Publications, New Delhi
5. De, A. K., Environmental Chemistry, Wiley Eastern Limited
6. Bahl B. S., Comprehensive Inorganic Chemistry
7. Foye A. O., Principles of Medicinal Chemistry, Publication Philadephia
8. Wilson, Gisvold, Doerge, Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott -Toppan
9. Korolkovas and Burkhalter, Essentials of Medicinal Chemistry, Wiley- Interscience
10. Lednicer D., and Mitscher, L. A., Organic Chemistry of Drugs Synthesis, Wiley Interscience
11. Singh P. P. and Rangnekar, D.W., An Introduction to Synthetic Drugs, Himalaya Publication, Bombay

THEORY
Course Title: Surface Chemistry and Catalysis
Course Code: CHE- III. E-3
Name of Faculty: Dr. S. B. Kakodkar
Maximum Marks: 75
Credits: 3

Course Objectives:
1. To understand the surface features of solid surfaces and its importance in chemical processes.
2. To understand the process of adsorption and its types.
3. To understand catalytic processes and some important classes of catalysts.

Learning outcome:
1. Will have an understanding of chemistry of surfaces and be able to interpret various types of adsorption.
2. Will understand the mechanism and applications of catalytic processes.
3. Will have practical knowledge of synthesis and characterisation of catalysts.

1. Surfaces of solids **08 L**

Introduction, surface mobility of solids-sintering; effect of past history on condition of solid surfaces; Thermodynamics of crystals; Surface tension and surface free energy; equilibrium shape of a crystal; Kelvin equation; Theoretical estimates of surface energies and free energies in various types of crystals and metals; Factors affecting surface energies and surface tensions of actual crystals; experimental methods for determining surface structure, reactions of solid surfaces.

2. Adsorption **17 L**

Introduction, Differences between adsorption, absorption and sorption, Characteristics of adsorption, sorption and occlusion, Adsorption of gases on solids; Physisorption and chemisorptions; Adsorption isotherms, Types of adsorption isotherms: Freundlich adsorption isotherm, Langmuir adsorption isotherm, The BET equation; Determination of surface area: Harkin and Jura method, Benton and White method, The BET method, Point B method, From electrical potential of adsorbed layer, Using rate of dissolution, From heat of wetting; Importance of surface area; Heat of adsorption and its measurement; Adsorption isobars; Adsorption from solution, Gibbs adsorption equation, Adsorption by porous solids, Adsorption in mesopores and micropores

3. Catalysis **20 L**

Introduction, Types of catalysis, Characteristics of catalysts; Theory of Homogenous catalysis, Function of a catalyst in terms of Gibbs Free energy of activation; Theory of heterogeneous catalysis, Quantitative treatment of Adsorption theory, Kinetics of heterogeneous reactions, Effect of temperature on heterogeneous reactions, Absolute rate theory in heterogeneous gas reactions; Classification of catalysis, Enzyme catalysis, Characteristics of enzyme catalysis; Factors governing rate of enzyme catalysed reactions; Mechanism and kinetics of enzyme catalysed reactions, Michaelis-Menten equation; Acid-base catalysis, Mechanism and kinetics of acid-base catalysis, catalytic coefficients, Hammett and Bronsted equation; Acidity function; some important classes of catalysts

PRACTICALS
Course Title: Surface Chemistry and Catalysis
Course Code: CHE- III. E-3
Name of Faculty: Dr. S. B. Kakodkar
Maximum Marks: 25
Credits: 1

1. To study the adsorption of acetic acid on charcoal and to verify Freundlich isotherm.
2. To study the adsorption of oxalic acid on charcoal and to verify Langmuir adsorption isotherm.
3. To study acid catalysed inversion of cane sugar by polarimetry.
4. To determine the interfacial tension between two immiscible liquids (chloroform-water) at room temperature.
5. To determine the indicator constant of a given indicator by colourimetric measurements.
6. To synthesize ZnO from zinc nitrate by decomposition method and determine the amount of zinc in ZnO by titrimetry.
7. To synthesize CuO from copper nitrate and determine the amount of copper in CuO using titrimetry.
8. To study the kinetics of iodination of acetone.
9. To study the hydrolysis of methyl acetate and determination of energy of activation in presence of sulphuric acid.
10. To investigate the auto-catalytic reaction between potassium permanganate and oxalic acid.
11. To determine the Scherrer particle size of any three catalysts using their X-ray diffraction data.
12. To calculate band gap of any five catalysts using their UV-DRS data.
13. To determine the Hammett constant of a substituted benzoic acid by pH measurements
14. To study the adsorption of iodine from alcoholic solution using charcoal
15. To investigate the autocatalytic reaction between $KMnO_4$ and oxalic acid

TEXT BOOK:
Raj Gurdeep, Advanced Physical Chemistry, Goel Publishing House

REFERENCE BOOK:
Adamson A. W., Physical Chemistry of Surfaces, Interscience Publishers

PRACTICAL BOOK

Rajbho S.W., Chondhekar T. K., Systematic Experimental Physical Chemistry

THEORY
Corse Title: Bioinorganic Chemistry
Course Code: CHE- III. E-4
Name of Faculty: Dr. Lactina R. Gonsalves
Maximum Marks: 75
Credits: 3

Course Objectives:
This course will provide an understanding of the importance of metal in biology and the key role that metal ions play in biological processes. The course begins with the essential and trace elements in biochemical process; their function and bioavailability. As the course progresses, the role of alkali and alkaline earth metals and transition metals like Fe and Cu to carry out vital biological reactions will be studied. Also, this course will give an insight into the structure of important bimolecular and enzymes which contain metal centers. The course will also provide significant insight into the developments which utilize metal ions for medicine

Learning outcome:
On successful completion of the course, the student will be able to:
1. Describe the role of metal ions that are involved in different processes like oxygen transport, electron-transfer reactions etc. in biological systems.
2. Describe the most common metal centres for electron-transfer reaction which are based on copper and iron ions.
3. Summarize the role of metal centres in the enzymes that are involved in the catalysis of various biological reactions.
4. Will be proficient in the basic principles of bioinorganic chemistry and biochemistry.
5. Will develop skills to prepare model systems which mimic the role of metal ions in biological systems.

1. Introduction to Bioinorganic Chemistry **05 L**
Essential and trace elements in biological processes; distribution of elements in biosphere; bio-availability and bio-stability; Biologically important compounds: sugars (carbohydrates), fatty acids (lipids), nucleotides (nucleic acids) and amino acids (proteins); Biological importance of water; Metallobiomolecules.

2. Alkali and Alkaline earth metals in biological systems **12 L**
Structure and functions of biological membranes; mechanism of ion transport across membranes; sodium pump; Ionophores: valinomycin; Crown ether complexes of Na^+ and K^+; Photosynthesis: chlorophyll a, PS I and PS II; Role of calcium in muscle contraction and blood clotting.

3. Iron and Copper containing compounds in biology **15 L**
Heme proteins: hemoglobin, myoglobin and cytochrome c; Non-heme proteins: hemerythrin and hemocyanin; Iron transport and iron storage proteins: Siderophores, transferrin and ferritin; Electron transfer: Iron-Sulphur clusters, cytochromes.

4. Metalloenzymes **07 L**
Copper enzymes: superoxide dismutase, cytochrome oxidase and ceruloplasmin; Zinc enzymes: carbonic anhydrase, carboxy peptidase and interchangeability of zinc and cobalt in enzymes; Molybdenum enzyme: xanthine oxidase; Coenzymes: Vitamin B12 and B12 coenzymes

5. Chemistry of elements in medicine **06 L**
Metals as diagnostic and therapeutic agents: chelation therapy, cancer treatment, anti-arthritis drugs; Platinum complexes as anticancer drugs; Pt-DNA binding; complexes of gold, copper, zinc, mercury, arsenic and antimony as drugs.

PRACTICALS:
Corse Title: Bioinorganic Chemistry
Course Code: CHE- III. E-4
Name of Faculty: Dr. Lactina R. Gonsalves
Maximum Marks: 25
Credit: 1

1. Preparation of acetylacetonato manganese (III) complex(minimum 3 hours)
2. Preparation of trisethylenediamine nickel (II) complex (minimum 3 hours)
3. Preparation of Tris(acetylacetonato) iron (III) (minimum 3 hours)
4. Estimation of Fe from the complex Tris(acetylacetonato) iron(III)
5. Preparation of tris(thiourea)copper(I)sulphate
6. Preparation of teraamine copper (II) sulphate monohydrate(minimum 3 hours)
7. Preparation of optical isomers, cis and trans dichloro(ethylenediamine)cobalt(III)chloride (minimum 3 hours)
8. Preparation of hexamine cobalt (III) chloride(minimum 3 hours)
9. Estimation of cobalt (III) from hexamine cobalt (III) chloride
10. Preparation of bis(dimethylglyoxime)cobalt (I) a Vitamin B12 model system(minimum 3 hours)
11. Determination of hardness of water by EDTA

TEXT BOOK:
Bertini I., Gray H. B., Lippard S. J. and Valentine J.S., Bioinorganic Chemistry, University Science Books

REFERENCE BOOKS:
1. Fausto da Siliva J. J. R. and Williams R. J. P., The Biological Chemistry of the Elements, Oxford University Press
2. Fenton D. E., Bio-coordination Chemistry, Oxford Chemistry Printers, Oxford University Press
3. Shriver and Atkins, Inorganic Chemistry, 5th Edition, Oxford University Press

PRACTICAL BOOK:
Bassett J., Denney R. C., Jeffrey G. H., Mendham J., Vogel's Text Book of Quantitative Inorganic Analysis .

Parvatibai Chowgule College of Arts and Science

AUTONOMOUS

DEPARTMENT OF CHEMISTRY

DRAFT SYLLABUS

FOR THE UNDERGRADUATE COURSE IN CHEMISTRY

AT

S. Y. B. Sc. SEMESTER – IV

FOR THE

ACADEMIC YEAR: 2016-2017

SEMESTER IV

CORE COURSE
THEORY
Course Title: Comprehensive Chemistry-II
Course Code: CHE- IV. C- 6
Name of Faculty: Sandesh T. Bugde and G. K. Naik
Maximum Marks: 75
Credits: 3

Course Objectives:

1. The main objective of this course is to study the organic compounds containing CHO elements.
2. This course focuses on the study of ethers, aldehydes, ketones, acids and esters with respect to their structural and chemical properties, method of formation and chemical reaction.

Learning outcome: Students will learn about;

1. Important classes of organic compounds include CHO elements.
2. Preparations involved in different classes of organic compound having CHO elements.
3. Important reaction involved in each class of included compounds.

SECTION I (ORGANIC CHEMISTRY)

1. a. Studies of organic compound containing C, H and O **04 L**

Chemistry of organic compounds containing C, H, O elements; Alcohols, ethers, acids, ester, aldehydes and ketones

b. Ethers

Properties of ethers, Symmetric and asymmetric ethers, crown ethers, Preparations of ethers: Williamson ether synthesis, alkoxymercuration-demercuration, Reaction of ethers with acids (HX).

2. Aldehydes and Ketones **08 L**

Properties of aldehydes and ketones, Geometry and polarity of the carbonyl group, Preparation of aldehydes: Oxidation of alcohols, reduction of acid chlorides, Ozonolysis of alkene; Preparation of ketones: oxidation of alcohols, Friedel-Crafts acylation, Reaction of acid chloride with organocopper compounds; Reactions of aldehydes and ketones: General mechanism of nucleophilic addition at carbonyl group; Oxidation and reduction of aldehyde and ketones; Reaction with amine derivative (imine formation with mechanism); Cannizaro reaction and addition of Grignard reagents; Addition of carbanions (Aldol condensation).

3. Carboxylic Acids **06 L**

Properties of carboxylic acids, Preparation of acids: Oxidation of primary alcohols and alkyl benzenes, hydrolysis of nitriles with mechanism; Reaction of acids: Salt formation, conversion to different functional groups (esters, amides, acid chlorides and anhydrides), reduction of acids.

4. Esters **05 L**

Properties of esters; Preparation of esters: from acids, acid chlorides and anhydrides; Reactions of esters: Conversion to acids (Hydrolysis along with mechanism), conversion to amides, Trans-esterification, reduction to aldehydes and alcohols.

SECTION II (ANALYTICAL CHEMISTRY)

1. The Scope and Nature and of Analytical Chemistry **05 L**

Introduction; quantitative and qualitative analysis; qualitative analysis by classical and instrumental methods; analytical chemistry and analytical process (steps involved in chemical analysis): defining the problem, sampling, separation of desired components, actual analysis, presentation and interpretation of results; factors affecting the choice of analytical method.

2. Sampling Techniques **07 L**

Terms encountered in sampling: Sample, the population or the universe, sampling unit, increment, the gross sample, the sub sample, Analysis sample, bulk ratio, size to weight ratio, random sampling, systematic sampling, multistage sampling, sequential sampling; sampling of gases, liquids and solids; Preservation, storage and preparation of sample solution.

3. Statistical Treatment of Analytical Data **10 L**

Limitations of analytical methods, classification of errors, accuracy and precision; Errors: determinate and indeterminate error, constant and proportionate errors, minimization of errors; Significant figures and rounding off; mean, median, mode, range; standard deviation; histogram and frequency polygon; measures of central tendency and dispersion; Gaussian distribution curve; Confidence limit; Test of significance: F test, Students T; Rejection of the results: Q test, 2.5 d and 4.0 d rule; linear least squares/ method of averages.

PRACTICALS
Course Title: Comprehensive Chemistry-II
Course Code: CHE- IV. C- 6
Name of Faculty: Sandesh T. Bugde and G. K. Naik
Maximum Marks: 25
Credit: 1

ORGANIC CHEMISTRY EXPERIMENTS

1. Qualitative analysis of organic compounds:
   Solids (examples: Benzoic acid, Nitro-benzaldehyde, Benzophenone)
   Liquids (Acetone, methylacetate, benzaldehyde)
2. Identification of type and separation of mixture of organic compounds:
   Solid-solid (Soluble-insoluble, insoluble-insoluble), solid-liquid (Solid and low boiling liquid), liquid-liquid) (High boiling and low boiling liquid)

ANALYTICAL CHEMISTRY EXPERIMENTS

1. To estimate the NO_2^- in the given solution by $KMnO_4$ method by back titration
2. To determine the amount of HCl in the given solution by pH metric titration
3. To determine the specific rotation of the given solution and to determine the percentage composition of unknown solution using polarimeter
4. To estimate the amount of benzoic acid in the given solution by back titration
5. To estimate the amount of vitamin C in the given solution
6. To estimate the amount of Aspirin present in the given tablet
7. To calibrate the burette and pipette using statistical treatment of data
8. To calibrate the volumetric flask of different volume capacity
9. To determine the hardness of water by EDTA method and to take at least five readings and apply the statistical data treatment to calculate mean, median, range, standard deviation and Q test. (Any six experiments to be performed)

ORGANIC CHEMISTRY
TEXT BOOK:

1. Morrison, R. T., Boyd, R. N. and Bhattacharjee, S. K., Organic Chemistry, Pearson India.

REFERENCE BOOKS:

1. Bruice, P. Y. Organic Chemistry, Pearson India
2. Carey, F. C. and Giuliano, R. M. Organic Chemistry, Tata McGraw-Hill India
3. Finar, I. L. Organic Chemistry, Pearson India

PRACTICAL TEXT BOOK:
Furniss, B. Brian, S., Vogel's Textbook of Practical Organic Chemistry, Pearson education

ANALYTICAL CHEMISTRY
TEXT BOOK:

1. Skoog, D. A., West, D. M., Holler F. J. and Crouch, S. R., Fundamentals of Analytical Chemistry, 8th Edition,

REFERENCE BOOKS:

1. Willard, H. H., Merritt, L. L., Dean, J. A., Settle, F. A., Instrumental Methods of Analysis, CBS Publishing, New Delhi, 7th Edition
2. Vogel's Text Book of Quantitative Inorganic Analysis - J. Bassett, R. C. Denney, G. H. Jeffrey, J. Mendham.
3. Christian, G. D., Analytical Chemistry, Analytical Chemistry, John Wiley, 5th Edition

PRACTICAL TEXT BOOK:
Yadav J. B. Advanced Practical Physical Chemistry, Goel Publishing House, 14th Edition

SEMESTER IV

ELECTIVE COURSES
THEORY
Course Title: Pharmaceutical Chemistry
Course Code: CHE- III. E-5
Name of Faculty: Sandesh T. Bugde
Maximum Marks: 75
Credits: 3

Course Objectives:

1. The main objective of this course is to study the Chemistry involved in pharmaceutical industries.
2. This course gives blend of chemical and pharmaceutical principles necessary for understanding structure–activity relationships and molecular mechanisms of drug action.
3. This course also includes synthesis of some important drugs.

Learning outcome:

1. Students will learn about important aspects with respect to pharmaceutical Chemistry.
2. Students will develop understanding in structure-activity relationship.
3. Students will learn efficient chemical synthesis involved in important drug.

1. Introduction to pharmaceutical Chemistry and its scope 05 L

Introduction to pharmaceutical Chemistry; Scope of pharmaceutical Chemistry; General terminologies used in pharmaceutical Chemistry: Pharmacoepia, Pharmacokinetics, Pharmacodynamics.

2. Drug design strategies and general pathways of drug metabolism 10 L

Drug designing; General pathways of drug metabolism: Oxidative reactions, reductive reactions, hydrolytic reactions, Phase II or conjugation reactions.

3. Anti-infective agents 10 L

Antifungal agents: Haloprogin and Flucytosine. (Definition, structures, Mechanism of action and uses); Antibacterial agents: Ciprofloxacin and Furazolidone (Definition, structures and uses); Anti protozoal agents: Metronidazole (Definition, structure and uses); Antihelmintics: Thiabendazole (Definition, structure and uses); Antibacterial agents: Linezolid (Definition, structure and uses); Synthesis of Flucytosine.

4. Central nervous system stimulant and depressant 10 L

Analeptics: Pentylenetetrazole (Definition, structure and uses); Central sympathomimetic agents (psychomotor stimulants): Pentylenetetrazole (Definition, structure and uses); Antidepressants: Desipramine Hydrochloride and Clomipramine Hydrochloride (Definition, structure and uses); Anxiolytic: Paroxetine (Definition, structure and uses); Sedative and hypnotic agents: Propofol, Methaquolone (Definition, structure and uses); Synthesis of clomipramine.

5. Cardiovascular agents 06 L

Antianginal Agents and Vasodilators: Nitroglycerin, Nifedipine (Definition, structures and uses); Antiarrhythmic Drugs: Quinidine sulfate (Definition, structure and uses); Antihypertensive Agents: Prazosin (Definition, structure and uses); Synthesis of Nifedipine by Hantsch synthesis, Prazosin.

6. An introduction to the Medicinal Chemistry of plants 04 L

Historical background; Type of plant, active ingredient structure and their medicinal properties: Capsicum, Garlic, turmeric.

PRACTICALS
Course Title: Pharmaceutical Chemistry
Course Code: CHE- III. E-5
Name of Faculty: Sandesh T. Bugde
Maximum Marks: 25
Credit: 1

1. Synthesis of Aspirin
2. Synthesis of Benzocaine
3. Synthesis of Paracetamol
4. Synthesis of Acetaminophen
5. Synthesis of benzophenone oxime.
6. Synthesis of phenytoin
7. Synthesis of benzimidazole
8. Estimation of acetyl salicylic acid in the given aspirin tablet by titrating against 0.1N alcoholic KOH potentiometrically.
9. Determination of purity of paracetamol spectrophotometrically.
10. Determination of optical rotation of pharmaceutical compounds.
11. UV Absorbance Standard Curve of Salicylic Acid
12. Assay by titration of the following: Ibuprofen, aspirin.
13. Hydroxyzine dihydrochloride (HDH) determination by titrimetry.
14. Assay of Nitrazepam potentoimetrically.
15. Quantitative estimation of aspirin in tablets using metformin hydrochloride.

TEXT BOOK:

1. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, 12th Edition

REFERENCES BOOKS:

1. Foye, W.O., Medicinal Chemistry
2. A. Pengelly, The Constituents of Medicinal plants
3. Lednicer and Meischer, Organic Chemistry of Drug Synthesis

THEORY
Course Title: Polymer and Colloid Science
Course Code: CHE- III. E-6
Name of Faculty: G. K. Naik
Maximum Marks: 75
Credits: 3

Course Objectives:
1. To understand the classification, properties and applications of colloids.
2. To understand the classification, synthesis and molecular weight determination of polymers.
3. To study the mechanism of polymer synthesis.

Learning outcome:
1. Will be able to classify colloids.
2. Will be able to calculate molar mass of polymers.
3. Will learn to synthesise some polymers in the laboratory

1. Colloidal Science
a. Introduction: **10 L**
Colloidal state; colloidal solution; classification of colloids; lyophobic and lyophilic colloids; true solution, colloidal solution and suspension; preparation of sols; purification of sols; stability of colloids; protective action; Hardy- Schulze Law; gold number

b. Properties of colloids: **07 L**
General properties; electrical properties; electrical double layers

c. Emulsions and gels: **06 L**
Definition; types of emulsions, preparation; gels: definition; classification, preparation and properties, inhibition; kinetics of coagulation; general applications of colloids on size of colloidal particles

2. Polymer Chemistry:
a. Introduction to Polymer Science **06 L**
Classification of polymers: thermoplastics and thermosetting, classification based on polymerization scheme, polymer structure: copolymers, tacticity, geometric isomerism; molecular weight: molecular weight distribution, molecular weight averages; chemical structure and thermal transitions.

b. Synthesis of high polymers **07 L**
Step growth polymerization: molecular weight in a step growth polymerization, step growth polymerization kinetics; chain growth polymerization: free redical polymerization and copolymerization, ionic polymerization and copolymerization; polymerization technique; bulk polymerization, solution polymerization, suspension polymerization, emulsion polymerization, solid state- gas phase and plasma polymerization.

c. Solution properties, thermodynamics and molecular weight determination **05 L**
Polymer conformation and chain dimensions; thermodynamics of polymer solution: Flory-Huggins theory, Flory-Krigbaum and Flory-Huggins theory, Equation of state theory; calculation of molecular weight: osmometry, light scattering method, intrinsic viscosity method

d. Solid state properties of polymer **04 L**
Amorphous state: chain enlargements and reputation, the glass transition, secondary relaxation processes; the crystalline state: ordering of polymer chains, crystalline-melting temperature, crystallization kinetics, technique to determine crystallinity.

TEXT BOOK:
Raj Gurdeep, Advanced Physical Chemistry; Goel Publishing House, Meerut, 27th Edition

REFERENCE BOOKS:

1. Puri B.R., Sharma L.R., Pathania M. S., Principles of Physical Chemistry
2. Fried J. R., Polymer Science and Technology; Prentice Hall of India private limited
3. Bhatnagar M.S., A Text Book of Polymer Science, Volume 1

PRACTICALS
Course Title: Polymer and Colloid Science
Course Code: CHE- III. E-6
Name of Faculty: G. K. Naik
Maximum Marks: 25
Credit: 1

1. To determine the flocculation value of univalent and divalent electrolyte for ferric hydroxide sol
2. To prepare colloidal solutions of cadmium sulphide and ferric hydroxide
3. To study the coagulation value of As_2S_3 sol with $AlCl_3$
4. To study the mutual coagulation value of ferric hydroxide sol
5. To determine the critical micelle concentration of a soap by surface tension method
6. To determine the viscosity of a given liquid using Ostwald's viscometer (minimum two liquids)
7. To determine the molar mass of a polymer using Ostwald's viscometer
8. To determine the viscosity of mixture A and B and test the validity of Kendalls equation
9. To determine the viscosity of mixture of A and B and determine the composition of the two liquids
10. To study the variation of the viscosity of a given liquid with temperature using Ostwald's viscometer
11. To determine the surface tension of a liquid by drop number method
12. To determine the composition of mixture of two liquids by surface tension method
13. To determine the molecular weight of a given polymer by turbidimetry
14. To separate the amino acids from the mixture by electrophoresis
15. To separate the inorganic cations by paper electrophoresis

THEORY
Course Title: Spectroscopic Techniques
Course Code: CHE-IV. E-7
Name of Faculty: G. K. Naik
Maximum Marks: 75
Credits: 3

Course Objectives:
1. To learn the basic principles on interaction of electromagnetic radiation with matter and instrumentation basics.
2. To understand principles, instrumentation and applications of UV-Visible spectroscopy and atomic spectrometric methods.
3. To provide a practical approach to understand UV-Visible spectroscopy.

Learning outcome:
1. Will be able to understand the basic components of instruments and the choice of solvents for spectrometry.
2. Will be able to perform qualitative and quantitative analysis using principles of spectrometry.
3. Will be able to operate an UV-visible spectrophotometer.

1. General Introduction **15 L**

Overview of spectroscopy; meaning of electromagnetic radiation; interaction of electromagnetic radiation with matter; wave properties of electromagnetic radiation; particle properties of electromagnetic radiation; the electromagnetic spectrum; regions of spectrum; atomic and molecular spectra; representation of spectra; photons as a signal source; basic components of spectroscopic instruments; sources of energy; sources of electromagnetic radiation; sources of thermal energy; chemical sources of energy; wavelength selection; wavelength selection using filters; wavelength selection using monochromators; interferometers; detectors; photon transducers; thermal transducers; signal processors; solvents for spectrometry; quantitative calculations; spectrometric errors in measurements

2. UV Visible Spectroscopy: **20 L**

Beer's Law; Lambert's Law; Beer-Lambert's Law; Deviations from Beer-Lambert's Law; validity and limitations of Beer- Lambert's law; principles of instrumentation: Sources, monochromators, cells; types of instruments; photoelectric colorimeters: single and double beam photoelectric colorimeters; single and double beam spectrophotometers; comparison between colorimeter and spectrophotometer; analytical applications of colorimeter and spectrophotometer: λ_{max}, quantitative analysis, identification of structural groups in a molecule, study of co-ordination compound; photometric titrations; Theory of electronic (UV) spectroscopy; Electronic transitions in a molecule; Chromophores and auxochromes; Bathochromic, hypsochromic, hyperchromic and hypochromic shifts; solvent effect; effect of temperature; applications of UV and visible spectroscopy: identification of structural groups, cis-trans isomerism, chemical kinetics, qualitative and quantitative analysis; limitations of UV and visible spectroscopy.

3. Atomic Spectroscopy **10 L**

Origins of atomic spectra, production of atoms and ions; Atomic Emission Spectrometry: Introduction, principle, instrumentation, applications, advantages and limitations of flame photometry and Inductively coupled plasma spectroscopy; Atomic Absorption Spectrometry: Introduction, principle, instrumentation, applications, internal standard and standard addition calibration, limitations Atomic Fluorescence Spectrometry: Introduction, principles, instrumentation and applications.

PRACTICALS
Course Title: Spectroscopic Technique/ Method
Course Code: CHE-IV. E-7
Name of Faculty: G. K. Naik
Maximum Marks: 25
Credit: 1

1. To test the validity of Beer-Lambert Law using spectrophotometer and determine the unknown concentration of a solution
2. To calibrate the UV- Visible spectrophotometer for control of absorbance and limit of stray light
3. Determination of Mn^{2+} ion concentration by periodate method using spectrophotometer
4. Determination of Fe^{3+} ion concentration by salicylic acid method using spectrophotometer
5. To verify the law of additivity of absorbance ($KMnO_4$ and $K_2Cr_2O_7$) at λ_{max} of $K_2Cr_2O_7$ and determine molar absorptivity
6. To verify the law of additivity of absorbance ($KMnO_4$ and $K_2Cr_2O_7$) at λ_{max} of $KMnO_4$ and determine molar absorptivity
7. To determine the amount of K_2CrO_4 present in given sample by using UV-Visible spectrophotometer
8. Spectrophotometric methods for determining the stoichiometry of a complex formed between iron and 1,10- phenanthroline by continuous variation method
9. Spectrophotometric methods for determining the stoichiometry of a complex formed between iron and 1,10- phenanthroline by mole ratio method
10. To determine the phosphate concentration in a soft drink by spectrophotometric method
11. To determine the dissociation constant of methyl red indicator by spectrophotometric method
12. To estimate the amount of nitrite in water sample by spectrophotometric method
13. To estimate the amount of paracetamol in tablet by spectrophotometric method
14. To estimate the amount of aspirin in the given tablet by spectrophotometric method
15. To determine the amount of Cr (VI) in the given solution as dichromate by least square method spectrophotometrically

TEXT BOOK:
Skoog, D. A., West, D. M., Holler F. J., Crouch, S. R., Fundamentals of Analytical Chemistry, 8th Edition

REFERENCE BOOKS:
1. Holler F. J., Skoog, D. A., Crouch, S. R., Principles of Instrumental Analysis, 6th Edition, Thomson Books
2. Willard, H.H., Merritt, L.L., Dean, J. A., Settle, F. A., Instrumental Methods of Analysis, CBS Publishing New Delhi, 7th Edition
3. Christian, G. D., Analytical Chemistry, John Wiley, 5th Edition
4. Ewing, G.W., Instrumental Methods of Chemical Analysis, 5th Edition, Mc-Graw Hill International Edition.
5. Bassett J., Denney R. C., Jeffrey G. H., Mendham J., Vogel's Text Book of Quantitative Inorganic Analysis, 4th Edition, ELBS and Longman

PRACTICAL BOOK:
Yadav, J. B., Advanced Practical Physical Chemistry, 14th Edition, Goel Publishing House

THEORY
Course Title: Chemistry of Natural Products
Course Code: CHE- III. E-8
Name of Faculty: Sandesh T. Bugde
Maximum Marks: 75
Credits: 3

Course Objectives:

1. The main objective of this course is to study the Chemistry of Natural products.
2. This course focuses on different classes of natural products, their importance, properties, biogenesis and chemical synthesis.
3. This course will also focus on the techniques involve in natural product separation and characterisation in brief.

Learning outcome:

1. Students will learn about importance of natural product in day today life.
2. Students will learn different techniques used in isolation and characterisation of natural products.
3. Students will learn important chemical synthesis involved in natural product.

1. Introduction to Natural Product Chemistry **02 L**

Introduction to natural products and classifications of natural products

2. Isolation, purification and characterization techniques in natural products Chemistry **15 L**

Extraction methods in isolation/purification of natural products; Distillation techniques, Column chromatography for separation of natural products; Chromatographic techniques in natural products characterization: TLC, Mass spectrometry, spectroscopic techniques: IR, UV-Visible (Introduction, basic principle, utilization of techniques in identification of organic compounds).

3. Terpenes **10 L**

Occurrence, classification and isolation of terpenes; Menthol, Geraniol- Biogenesis, biosynthesis and chemical synthesis and Structure elucidation

4. Alkaloids **09 L**

Occurrence, Classification and isolation of alkaloids; Chemical synthesis and structure elucidation of selected alkaloids: Morphine and Nicotine.

5. Biomolecules of life **09 L**

Fats: Occurrence and composition; Hydrolysis of fats; Carbohydrates: Classification, nomenclature and uses; Amino acids: Classification, nomenclature and uses. Structures and classes of peptides and proteins; Nucleic acids: different types of nucleic acids, Nucleosides, nucleotides and structure of DNA.

PRACTICALS
Course Title: Chemistry of Natural Products
Course Code: CHE- III. E-8
Name of Faculty:
Maximum Marks: 25
Credit: 1

1. Synthesis of dilantin natural product from benzyl
2. Synthesis of 2-phenyl-3,1-benzoxazin-4-on from anthranilic acid
3. Identification of citric acid in lemon juice as calcium citrate
4. Conversion of calcium citrate to citric acid
5. Synthesis of Benzylideneacetophenone
6. Carotenoid extraction from tomato using a green solvent
7. Carotenoid extraction from carrot using a green solvent
8. To prepare isopentyl acetate from isopentyl alcohol and acetic acid by the Fischer esterification reaction
9. To prepare octyl acetate from octyl alcohol and acetic acid by the Fischer esterification reaction
10. To prepare ethyl butyrate from ethyl alcohol and butyric acid by the Fischer esterification reaction
11. To synthesize salicylic acid from methyl salicylate in wintergreen oil
12. To identify the natural products using Spectroscopic techniques such as Mass spectrometry, IR, UV spectroscopy
13. Synthesis of dihydropyrimidinone
14. Preparation of caffiec acid from 3, 4 dihydroxy benzaldehyde
15. Isolation of caffeine from tea leaves

TEXT BOOKS:

1. Nakanishi K., Natural Product Chemistry, Academic Press

REFERENCE BOOKS:

1. Manitto P., Biosynthesis of Natural Products, Horwood Ltd
2. Finar I. L., Textbook of organic Chemistry, Volume II
3. Finar I. L., Organic Chemistry: Stereochemistry and the Chemistry of Natural Products, ELBS Edition

Pattern of Question Paper

SEMESTER I/II (MAJOR/MINOR)

DURATION: 2 HOURS MAXIMUM MARKS: 45

SECTION I (PHYSICAL/ORGANIC CHEMISTRY) 30 MARKS

Q 1.	10 Marks
Q 2.	10 Marks
Q 3.	10 Marks

SECTION II (INORGANIC CHEMISTRY) 15 MARKS

Q 4.	12 Marks
Q 5.	03 Marks

Pattern of Question Paper

SEMESTER II/III/IV

DURATION: 2 HOURS	MAXIMUM MARKS: 45

SECTION I (PHYSICAL/ORGANIC CHEMISTRY) 23 MARKS

Q 1.	09 Marks
Q 2.	08 Marks
Q 3.	06 Marks

SECTION II (ANALYTICAL/INORGANIC CHEMISTRY) 22 MARKS

Q 4.	09 Marks
Q 5.	07 Marks
Q 6.	06 Marks

Parvatibai Chowgule College of Arts and Science (Autonomous)

DEPARTMENT OF CHEMISTRY
COURSE STRUCTURE
THREE YEAR B.Sc. DEGREE COURSE IN CHEMISTRY

SEMESTER	CORE COURSES		ELECTIVE COURSES			
I	CHE-I. C-1 General Physical and Inorganic Chemistry	CHE-II. C-2 General Organic and Inorganic Chemistry	---	---	---	---
II	CHE-II. C-3 Concepts in Physical and Analytical Chemistry	CHE-II. C-4 Concepts in Organic and Inorganic Chemistry	---	---	---	---
III	CHE-III. C-5 Comprehensive Chemistry –I	---	CHE-III. E-1 Name Reactions and Synthetic Methodologies	CHE-III. E-2 Industrial Chemistry	CHE-III. E-3 Surface Chemistry and Catalysis	CHE-III. E-4 Bioinorganic Chemistry
IV	CHE-IV. C-6 Comprehensive Chemistry -II	---	CHE-IV. E-5 Pharmaceutical Chemistry	CHE-IV. E-6 Polymer and Colloid Science	CHE-IV. E-7 Spectroscopic Techniques	CHE-IV. E-8 Chemistry of Natural Products
V	CHE-V. C-7 Advanced Chemistry – I (Physical & Inorganic Chemistry)	---	CHE-V. E-9 Heterocyclic Chemistry	CHE-V. E-10 Nanomaterials and solid state Chemistry	CHE-V. E-11 Organometallic Chemistry	CHE-V. E-12 Chemistry of main group elements
VI	CHE-VI. C-8 Advanced Chemistry-II : Organic and Analytical Chemistry	---	CHE-VI. E-13 Spectroscopic Methods in Organic Chemistry	CHE-VI. E-14 Environmental Chemistry	CHE-VI. E-15 Selected Topics in Inorganic Chemistry	CHE-VI. E-16 Solid State Chemistry

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Parvatibai Chowgule College of Arts and Science

AUTONOMOUS

DEPARTMENT OF CHEMISTRY

SYLLABUS DRAFT

FOR THE UNDERGRADUATE COURSE IN CHEMISTRY

AT

T. Y. B. Sc. SEMESTER – V

FOR THE

ACADEMIC YEAR: 2017-2018

SEMESTER V

CORE COURSE

THEORY
Course Title: Advanced Chemistry I: Physical and Inorganic Chemistry
Course Code: CHE- I. C-7
Marks: 75
Credits: 03

Course Objectives:

1. To provide a basic understanding of the core areas of Physical Chemistry based on the theme of electrochemistry, spectroscopy etc.
2. To obtain a comprehensive understanding of the basic concepts in Inorganic Chemistry.
3. To generally provide practical skills to correlate with the theory.

Learning outcome

1. Will have a working knowledge of the main areas of Physical Chemistry, will develop critical thinking abilities and be able to work in chemical or related fields.
2. Will help to get better understanding about the basics of Physical and Inorganic Chemistry.
3. Will be able to carry out experiments with required skills.

SECTION I (PHYSICAL CHEMISTRY)

UNIT I: Molecular Spectroscopy **7L**

Definition of spectrum. Electromagnetic radiation, quantization of different forms of energies in molecules : translational, rotational and electronic, Born Oppenheimer approximation, factors affecting line width and intensity.

Infrared spectroscopy

Hook's law, energy levels and transitions: Simple harmonic oscillator, anharmonic oscillator (derivations expected), Calculation of force constant, Stretching and bending vibrations, modes of vibration of diatomic, linear triatomic (CO_2) and non linear triatomic (H_2O) molecules, applications of IR spectroscopy.

Raman spectroscopy- Rayleigh and Raman scattering, Stokes and Antistokes lines. Mutual exclusion principle. Differences between Raman and IR spectroscopy

Numerical problems expected

UNIT II: Photochemistry **4L**

Interaction of radiation with matter, difference between thermal and photochemical processes, Laws of photochemistry: Grothus – Drapper law, Stark – Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non- radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions.

Numerical problems expected

UNIT III: Electrochemistry **7L**

EMF of a cell and its measurements, concentration cells: electrode and electrolyte with and without transport, liquid junction potential and its measurement; applications of concentration cell: determination of ionic product of water, transport number of ions, solubility and solubility product.

Numerical problems expected

UNIT IV: Nuclear Chemistry **5L**

Natural Radioactivity: kinetics of radioactive decay, half-life and average life of radioelements (derivations expected),

Measurement of radioactivity: GM counter, Scintillation counter

Artificial radioactivity: Chain reaction and conditions for its control.

Radioisotopes and their applications; radiolabelled reactions, radiocarbon dating, medicinal and agricultural field, hazards of radiation.

Numerical problems expected

SECTION II (INORGANIC CHEMISTRY)

UNIT V: Metal-Ligand Bonding in Transition Metal Complexes **11L**

Principles and limitations of Valence bond theory, Crystal field theory (CFT) splitting of d- orbitals in octahedral, tetrahedral and square planar complexes. Crystal Field Stabilization Energy (CFSE), Measurement of 10 Dq for $[Ti(H_2O)_6]^{3+}$ complex, Factors affecting 10 Dq, Spectrochemical series, Effect of crystal field splitting on properties of Octahedral complexes: Magnetic, Spectral.

UNIT VI: Electronic spectra of Transition Metal Complexes: **11L**

Introduction, types of electronic transitions: The d-d transitions (d^1/d^9 and d^2/d^8), charge transfer transitions and ligand-ligand transitions, selection rules (Laporte orbital and spin), applications (ligand field strength, colour of complexes, *cis*-, *trans*- isomerism and geometry of complexes).

PRACTICALS
Course Title: Advanced Chemistry I: Physical and Inorganic Chemistry
Course Code: CHE- I. C-7
Marks: 25
Credits: 01

List of experiments:
Physical Experiments:

1. To determine the percent composition of acid mixture (strong and weak acid) by titrating against standard 0.1 N NaOH solution.
2. To determine the strength of mixture containing weak acid (CH_3COOH) and weak base (NH_4OH) by titrating against standard 0.1N NaOH solution
3. To determine the formal redox potential of Fe^{2+}/Fe^{3+} system using standard 0.1N $K_2Cr_2O_7$ solution.
4. To determine the percent composition and amount of halide ions from their mixture (any two halides) using standard 0.1N $AgNO_3$ solution.
5. To determine the dissociation constant of weak monobasic acid (CH_3COOH) by titrating against standard 0.1N NaOH solution.
6. To study the acid hydrolysis of methyl acetate at three different temperatures and compare the energy of activation.

Any six

Inorganic experiments

1. Preparations of the following complexes. (2hours each)
    a) $[Ni(NH_3)_6]Cl_2$
    b) $[Co(NH_3)_3(NO_2)_3]\ Cl_3$
    c) $[Co(NH_3)_6]Cl_3$
    d) $K_3[Al(C_2O_4)_3].H_2O$
    e) Preparation and estimation of Ti in $[Ti(H_2O)_6]^{3+}$ complex.
2. Estimation of Ni in $[Ni(NH_3)_6]Cl_2$ gravimetrically

3. Estimation of Co in $[Co(NH_3)_6]Cl_3$ gravimetrically

REFERENCE BOOKS:
Physical Chemistry
TEXTBOOK:

1. Bahl B.S, et.al, 2004, "Essentials of Physical Chemistry" S. Chand & Co., New Delhi

ADDITIONAL READING:

2. Arnikar H.J.,1995, "Essentials of Nuclear Chemistry", Wiely-Eastern Ltd., New Delhi
3. Atkins P, et.al, 2006,"Physical Chemistry", Oxford University Press, New Delhi
4. Castellan, G.W,2002, "Physical Chemistry", Narosa Publishing House, New Delhi,
5. Kundu K. et.al,2003, "Physical Chemistry", S. Chand & Co., Ltd., New Delhi
6. Puri B.R et.al,2008,"Principles of Physical Chemistry",Vishal Publishing Company, Jalandhar
7. Raj Gurdeep, 2000 ,"Advanced Physical Chemistry", Goel Publishing House, Meerut
8. Srivastava A.K, et.al, 1989,"Essential of Nuclear Chemistry", S.Chand & Co, New.Delhi

Inorganic Chemistry

TEXTBOOK:

1. Atkins P, Overton T, Rourke J et.al, *Shriver and Atkins' Inorganic Chemistry*, 5th Edition, Oxford University Press.

ADDITIONAL READING:

2. Cotton F.A and Wilkinson G, *Basic Inorganic Chemistry*,Wiley Eastern Ltd.
3. Huheey J.E, Keiter E.A, Keiter R.L, Medhi O.K, *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Edu.
4. Lee J.D, *Concise Inorganic Chemistry*, Wiley-India

SEMESTER V

ELECTIVE COURSES
THEORY
Course Title: Heterocyclic Chemistry
Course Code: CHE- V. E-9
Maximum Marks: 75
Credits: 03

Course Objectives:

1. The main objective of this course is to study the chemistry of heterocyclic compounds.
2. This course gives an overview of different classes of heterocyclic compounds.
3. It includes physical, chemical properties and synthesis of most of the heterocyclic compounds.

Learning outcome:

1. Students will learn about important aspects with respect to heterocyclic chemistry.
2. Students will develop understanding with regards to reactivity of heterocyclic chemistry.
3. Students will learn efficient chemical synthesis involved in heterocyclic compounds.

UNIT I: Introduction to heterocyclic compounds 03L

Classification and Nomenclature of aliphatic and aromatic heterocycles.

UNIT II: Aliphatic heterocycles 10L

Structure and reactivity of nitrogen and oxygen containing aliphatic heterocycles. Methods of preparation and reactions of oxiranes, aziridines, tetrahydrofuran, pyrrolidine.

UNIT III: Five and six membered aromatic heterocycles 12L

Structure and reactivity of five and six membered heterocycles: furan, pyrrole, thiophene and pyridine; comparison of basicity of pyrrole, pyridine & piperidine. Electrophilic substitution reactions of five and six membered heterocycles: General mechanism, mechanism of halogenation, nitration and reaction using acids (HCl, H_2SO_4 and HNO_3). Methods of preparation of furan, pyrrole, thiophene and pyridine. Nucleophilic substitution reactions of aromatic heterocycles.

UNIT IV: Condensed heterocycles 10L

Structure and reactivity of condensed heterocycles like benzofuran, Indole, benzothiophene, quinoline and isoquinoline. Electrohilic and nucleophilic substitution reactions of condensed heterocyles: General mechanism and with examples. Oxidation and reduction of condensed hetero cylcles. Methods of preparation of benzofuran, Indole, benzothiophene, quinoline and isoquinoline.

UNIT V: Heterocycles containing more than one heteroatom 10L

Classification of heterocycles containing more than one heteroatom. Reactions of 1,2-azoles, 1,3-azoles, oxazoles, imidazole, purines and pyrimidines: Reactions with electrophilic reagents, reactions with nucleophilic reagents. Methods of preparations of 1,2-azoles, 1, 3-azoles, oxazoles, imidazole and purines.

PRACTICALS
Course Title: Heterocyclic Chemistry
Course Code: CHE- V. C-9
Marks: 25
Credits: 01

List of experiments:

1. Epoxidation of chalcones (2steps)
2. Synthesis of the Coumarins via Pechmann condensation
3. Synthesisof 3,4- dihydropyrimidin-2(1H)-ones by a one-pot three component cyclocondensation reaction of 1,3 dicarbonyl compound, aldehyde, and urea via Biginelli reaction
4. Synthesis of 1,3,5-trisubstituted pyrazoles (2steps)
5. Synthesis of benzimidazole from o-phenylenediammine and formic acid
6. Synthesis of 2-substituted benzoxazoles from 2-amino phenol and aromatic aldehydes.
7. Synthesis of quinoxaline derivatives
8. Synthesis of flavones via Baker-Venkataraman rearrangement (3steps)
9. Preparation of 2-phenyl indole via fischer indole synthesis

REFERENCES:

TEXT BOOK

1. Joule J. A. and Mills K. **2010.** "*Heterocyclic Chemistry*". Wiley publications

ADDITIONAL READING:

1. Carey, F. C. and Giuliano, R. M. **2000.** "*Organic Chemistry"* Tata McGraw-Hill India.
2. Gilchrist T. **2007.** "*Heterocyclic Chemistry".* Pearson Education India
3. Smith, M. B and March, J . **2012.** " March's Advance organic Chemistry" Wiley publications.

THEORY
Course Title: Nanomaterials and Solid State Chemistry
Course Code: CHE-VI. E-10
Maximum Marks: 75
Credits: 3

Course Objectives:
The main objective of this course is to study the chemistry of nanomaterials, their synthesis, properties and applications. It also provides fundamental knowledge of solid state chemistry which involves reaction of solids and their electrical and magnetic properties.

Learning outcome:
1. Students will have a basic and concise knowledge of nanomaterials.
2. Students will develop skills in nanomaterial synthesis.
3. Will be able to understand characterization techniques in solid state chemistry.

UNIT I: Introduction and properties of nanomaterials **6L**
Fundamentals: terminology and history, classification of nanomaterials, properties of nanomaterials: optical, magnetic, electronic, surface area, catalytic and mechanical.

UNIT II: Synthesis and characterization of nanomaterials **10L**
Synthesis Approach with at least one example of each: Chemical methods (sol-gel, hydrothermal, sonochemical, microwave, precursor). Top down and bottom up, physical methods (mechanical methods, methods based on evaporation, sputter deposition, chemical vapour deposition), biological methods (using microorganism and plant extract).
Characterization techniques: electron microscopic techniques (SEM/TEM), diffraction techniques, spectroscopic (UV-Visible, magnetic measurement), BET surface area.

UNIT III: Applications of nanomaterials **6L**
Energy, automobiles, sports, textile, cosmetics, medicinal, space, defence, engineering and catalytic.
Toxicity of nanomaterials

UNIT IV: Solid state chemistry **11L**
Reactions of solids: tarnish reactions, decomposition reaction, solid-solid reactions, addition reactions, double decomposition reaction, electron transfer reaction, solid-gas reactions. Sintering.
Phase transformations in solids: structural change in phase transformation, Martensite transformation, temperature and pressure induced transformations, order-disorder transitions.

UNIT V: Electrical and magnetic properties of solids **12L**
Electrical conductivity, insulators, semiconductor and conductors. Band theory of semiconductors, photo conductivity and ionic conductivity. Superconductivity, BCS theory, Meissner effect, types of superconductor.
Piezoelectric, ferroelectric materials and applications.
Introduction to magnetism, behavior of substance in a magnetic field, magnetic moments, diamagnetism, paramagnetism, experimental determinations of susceptibility, ferromagnetism, antiferromagnetism, ferrimagnetism, magnetizations of a ferromagnetic substance.

PRACTICALS
Course Title: Nanomaterials and Solid State Chemistry
Course Code: CHE-VI. E-10
Maximum Marks: 25
Credits: 01

List of Practicals:
1. Synthesis of silver nanoparticles by chemical method.
2. Synthesis of ZnO nanomaterials.
3. Synthesis of CdS nanomaterials.
4. Synthesis of nanoparticles using plant extract (metal/ metal oxides).
5. To find out particle size using SEM/TEM data.
6. To study the X-ray diffraction pattern of given sample (Phase and particle size).
7. Preparation of zinc oxalate dihydrate and analysis of its TG/DTA pattern.
8. To prepare mixed metal oxide of Zn and Fe using co-precipitation technique.
9. To prepare mixed metal oxide of Zn and Fe using precursor technique.
10. Measurements of electrical and magnetic properties of pure and mixed metal oxides.

REFERENCE BOOKS:
TEXTBOOK:

1. Atkins P. W., Overton T. L., Rourke J. P., Weller M. T. and Armstrong F. A., *Shriver and Atkins Inorganic Chemistry*, Oxford University press.

ADDITONAL READING:

1. Keer H. V., *Principles of Solid State Chemistry*, New Age International Publishers,
2. Kulkarni S. K., *Nanochemistry, Principles and Practices*, Capital publishers.
3. Poole C. P. and Owens F. J., *Introduction to Nanotechnology*, John-Wiley and Sons.
4. Rao M. B. and Reddy K. K., *Introduction to Nanotechnology*, Campus books International.
5. West A. R., *Solid State Chemistry and its Applications*, John-Wiley and Sons.

THEORY
Course Title: Organometallic Chemistry
Course Code: CHE- III. E-11
Maximum Marks: 75
Credits: 03

Course Objectives:

To provide knowledge of fundamental content in the area of organometallic chemistry and impart practical skills so that the student will be able to integrate the knowledge with critical thinking to solve problems.

Learning outcome: Upon completion of the course, the student will be able to:

1. Use the basic principles of chemistry and molecular orbital theory to describe chemical bonding and structure of organometallic compounds and describe the structure and behaviour of organometallic compounds.
2. Explain and predict the chemical behavior and reactivity of organometallic compounds.
3. Describe and explain catalytic processes using an organometallic compound as a catalyst and explain how organometallic compounds are used as catalysts in organic synthesis.

UNIT I: Introduction to organometallic chemistry 08L

Definition, classification of organometallic compounds, Nomenclature, ligands, concept of hapticity of organic ligands, 18 electron rule, EAN concept, electron counting and oxidation states in complexes. General methods of preparation with one example of each (direct combination, reductive carbonylation, thermal and photochemical decomposition) and general properties of organometallic compounds of 3d series.

UNIT II: Metal carbonyls 10L

Classification of metal carbonyls; Mononuclear metal carbonyls: Preparation, properties, structure and bonding of $Ni(CO)_4$, $Fe(CO)_5$, $Cr(CO)_6$ using VBT; Polynuclear metal carbonyls: Preparation, properties, structure and bonding of $Co_2(CO)_8$, $Mn_2(CO)_{10}$, $Fe_2(CO)_9$ and $Fe_3(CO)_{12}$. π-acceptor behaviour of CO (MO diagram of CO), synergic effect and use of IR data to explain structure and bonding in metal carbonyls.

UNIT III: Metallocenes 09L

Sandwich compounds, Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation etc.). Structure and aromaticity, comparison of aromaticity and reactivity with benzene. Synthesis and reactivity of cyclopentadienyl compounds, bonding in bis(cyclopentadienyl) complexes, Fluxional behaviour of metallocenes. Metal-metal bonding and metal clusters: structure of clusters, electron counting in clusters, synthesis of clusters.

UNIT IV: Organometallic compounds of Main group elements 09L

Preparation, properties, reactions and structure of alkyls and aryls of Group 1 elements (Li, Na); Group 2 elements (Be, Mg); Group 13 elements (B, Al), Group 14 (Sn, Pb). Alkyls and aryl compounds of Ti, Zn and Hg

UNIT V: Reactivity of organometallic compounds 09L

Reactions of organometallic compounds: Ligand substitution, Oxidative addition and reductive elimination, σ-bond metathesis, 1,1-migratory insertion reactions, 1,2-insertions and β-hydride elimination. Catalysis by organometallic compounds: Alkene hydrogenation with Wilkinson's catalyst, hydroformylation, Ziegler-Natta catalysts.

PRACTICALS
Course Title: Organometallic Chemistry
Course Code: CHE- III. E-11
Maximum Marks: 25
Credit: 01

List of practicals:
1. Synthesis of Bromo(4-tert-butylpyridine)cobaloxime
2. Synthesis of Ethyl(4-tert-butylpyridine) cobaloxime
3. Preparation of chloro(pyridine) *bis* (dimethylglyoximato) cobalt(III)
4. Preparation of bromo (pyridine) bis (dimethylglyoximato) cobalt (III)
5. Preparation of Grignard reagents with different alkyl/aryl substituent.
   i. phenyl magnesium bromide
   ii. phenyl magnesium chloride
   iii. methyl magnesium iodide
6. Preparation of alcohol using Grignard reagent (or any other Grignard reaction)
7. Structure analysis of metal-carbonyls based on IR data.
8. Metal complexes with triphenyl phosphine (minimum 4 hrs)

i. $Co(PPh_3)Cl_2.\ 2H_2O$
ii. $Ni(PPh_3)Cl_2.2H_2O$

REFERENCE BOOKS:

TEXTBOOK:

1. Atkins P, Overton T, Rourke J et.al, *Shriver and Atkins' Inorganic Chemistry*, 5th Edition, Oxford University Press.

ADDITIONAL READING:

2. Cotton F.A and Wilkinson G, *Basic Inorganic Chemistry*,Wiley Eastern Ltd.
3. Huheey J.E, Keiter E.A, Keiter R.L, Medhi O.K, *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Edu.
4. Lee J.D, *Concise Inorganic Chemistry*, Wiley-India

Parvatibai Chowgule College of Arts and Science

AUTONOMOUS

DEPARTMENT OF CHEMISTRY

SYLLABUS DRAFT

FOR THE UNDERGRADUATE COURSE IN CHEMISTRY

AT

T. Y. B. Sc. SEMESTER – VI

FOR THE

ACADEMIC YEAR: 2017-2018

SEMESTER VI

CORE COURSE

THEORY
Course Title: Advanced Chemistry: Organic and Analytical
Course Code: CHE- VI. C-8
Marks: 75
Credits: 03

Course Objectives:
1. To provide a basic understanding of the core areas of Organic and Analytical Chemistry.
2. To understand principles, techniques and applications of separation techniques
3. To use separation techniques for qualitative and quantitative analysis.

Learning outcome
1. Will learn to write mechanisms with stereochemistry.
2. Will learn principles of separation and its applications.
3. Will have practical knowledge of chromatographic techniques.
4. Will be able to carry out experiments with required skills.

SECTION I (ORGANIC CHEMISTRY)

UNIT I: Mechanism and stereochemistry of addition, substitution and elimination reactions **7L**

Mechanism and stereochemistry of (i) Addition of halogens acids (HX) and halogen (X_2) to open chain alkenes. Markownikoff's and anti-Markownikoff's addition. (ii) S_N1, S_N2, S_Ni , substitutions and (iii) E1, E2 and E1cb elimination reactions.

UNIT II: Organic Compounds containing Nitrogen **6L**

Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media. Picric acid: preparation and properties. Structure and nomenclature of amines, physical properties. Structural features affecting basicity of amines. Amine salts as phase-transfer catalysts. Preparation of alkyl and aryl amines by reduction of nitro compounds and nitriles, reductive amination of carbonyl compounds, Gabriel phthalimide reaction and Hofmann rearrangement.

UNIT III: Carbohydrates **6L**

Classification and nomenclature. Monosaccharides: General reactions, chain lengthening by Killiani-Fischer synthesis and chain shortening by Ruff degradation of aldoses, mechanism of osazone formation. Configuration of monosaccharides with reference to glucose. d(+)/l(-) and D/L systems of nomenclature. Interconversion of glucose to fructose and glucose to mannose. Cyclic structure of D(+)glucose. Mechanism of mutarotation. Formation of glycosides, ethers and esters. Structure of sucrose and inversion of cane sugar.

UNIT IV: Chemistry of Organosulfur and organophosphorus compounds **4L**

Nomenclature and classification of Organosulfur compounds. Methods of preparation and chemical reactions of thiols, disulfides and sulphonic acids. Nomenclature and classification of organophosphorus compounds. Preparation of phosphines. Phosphorous ylides and their general methods of preparation. Wittig reaction and its synthetic applications.

SECTION II (ANALYTICAL CHEMISTRY)

UNIT V: Solvent Extraction **05L**

Principle, efficiency of extraction, percentage extraction, complexing agents in solvent extraction, separation factor, types of extraction, applications of solvent extraction

(Numericals expected)

UNIT VI: Chromatographic techniques **17L**

Principle, classification of chromatographic techniques
Column Chromatography: Principle, technique and applications
Paper chromatography: Principle, technique and applications
Thin layer chromatography: Principle, technique and applications
Theory of chromatographic separation: Distribution equilibrium, rate of travel, retention time, retention volume and relative retention.
Ion exchange chromatography: Principle, classification of ion exchangers. Factors affecting the distribution of ions between the resin and the solution, ion exchange capacity, applications of ion exchange chromatography
Gas chromatography: Principle, instrumentation, and applications. Comparison of GSC and GLC
HPLC: Principle, instrumentation and applications
Hyphenated techniques: GC-MS and LC-MS
(Numericals expected)

PRACTICALS
Course Title: Advanced Chemistry II
Course Code: CHE- I. C-8
Marks: 25
Credits: 01

List of experiments:

ORGANIC CHEMISTRY EXPERIMENTS:

Organic mixture separation, purification of individual compounds and qualitative analysis of separated compound.
At least 08 mixtures of compounds:
Solid-solid, 04 mixtures
Solid-liquid, 02 mixtures
Liquid-liquid, 02 mixtures

Note: 1 gm of solid-solid mixture to be analyzed on small scale. 3-4 ml of liquid to be added in mixture.

ANALYTICAL CHEMISTRY EXPERIMENTS:

1. To estimate sodium from NaCl using cation exchanger resin
2. To separate metal ions by paper chromatography and determine retardation factor
3. To study separation of organic compounds by TLC
4. To estimate magnesium from Zn^{2+}/Mg^{2+} mixture by using an anion exchanger resin
5. To estimate zinc from Zn^{2+}/Mg^{2+} mixture by using an anion exchanger
6. To determine the equilibrium constant for the reaction $KI + I_2 = KI_3$
7. To determine partition coefficient for the distribution of iodine between CCl_4 and water
8. To separate a mixture of carboxylic acid and neutral compound by using solvent extraction technique.

9. To determine distribution coefficient for the partition of benzoic acid between methylene dichloride and water

REFERENCE BOOKS:
Organic Chemistry
TEXT BOOK

1. Morrison, R. T., etal. **2010. "**Organic Chemistry". Pearson Publications, Noida India.

ADDITIONAL READING

1. Bruice, P. Y. **2015**. "Organic Chemistry". Pearson Publications, Noida India.
2. Carey, F. C., etal. **2012.** "Organic Chemistry". Tata McGraw-Hill India.
3. Finar, I. L. **2013**. "Organic Chemistry". Volume 1. Pearson Publications, Noida India.

ANALYTICAL CHEMISTRY

1. Christian, G. D. "Analytical Chemistry". 5th edition. John Wiley publications
2. Skoog D.A., West D. M. and Holler F. J.; Fundamentals of Analytical Chemistry, 4th Saunders College Publishing

SEMESTER VI

ELECTIVE COURSE
THEORY
Course Title: Spectroscopic Methods in Organic Chemistry
Course Code: CHE-VI. E-13
Maximum Marks: 75
Credits: 03

Course Objectives:

1. To understand the importance of spectroscopy in organic chemistry.
2. To understand principles and applications of UV-Visible spectroscopy, IR Spectroscopy, Nuclear Magnetic Resonance and Mass Spectrometry.
3. To learn structure elucidation of organic compounds based on spectral data.

Learning outcome:

1. Will be able to do spectral analysis of organic compounds.
2. Will learn theory of important spectroscopic techniques.
3. Will be able to elucidate structures of organic compounds based on spectral data.
4. Will be able to operate an UV-visible spectrometer.

UNIT I: Introduction to spectroscopy **3L**

Nature of electromagnetic radiation: wave length, frequency, energy, amplitude, wave number, and their relationship, different units of measurement of wavelength frequency, different regions of electromagnetic radiations, Regions of electromagnetic radiation. Interaction of radiation with matter: absorption, emission, fluorescence and scattering, types and advantages of spectroscopic methods.

UNIT II: UV-Visible Spectroscopy **6L**

Ultraviolet (UV) absorption spectroscopy: Absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophores and auxochromes, bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated dienes and enones, Woodward-Fieser rules for calculation of UV maxima of the above two systems.
Numerical problems expected

UNIT III: Infra Red (IR) absorption spectroscopy **6L**

Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, functional group region, finger print region and its use to establish identity, applications to determine purity, to study progress of chemical reactions and hydrogen bonding. Characteristic absorptions bands of various functional groups and interpretation of IR spectra of organic compounds. Structure elucidation by using UV and IR spectral data is expected.

UNIT IV: Proton Magnetic Resonance (^{1}H NMR) spectroscopy **13L**

Introduction to NMR Spectroscopy, types of protons: equivalent, non-equivalent, homotopic, enantiotopic and diastereotopic protons, NMR Spectrometer (block diagram), nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, intensity of peaks, interpretation of ^{1}H NMR spectra of simple organic molecules. Structure elucidation of organic compounds using ^{1}H NMR spectral data is expected.

UNIT V: ^{13}C Nuclear Magnetic Resonance **10L**

Number of signals, splitting of signals, proton coupled and decoupled spectra, off resonance decoupled spectra. ^{13}C NMR chemical shifts, identification of hybridization of carbons and nature of functionalization. Structure elucidation of organic compounds using ^{13}C NMR spectral data is expected.

UNIT VI: Mass Spectrometry **7L**

Instrumentation, definitions of parent or molecular ion peak and base peak. Isotope effect with respect to alkyl halides. Fragmentation of ketones: α-cleavage and Mc-Lafferty rearrangement.
[Structure elucidation of organic compounds using Mass, UV, IR, ^{1}H NMR and ^{13}C NMR spectral data is expected]

PRACTICALS
Course Title: Spectroscopic Methods in Organic Chemistry
Course Code: CHE-VI. E-13
Maximum Marks: 25
Credits: 01

List of experiments:

1. Calculate UV maxima for given organic structure and match it with the given spectra of organic compounds.
2. Match the given set of organic compounds with the given set of spectra. List: Alkane, alkene, alcohol, ether, amine, carboxylic acid, ester and amides.
3. Verify Bathochromic, hypsochromic, hyperchromic and hypochromic shifts in phenol and aniline using UV-Vis spectrometer.
4. Identification of organic compounds based on given IR spectra of organic compounds.
5. On basis of IR spectra, distinguish between the given set of organic compounds. (set of 2 compounds × 3).
6. Identify the compounds based on given Mass Spectra. List: Alkane, alkene, alcohol, ether, amine, carboxylic acid, ester and amides.
7. Give the fragmentation patterns for the given mass spectra of organic compounds.
8. Compare relative abundance of isotopes of halogen containing compound.
9. Determination of organic compound using given set of ^{1}H NMR data.
10. Determination of organic compound using given ^{1}H NMR spectrum.
11. Assigning the chemical shift values to the peaks of given ^{1}H NMR spectrum of organic compounds.
12. Determination of organic compound using given set of ^{13}C NMR data.
13. Assigning the chemical shift values to the peaks of given ^{13}C NMR spectrum of organic compounds.
14. Assigning the chemical shift values to the peaks of given ^{1}H NMR spectrum of organic compounds.
15. Identification of organic compounds based on given spectroscopic information.

REFERENCE BOOKS:

TEXTBOOKS:

1. Silverstein, R. M., et. al. **2015.** **"***Identification of Organic Compounds*". Wiley publications

REFERENCE:

1. Kalsi, P. S. **2007.** **"***Spectroscopy of Organic compounds*". New Age International (P) Ltd. New Delhi.
2. Morrison, R. T., et. al. **2010.** **"***Organic Chemistry*". Pearson Publications, Noida India.
3. Pavia, D. L., et. al. **2008**. "*Introduction to Spectroscopy"*. Cengage Learning.

THEORY
Course Title: Environmental Chemistry
Course Code: CHE-VI. E-14
Maximum Marks: 75
Credits: 03

Course Objectives:

1. To provide a basic interdisclipinary introduction to environmental challenges
2. To obtain a comprehensive understanding of the basic concepts in analytical instrumental techniques
3. To generally provide practical skills to correlate with the theory.

Learning outcomes

The course provides understanding how:

1. pollution affects our environment
2. knowledge of chemistry can be used to solve problems.
3. instrumental techniques can be used for chemical analysis of pollutants.

UNIT I: Introduction **7L**

Atmosphere: Composition, Structure, properties vertical temperature behavior, lapse rate and temperature inversion.

a) **Air pollution**: Introduction, classification of pollutants, sources, control, effect w.r.t. oxides of Nitrogen, Carbon and Sulphur, Photochemical smog, acid rain and Green House effect
b) **Water pollution**: Chemical, physical and biological characteristics of water pollution, specific and Nons pecific characterization of water. DO, BOD, COD and chlorine demand, typical water treatment and waste water treatment. Importance of buffer and buffer index in waste water treatments.
c) **Chemistry of soils**: Macro- and micro-nutrients in soil, chemistry of minerals of soil forming rocks. Toxic elements in soil including those are in trace quantities, pollutant materials.

UNIT II: Sampling of Pollutants **5L**

Sampling of air pollutants**:**

a) Absorption in liquids
b) Adsorption on solids: cold trapping adsorption and collection of particulates.

Sampling of water pollutants: sampling and sample preservation.
Sampling of solids: sample size, equipment and methods of sampling, Auger sampler, tube sampler.

UNIT III: Chemistry of atmosphere and soil **7L**

Reactions in the atmosphere: a) formation in the atmosphere b) reaction of hydroxyl radical with trace gases and as sources of hydroperoxy radical and hydrogen peroxide.
The methane cycle.
Chemistry of minerals and soil forming rocks, trace material in soil.
Macronutrients : N, P,K in soil.
Pollutants in soil

UNIT IV: Adverse effects of specific pollutants **3L**

Effects of Hg, Pb and nitrites on humans and other living organisms.
Oil Spill: Biological and physical effects.
Acid, mine and drainage: Reactions of FeS_2 (pyrites), Cr, As and F.

UNIT V: Ozone Chemistry **06L**

Major atmospheric species involved in ozone formation and destruction.
Some major chemical reactions in the troposphere associated with ozone.
Stratospheric ozone: pollutants destroying stratospheric ozone layer
Species destroying ozone layer: a) catalytic NO, b) photo dissociation of CFCs, c) catalytic role of chlorine, and d) combined chain reaction
The ozone holes
Ozone layer and the green house effect.

UNIT VI: Techniques of water treatment **7L**

Water conditioning

a) Treatment of water for municipal purpose: important process involved in purification of water.
b) Treatment of water for Industries: removal of hardness of water Clark's method, use of ion exchange resins. Solid waste management
c) Classification of solid wastes, types of waste of origin.
d) Solid waste management method: (i) Utilisation, (ii) Recovery, (iii) Reuse (iv) Recycling of wastes/ residues, (v) Recycling avoidance of solid waste.
e) Use of Remote Sensing in Environmental Management**.**

UNIT VII: Optical and radiochemical techniques **3L**

1. Turbidimetry and Nephelolmetry: introduction, basic principle
2. Isotope dilution analysis: principles and applications
3. Neutron activation analysis: principles and applications

UNIT VIII: Application of instrumental techniques in environmental and chemical analysis **7L**

1. Air analysis: (a) SO_2, (b) H_2S, c) CO and d) CO_2.
2. Water analysis: a) determination of organic loadings b) determination of toxic metal ions by
   (i) Atomic Absorption Analysis,
   (ii) Atomic Emission techniques: mass spectrometry
3. Soil/Sediment analysis:
   a) Bulk density, b)Specific gravity, c) Moisture content d) Water holding capacity e) Conductivity f) Alkalinity, and g) detection of Sulphate, calcium and iron

PRACTICALS
Course Title: Environmental Chemistry
Course Code: CHE-VI. E-14
Maximum Marks: 25
Credits: 01

List of Practicals:

1. Determination of sodium in water: ion exchange method
2. Determination of Total solids, Total dissolved solids and total suspended solids and its significance.
3. Determination of chlorine content in tap water samples: Mohr's method
4. Determination of acidity and alkalinity in water samples.
5. Determination of total, permanent and temporary hardness of water sample
6. Determination of DO of water sample
7. Determination of polluting elements such as Pb, Hg and As in water.
8. Analysis of Mn in a water sample by visual titrimetry.
9. Analysis of different types of soil- pH, conductivity, alkalinity
10. Determination of nitrite in water : colorimetric method
11. Determintion of COD of water samples
12. Determintion of BOD of water samples
13. Determination of phosphate: Colorimetric method

REFERENCE BOOKS:

1. Christan G. D., 5th edition ,"Analytical Chemistry ", Wiley publication
2. De, A. K,1995 "Environmental Chemistry", Wiley eastern Ltd.
3. Iqbal,S.A.et.al,1995," Chemistry of Air and Air Pollution", Discovery Publishing House, New Delhi
4. Katyal Jimmy et.al, 1993,"Environmental Pollution", Anmol Publications, New Delhi
5. Manahan, S.E. 1994,"Environmental Chemistry" Lewis Publishers
   Neil,P. O 2007,"Environmental Chemistry", Blackie Academic & Professional
6. Raghuraman, K.et al,4th edition," Basic Principles of Analytical Chemistry",sheth publishers
7. Schroede, E.D,1997, "Water & waste water treatment", Mc. Graw Hill
8. Skoog et.al, 4th International edition ,"Principles of Analytical Chemistry"
9. Trivedi P.R. et.al, 1st edition"Environmental Water and Soil Analysis",
10. Akashdeep Publishing House, New Delhi
11. Tyagi, O.D. et.al, 1992,"A Text Book Of Environmental Chemistry" Anmol Publications, New Delhi
12. Vanloon G.W. et.al, 2003,"Environmental Chemistry", Oxford University Press

THEORY
Course Title: Selected Topics in Inorganic Chemistry
Course Code: CHE- III. E-15
Maximum Marks: 75
Credits: 03

Course Objectives:
To provide knowledge of fundamental content in various areas of inorganic chemistry and impart practical skills so that the student will be able to integrate the knowledge with critical thinking to solve problems.

Learning outcome: Upon completion of the course, the student will be able to:

4. encourage students to analyze and integrate concepts relevant to graduate level Inorganic chemistry.
5. understand the bond formation of compounds with special reference to MOT and CFT.

UNIT I: Inorganic Polymers 8L
Definition, properties, classification (condensation, addition and coordination), preparation, structure and bonding and applications of polymers containing Boron (borazine), phosphorous (phosphazenes), silicon (silicones), sulfur (S_4N_4, thiazyl halides).

UNIT II: Magnetic Properties of Transition Metal Complexes 7L
Types of magnetic behaviour, magnetic susceptibility, effect of temperature on magnetic properties, Curie temperature, Neel temperature, Curie-Weiss law. Methods of determining magnetic susceptibility, Guoy's balance, spin only formula, calculation of magnetic moment of transition metal ions, application of magnetic moment data for 3d-metal complexes.

UNIT III: Thermodynamic and Kinetic Aspects of Metal Complexes 12L

Thermodynamic and kinetic stability of metal complexes, equilibrium constants, formation constants, lability, inert complexes, factors affecting the stability, substitution reactions in tetrahedral and octahedral complexes. Electron transfer reactions- inner sphere mechanism and outer sphere mechanism, Trans effect with respect to square planar complexes.

UNIT IV: Materials Chemistry 10L
Zeolites: types, structure and applications.
Composite materials: Metal-organic frameworks (MOF's); structure, ligands, applications.
Molecular materials: Fullerides, liquid crystals, molecular magnets.
Superconductors: discovery, critical temperature, Meissner effect, types of superconductors.
Corrosion: response of material to chemical environments, galvanic corrosion and other forms of corrosion. Prevention methods.

UNIT V: Molecular Symmetry 8L

Symmetry elements and operations: Centre of symmetry, Rotation axis, Mirror plane, rotation-reflection axis, Identity element. Point groups, Identifying symmetry elements and point group in molecules. (examples to be solved)

PRACTICALS
Course Title: Selected Topics in Inorganic chemistry
Course Code: CHE- III. E-15
Maximum Marks: 25
Credit: 01

List of practicals

1. Separation and Determination of transition metal ions
    a) Separation of Mg^{2+} and Zn^{2+} by ion exchange and its estimation (4 hrs)
    b) Separation of Cd^{2+} and Zn^{2+} by ion exchange and its estimation (4 hrs)
2. Determination of stability constant of complex ions in solution
    a) Fe(III) – salicylic acid complex (Job's Method)
    b) Fe(II) – 1,10-phenanthroline
3. Determination of instability constant for the reaction between Ag^{+} and NH_3
4. Determination of instability constant for the reaction between Cu^{2+} and en
5. Estimation of Ca in compounds containing calcium.
6. Estimation of Ni in compounds containing nickel.
7. Estimation of Cu in compounds containing copper.
8. Estimation of metal ions in mixed metals compound.

REFERENCE BOOKS:

TEXTBOOKS:

1. Atkins P, Overton T, Rourke J et.al, *Shriver and Atkins Inorganic Chemistry*, Oxford University Press.

ADDITIONAL READING:

1. Lee J.D, *Concise Inorganic Chemistry*, Wiley-India
2. Huheey J.E, Keiter E.A, Keiter R.L, Medhi O.K, *Inorganic Chemistry: Principles of structure and reactivity*, Pearson Edu., 1993
3. Cotton F.A and Wilkinson G, *Basic Inorganic Chemistry*,Wiley Eastern Ltd, 1993
4. Puri B.R, Sharma L.R, Kale K.C, *Principles of Inorganic Chemistry*, Vallabh Publications.

Parvatibai Chowgule College of Arts & Science
(Autonomous)
Margao – Goa

MINUTES OF THE MEETING OF THE BOARD OF STUDIES IN CHEMISTRY

held on 7th April 2018 at 9.30 A.M.

Part B : Resolutions/ Recommendations of BOS that require consideration/ approval of the Academic Council

1. The Syllabi of the following undergraduate courses :

SEMESTER	CORE COURSES		ELECTIVE COURSES			
I	CHE-I. C-1 General Physical and Inorganic Chemistry	CHE-I. C-2 General Organic and Inorganic Chemistry	---	---	---	---
II	CHE-II. C-3 Concepts in Physical and Analytical Chemistry	CHE-II. C-4 Concepts in Organic and Inorganic Chemistry	---	---	---	---
III	CHE-III. C-5 Comprehensive Chemistry –I	---	CHE-III. E-1 Name Reactions and Synthetic Methodologies	CHE-III. E-2 Industrial Chemistry	CHE-III. E-3 Surface Chemistry and Catalysis	CHE-III. E-4 Bioinorganic Chemistry
IV	CHE-IV. C-6 Comprehensive Chemistry -II	---	CHE-IV. E-5 Pharmaceutical Chemistry	CHE-IV. E-6 Polymer and Colloid Science	CHE-IV. E-7 Spectroscopic Techniques	CHE-IV. E-8 Chemistry of Natural Products
V	CHE-V. C-7 Advanced Chemistry – I (physical & Inorganic Chemistry)	---	CHE-V. E-9 Heterocyclic Chemistry	CHE-V. E-10 Nanomaterials and Solid State Chemistry	CHE-V. E-11 Organometallic Chemistry	CHE-V. E-12 Chemistry of main group elements
VI	CHE-VI. C-8 Advanced Chemistry – II Organic and Analytical chemistry	---	CHE-VI. E-13 Spectroscopic Methods in Organic Chemistry	CHE-VI. E-14 Environmental Chemistry	CHE-VI. E-15 Selected Topics in Inorganic Chemistry	CHE-VI. E-16 Solid State Chemistry

SEMESTER- I

CORE COMPULSORY MAJOR PAPER

THEORY

Paper Title: General Physical and Inorganic Chemistry + Laboratory Course-1

Paper Code: CHE- I. C-1

Name of Faculty: Dr. Manjita R. Porob and Dr. L.R. Gonsalves

Marks: 75

Credits: 3

Course Objectives:
1. To provide a basic understanding of the core areas of Physical Chemistry based on the theme of systems, states and processes.
2. To obtain a comprehensive understanding of the basic concepts in Inorganic Chemistry.
3. To generally provide practical skills to correlate with the theory.

Learning outcome:
1. Will have a working knowledge of the main areas of Physical Chemistry, will develop critical thinking abilities and be able to work in chemical or related fields.
2. Will help to get better understanding about the basics of Physical and Inorganic Chemistry.
3. Will be able to carry out experiments with required skills.

SECTION- I (PHYSICAL CHEMISTRY)

1. Mathematical Preparations for Chemists **06 L**
Logarithmic relations curve sketching: linear graphs, and calculation of slopes. Differentiation of functions: Kx, e^x (exponential), sin x, log x, maxima and minima. Integration of some useful functions.

2. Chemical Kinetics **08 L**
Rate of reaction, factors influencing rate of the reaction- concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates. Zero, first, second order kinetics. Half life and average life. Determination of order of reaction: Integrated rate equation method, graphical method, differential method, half-life method and isolation method. Effect of temperature on the rate of the reaction, Arrhenius equation and concept of activation energy.
(Numerical expected)

3. Solid State **08 L**
Introduction, difference between crystalline and amorphous solids, laws of crystallography: law of constancy of interfacial angles, law of symmetry and law of rationality of indices, Symmetry and crystal systems, elements of symmetry, introduction to point groups, lattice and unit cells, The Bravais lattices, the seven crystal systems, Miller and Weiss indices. Bragg's equation, Inter planar distance.
(Numerical expected)

4. Gaseous State **08 L**
Gas laws (to introduce), Ideal gas equation, compressibility factor, PV isotherms of real gases. kinetic molecular theory of gases, its postulates and derivation of kinetic gas equation. the van der Waal's

equation of state. Berthelot Equation (derivation not expected). qualitative discussion of the Maxwell's distribution of molecular velocities. Critical phenomena: relationship between critical constants and van der Waal's constants, the law of corresponding states and reduced equation of state, Joule-Thomson effect . Liquefaction of gases (Clarke's method).
(Numerical expected)

SECTION- II (INORGANIC CHEMISTRY)

1. Atomic Structure and the Periodic Table **05 L**
Atomic spectra of hydrogen, Bohr's model of hydrogen atom, probability picture of electron, dual nature of electrons, Heisenberg uncertainty principle, Schrodinger wave equation, quantum numbers, shapes of s, p, d, orbitals, Aufbau and Pauli exclusion principles, Hund's rule of maximum multiplicity, sequence of energy levels and arrangement of elements in groups in the periodic table, periodic trends and effective nuclear charge.

2. Covalent Bonding **10 L**
Covalent bond: Valence Bond Theory (VBT) and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions, Valence Shell Electron Pair Repulsion Theory (VSEPR) applied to NH_3, H_3O^+, SF_4, ClF_3, ICl_2^- and H_2O, Molecular Orbital Theory, homonuclear and heteronuclear diatomic molecules(CO and NO), multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

PRACTICALS

Paper Title: General Physical and Inorganic Chemistry + Laboratory Course-1

Paper Code: CHE- I. C-1

Name of Faculty: Dr. Sachin B. Kakodkar and Dr. L. R. Gonsalves

Marks: 25

Credits: 1

PHYSICAL CHEMISTRY
1. Preparation of standard solutions based on normality, molarity, molality. Also further dilutions from a standard solution to a volume of 50 mL.
2. To investigate the order of the reaction between $K_2S_2O_8$ and KI using equal initial concentrations of both the reactants.
3. To study hydrolysis of Methyl acetate using two different initial concentrations in presence of mineral acid (HCl) as catalyst
4. To determine the relative strength of two acids i.e. HCl and H_2SO_4 by using them as catalysts for the hydrolysis of methyl acetate.
5. To study the solubility of benzoic acid at room and below room temperature by volumetric method.

INORGANIC CHEMISTRY
1. Preparation of standard 0.1M $K_2Cr_2O_7$ solution and carry out the dilution to 0.05, 0.01, 0.001 M in 50 mL standard volumetric flask
2. To prepare 100 ppm of Manganese solution using $KMnO_4$ and carry out the further dilutions like 5, 10, 20 ppm in 50 mL standard volumetric flasks
3. To prepare 0.1 N $Na_2C_2O_4$ solution and use it to standardize the given $KMnO_4$ solution.

CORE COMPULSORY MAJOR PAPER

THEORY

Paper Title: General Organic and Inorganic Chemistry + Laboratory Course-2

Paper Code: CHE-I. C-2

Name of Faculty: Shri. N.G. Rivonkar; Mrs. Padmini C. Panjikar; Sandesh T. Bugde and Dr. R. K. Kunkalekar

Marks: 75

Credits: 3

Course Objectives:

1. The main objective of this course is to study the basics of Organic Chemistry, which includes the study of structure and reactivity of organic molecules. Also this course focuses on the detail study of alkanes and alkenes with respect to their method of formation and chemical reaction. The special unit has been included to study IUPAC nomenclature of organic compounds.
2. To study the chemistry related to molecular structure in three dimensions (Stereochemistry), which includes the detail study representing stereo isomers on a 2 D surfaces
3. To provide a basic knowledge of the elements in the periodic table and their General Chemistry.

Learning outcome:

1. Students will learn about the basic concepts in Organic Chemistry like the hybridisation in organic molecules, molecular interaction.
2. Students will briefly learn about the types of reaction, reactive intermediates and reaction mechanism in organic chemistry.
3. Students will learn how to name different classes of organic compounds using IUPAC nomenclature.
4. Students will learn how to represent 3 D of organic molecule on 2 D surfaces. Also how the orientation of a molecule in space can give a compound different reactivity.
5. Students will learn two important classes of organic compounds like alkanes and alkenes.
6. Develop skills to carry out related experiments.

SECTION- I (ORGANIC CHEMISTRY)

1. IUPAC Nomenclature of Organic Compounds **02 L**

Basic rules of IUPAC nomenclature, nomenclature of the compounds- alkanes, cycloalkanes, alkenes, alkynes, haloalkanes, acids, alcohols, ethers, aldehydes, ketones, nitriles, acid halides, esters, anhydrides, amides.

Nomenclature of aromatic compounds, mono and di substituted benzene with two functional groups, bridged cycloalkanes.

2. Structural Theories and Reactivities of Organic Compounds **10 L**

Bond formation in organic compounds; sp sp^2, sp^3 with respect to methane, ethene and acetylene (hybridisation concept), discussion on shape, bond length, bond angles of organic molecules.

Polar covalent bonds, electronegativity and bond dipoles in organic molecules, introduction and examples of Van der Waal's forces, inductive effect, field effect, hyperconjugation and resonance, hydrogen bonding.

Curved arrows in organic chemistry, homolytic and heterolytic bond breaking, types of reagents, electrophiles and nucleophiles, types of organic reactions: addition, elimination, substitution, oxidation, reduction and rearrangement with examples. Introduction to reactive intermediates: carbocations, carbanions, free radicals, carbenes, arynes and nitrenes with shape, stabilities, methods of formation and reaction. Methods of determination of reaction mechanisms: Determination of structure, intermediates, isotope effects, kinetic and stereochemical studies.

3. Stereochemistry **08 L**

Isomerism, types of isomers: constitutional, conformational and configurational isomerism. Chirality, chiral centre, enantiomers and diastereomers (with example of threo and erythro diastereomers, meso compounds). Representation of configuration by- 3D Projection (Wedge and dotted projection), Fischer projection, Newmann projection and Saw horse projection. R/S configuration (Can-Ingold-Prelog sequence rules to be exlained). E/Z nomenclature.

4. Study of alkanes, cycloalkanes and alkenes **10 L**

Alkanes and Cycloalkanes**:** Physical properties of alkanes and cycloalkanes, sources of alkanes and cycloalkanes, chemical properties: combustion and pyrolysis of alkanes, methods of preparation: Corey-House reaction, Wurtz reaction.

Alkenes: Physical properties and relative stabilities of alkenes, preparation of alkenes, elimination reactions, dehydration of alcohols, regioselectivity in alcohol dehydration: The Zaitsev rule, rearrangement in alcohol dehydration, dehydrohalogenation: E1 and E2 mechanisms, reactions of alkenes: hydrogenation, addition of halides and hydrogen halides, regioselectivity of hydrogen halide addition, hydroboration and oxidation reactions, oxymercuration- demercuration reactions, epoxidation of alkenes, ozonolysis of alkenes.

SECTION- II (INORGANIC CHEMISTRY)

1. Chemistry of s- block elements **05 L**

General properties, comparative study within groups, diagonal relationship, salient features of hydrides, solvation and complexation tendencies and biological importance, introduction to alkyls and aryls

2. Chemistry of p- block Elements **10 L**

Comparative study within group and diagonal relationship of groups 13, 14, 15, 16, 17, Hydrides of Boron, diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), phosphazenes, tetra sulfur tetranitride, basic properties of halogens, inter halogens and polyhalides.

PRACTICALS

Paper Title: General Organic and Inorganic Chemistry + Laboratory Course-2

Paper Code: CHE- I. C-2

Name of Faculty: Shri. N.G. Rivonkar; Dr.Sandesh T. Bugde; Dr. L. R. Gonsalves

Marks: 25

Credits: 1

ORGANIC CHEMISTRY

1. Purification techniques for organic solid compounds

A. **Crystallization:** a. Benzoic acid from water
b. m-Dinitrobenzene from ethanol
B. **Sublimations:** a. Naphthalene b. Anthracene c. Camphor (**Any 2**)

3. **Organic synthesis:** a. Benzoylation of β-naphthol and aniline. (**Any 2**)
b. Bromination of aromatic compounds using $KBrO_3$
c. Anthraquinone from anthracene (Oxidation reaction)

4. **Qualitative Analysis (Solids) (Any 4)**

Acids: Benzoic, salicylic, phthalic
Phenols: α-Naphthol, β-naphthol
Bases: p-Toluidine, diphenylamine, o-, m- and p-nitroanilines
Anilides: Acetanilide, benzanilide
Hydrocarbons: Naphthalene, anthracene
Amides: Benzamide, urea
Haloarenes: p-Dichlorobenzene
Nitro Compounds: m-Dinitrobenzene, p-nitrotoluene
Carbohydrates: Glucose, fructose, mannose

INORGANIC CHEMISTRY

1. To prepare 0.001 M EDTA and separately estimate the amount of Zn^{2+} ion from $ZnCO_3$, Mg^{2+} ion from MgO.
2. Volumetric estimation of Fe^{2+} using internal indicator by potassium dichromate method
3. Determination of alkali content in antacid tablet using Standard HCl solution

SEMESTER- II

CORE COMPULSORY MAJOR PAPER

THEORY

Paper Title: Concepts in Physical and Analytical Chemistry + Laboratory Course-3

Paper Code: CHE-II. C-3

Name of Faculty: Dr. Manjita R. Porob and Dr. G. K. Naik

Marks: 75

Credits: 3

Course Objectives:

1. To provide an understanding of some important topics in Physical Chemistry
2. To provide an understanding of titrimetric methods of analysis.

Learning Outcome:

1. Will have knowledge of the main areas of Physical Chemistry, will develop critical thinking abilities and be able to work in chemical or related fields.
2. Will be able to understand the principles of titrimetric methods.
3. Attain practical skills.

SECTION- I (PHYSICAL CHEMISTRY)

1. Thermodynamics **10 L**

Thermodynamic terms: system, surrounding, types of systems, intensive and extensive properties, State and path functions and their differentials, Thermodynamic process, Concept of work and heat, First law of thermodynamics: Definition and statements of internal energy and enthalpy, Heat capacities at constant volume and pressure and their relationships, Joule's law, Joule Thomson coefficient and inversion temperature, Calculation of w, q, dU, dH, for the expansion of ideal gases under isothermal

and adiabatic conditions for reversible processes Thermochemistry: Standard state, standard enthalpy of formation, Hess's law of heat summation and its applications, Heat of reaction at constant pressure and at constant volume, Enthalpy of neutralisation, bond dissociation energy and its calculation from thermodynamical data, Temperature dependence of enthalpy, Kirchoff's equation.
(Numerical expected)

2. Liquid State and Applications **07 L**
The Intermolecular forces, structure of liquids (qualitative description), structural differences between solids, liquids and gases, Physical properties of liquids: vapour pressure, surface tension, surface tension by capillary rise method, drop number method using stalagmometer, Viscosity of liquids, Poiseuille equation, determination of viscosity using Ostwald's viscometer, Introduction to l
iquid crystals.
(Numerical expected)

3. Phase Equilibria **06 L**
Statement, meaning of terms: phase, components, degrees of freedom, Gibbs phase rule, derivation of Gibbs phase rule, Phase equilibria of one component system: water system, sulphur system, Phase equilibria of two component system, simple eutectic system, Pb/Ag system. Nernst distribution law, deviations from Nernst distribution law, applications of the law.

SECTION- II (ANALYTICAL CHEMISTRY)

1. Introduction to Analytical Chemistry and some basic concepts **04 L**
Analytical Chemistry and its role in sciences. some important units of measurement, solutions and their concentrations, stoichiometric calculations.
(Numericals expected)

2. Titrimetric methods of analysis **05 L**
Some general aspects of volumetric titrimetry, standard solutions, volumetric calculations. Variables that influence the magnitude of salt effect, activity coefficients, titration curves in titrimetric methods.
(Numericals expected)

3. Theory and applications of neutralization titrations **05 L**
Solutions and indicators for acid/base titrations, titration curves for strong acids and strong bases, buffer solutions, titration curves for weak acids, titration curves for weak bases, composition of buffer solutions as a function of pH. Reagents for neutralization titrations, applications of neutralization titrations.
(Numericals expected)

4. Titration curves for polyfunctional acids and polyfunctional bases **04 L**
Polyfunctional acids and polyfunctional bases, titration curves for polyfunctional acids, titration curves for polyfunctional bases, composition of solutions of a polyprotic acid as a function of pH.
(Numericals expected)

5. Precipitation and Complex formation titrations **04 L**
Titration curves, end points for argentometric titrations, applications of standard silver nitrate solutions. Complex formation reactions, titrations with aminopolycarboxylic acids.
(Numericals expected)

PRACTICAL

Paper Title: Concepts in Physical and Analytical Chemistry + Laboratory Course-3

Paper Code: CHE- II. C-3

Name of Faculty: Dr. Sachin B. Kakodkar

Marks: 25

Credits: 1

PHYSICAL CHEMISTRY

1. To determine the partition coefficient of I_2 between $C_2H_4Cl_2$ and H_2O.
2. To determine the amount of strong acid (HCl) present in the given solution by conductometric titration using standard NaOH solution.
3. To determine the amount of weak acid (CH_3COOH) present in the given solution by conductometric titration using standard NaOH solution.
4. To determine viscosity of a given liquid using Ostwald's Viscometer.

ANALYTICAL CHEMISTRY

1. To standardize hydrochloric acid against sodium carbonate.
2. To standardize sodium hydroxide against potassium hydrogen phthalate.
3. To determine hardness in water.
4. To standardize sodium thiosulphate solution against copper.

CORE COMPULSORY MAJOR PAPER

THEORY

Paper Title: Concepts in Organic and Inorganic Chemistry + Laboratory Course-4

Paper Code: CHE-II. C-4

Name of Faculty: Shri. N.G. Rivonkar; Mrs. Padmini C. Panjikar and Dr. L.R. Gonsalves

Marks: 75

Credits: 3

Course Objectives:

1. The main objective of this course is to detail study on alkynes with respect to their properties, method of formation and chemical reaction. Also this course focuses on the learning on arenes, aromaticity, alcohols and aryl halides with respect to their classification, method of formation and chemical reactions.
2. Intends to provide, both theoretical as well as a practical understanding of the structure and bonding in ionic solids and the various defects which leads to a perfect or imperfect crystal structure.
3. To provide a simple framework in order to fit the factual knowledge and extrapolate from this to predict unknown facts.

Learning Outcome:

1. Students will learn a important classes of organic compound: Alkynes.
2. Students will briefly learn about the aromatic chemistry involving different types of reaction can aromatic compounds undergoes. Also they will learn about the mechanism involve in reactions

having aromatic compounds.
3. Students will also learn chemistry of alcohols and alkyl halides
4. Will have an understanding of crystalline solids in terms of their structure, ionic radii and coordination there by able to predict crystal structure.

SECTION- I (ORGANIC CHEMISTRY)

1. Study of alkynes **03 L**

Alkynes: Sources of alkynes, physical properties of alkynes, acidity of acetylene and terminal alkynes, preparation of alkynes by elimination reactions, alkylation of acetylene and terminal alkynes, reactions of alkynes: hydrogenation, metal-ammonia reduction, addition of hydrogen halides, hydration of alkynes.

2. Arenes and Aromaticity **08 L**

The aryl group, structure of benzene: Molecular formula and Kekule structure, stability and carbon-carbon bond lengths of benzene, resonance structure, molecular orbital picture, Huckel's rule, polycyclic aromatic hydrocarbons, physical properties of arenes, electrophilic aromatic substitution reactions-reactions and mechanisms of nitration, halogenations, sulphonation and Friedel Craft's reactions, activating and deactivating substituents, orientation and ortho/para ratio, side chain reactions of benzene derivatives, Birch reduction.

3. Study of Alcohols and Alkyl Halides **12 L**

Alcohols: Classification, structure and bonding, physical properties, methods of preparation- catalytic hydrogenation, metal hydride reduction, Grignard reaction (using formaldehyde, other aldehydes, ketones, esters, nitriles and epoxides), reactions of alcohols- oxidation reactions using chromic acid, $KMnO_4$, PCC and PDC (structures of PCC and PDC), conversion of alcohols to ethers, Fischer Esterification.

Diols: Classification, methods of preparation (syn and anti diols), reactions of vicinal diols- Pinacol-Pinacolone rearrangement and periodic oxidative cleavage.

Alkyl Halides: Classification, structure and bonding, physical properties, methods of preparation- using alcohols and hydrogen halides, $SOCl_2$, PCl_3, halogenation of alkanes, mechanism for chlorination of methane, relative reactivity and selectivity with respect to chlorination and bromination, mechanisms of nucleophilic substitution reactions of alkyl halides, S_N1 and S_N2 reactions with energy profile diagrams.

SECTION- II (INORGANIC CHEMISTRY)

1. Chemistry of transition elements **12 L**

Chemistry of elements of the first transition series: properties, their binary compounds, oxidation states and their stability, coordination number and geometry, comparative study with 4d and 5d analogues with respect to their ionic radii, magnetic behaviour, oxidation states and spectral properties.

2. Ionic Solids: Structure and Bonding **10 L**

Introduction to bonding in solids, types of bonds, properties of ionic substances, structure of ionic solids (NaCl, CsCl, ZnS, CaF_2, TiO_2-rutile), lattice energy and Born-Haber's Cycle, factors affecting radii of ions, packing efficiency, radius ratio and coordination number, limitations of radius ratio, Fajan's rules, defects in solids: point defects, color centres, extended defects, non-stoichiometric defects, conductivity in ionic solids;

PRACTICALS

Paper Title: Concepts in Organic and Inorganic Chemistry + Laboratory Course-4

Paper Code: CHE- II. C-4

Name of Faculty: Dr. L.R. Gonsalves; Shri. N.G. Rivonkar; Dr.Sandesh T. Bugde;

Marks: 25

Credits: 1

ORGANIC CHEMISTRY

1. Purification techniques for organic compounds (Liquids) and determination of physical constant.
   Distillation: a. Separation of acetone and toluene
   b. Separation of ethyl acetate and nitrobenzene
2. Organic synthesis: a. p-Bromo acetanilide from aniline **(Any 2)**
   b. oxidising agent PCC (Pyridinium Chlorochromate)
   c. Oxime from cyclohexanone
3. Qualitative Analysis (Liquids) **(Any 4)**
   Haloalkane and haloarene: Chloroform, carbon tetrachloride, chlorobenzene, bromobenzene
   Nitro Compounds: Nitrobenzene
   Alcohols: Methanol, ethanol, 2-propanol, cyclohexanol
   Phenols: Phenol
   Carbonyl compounds (Neutral compounds): Benzaldehyde, acetone
   Esters: Methyl acetate, ethyl acetate, ethyl benzoate, methyl salicylate
   Bases: Aniline, N-methylaniline

INORGANIC CHEMISTRY

1. Semi-micro qualitative analysis: To analyse 2-3 inorganic mixtures containing four ions only (two cations and two anions).

Cations : Pb^{2+}, Cu^{2+}, Cd^{2+} , Sn^{2+} , Fe^{2+} , Fe^{3+}, Al^{3+}, Cr^{3+} , Zn^{2+}, Mn^{2+}, Ni^{2+}, Co^{2+}, Ba^{2+}, Sr^{2+} , Ca^{2+}, Mg^{2+}, $(NH4)^{+}$, K^{+}

Anions: Cl^{-} , Br^{-} , I^{-}, NO_2^{-}, NO_3^{-}, SO_3^{2-}, CO_3^{2-}, SO_4^{2-}, PO_4^{3-}

2. Gravimetric estimation of Ba as $BaSO_4$
3. Gravimetric estimation of Fe as Fe_2O_3

SEMESTER- I

CORE COMPULSORY MINOR PAPER

THEORY

Paper Title: General Physical and Inorganic Chemistry + Laboratory Course-1

Paper Code: CHE- I. C-1

Name of Faculty: Dr. Manjita R. Porob and Dr. L.R. Gonsalves

Marks: 75

Credits: 3

Course Objectives:

1. To provide a basic understanding of the core areas of Physical Chemistry based on the theme of systems, states and processes.
2. To obtain a comprehensive understanding of the basic concepts in Inorganic Chemistry.
3. To generally provide practical skills to correlate with the theory.

Learning outcome:

1. Will have a working knowledge of the main areas of Physical Chemistry, will develop critical thinking abilities and be able to work in chemical or related fields.
2. Will help to get better understanding about the basics of Physical and Inorganic Chemistry.
3. Will be able to carry out experiments with required skills.

SECTION- I (PHYSICAL CHEMISTRY)

1. Mathematical Preparations for Chemists **06 L**

Logarithmic relations curve sketching: linear graphs, and calculation of slopes. Differentiation of functions: Kx, e^x (exponential), sin x, log x, maxima and minima. Integration of some useful functions.

2. Chemical Kinetics **08 L**

Rate of reaction, factors influencing rate of the reaction- concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates. Zero, first, second order kinetics. Half life and average life. Determination of order of reaction: Integrated rate equation method, graphical method, differential method, half-life method and isolation method. Effect of temperature on the rate of the reaction, Arrhenius equation and concept of activation energy.
(Numerical expected)

3. Solid State **08 L**

Introduction, difference between crystalline and amorphous solids, laws of crystallography: law of constancy of interfacial angles, law of symmetry and law of rationality of indices, Symmetry and crystal systems, elements of symmetry, introduction to point groups, lattice and unit cells, The Bravais lattices, the seven crystal systems, Miller and Weiss indices. Bragg's equation, Inter planar distance.
(Numerical expected)

4. Gaseous State **08 L**

Gas laws (to introduce), Ideal gas equation, compressibility factor, PV isotherms of real gases. kinetic molecular theory of gases, its postulates and derivation of kinetic gas equation. the van der Waal's equation of state. Berthelot Equation (derivation not expected). qualitative discussion of the Maxwell's distribution of molecular velocities. Critical phenomena: relationship between critical constants and van der Waal's constants, the law of corresponding states and reduced equation of state, Joule-Thomson effect. Liquefaction of gases (Clarke's method).
(Numerical expected)

SECTION- II (INORGANIC CHEMISTRY)

1. Atomic Structure and the Periodic Table **05 L**

Atomic spectra of hydrogen, Bohr's model of hydrogen atom, probability picture of electron, dual nature of electrons, Heisenberg uncertainty principle, Schrodinger wave equation, quantum numbers, shapes of s, p, d, orbitals, Aufbau and Pauli exclusion principles, Hund's rule of maximum multiplicity, sequence of energy levels and arrangement of elements in groups in the periodic table, periodic trends and effective nuclear charge.

2. Covalent Bonding **10 L**

Covalent bond: Valence Bond Theory (VBT) and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions, Valence Shell Electron Pair Repulsion Theory (VSEPR) applied to NH_3, H_3O^+, SF_4, ClF_3, ICl_2^- and H_2O, Molecular Orbital Theory, homonuclear and heteronuclear diatomic molecules(CO and NO), multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

PRACTICALS

Paper Title: General Physical and Inorganic Chemistry + Laboratory Course-1

Paper Code: CHE- I. C-1

Name of Faculty: Dr. Sachin B. Kakodkar and Dr. L. R. Gonsalves

Marks: 25

Credits: 1

PHYSICAL CHEMISTRY

6. Preparation of standard solutions based on normality, molarity, molality. Also further dilutions from a standard solution to a volume of 50 mL.
7. To investigate the order of the reaction between $K_2S_2O_8$ and KI using equal initial concentrations of both the reactants.
8. To study hydrolysis of Methyl acetate using two different initial concentrations in presence of mineral acid (HCl) as catalyst
9. To determine the relative strength of two acids i.e. HCl and H_2SO_4 by using them as catalysts for the hydrolysis of methyl acetate.
10. To study the solubility of benzoic acid at room and below room temperature by volumetric method.

INORGANIC CHEMISTRY

1. Preparation of standard 0.1M $K_2Cr_2O_7$ solution and carry out the dilution to 0.05, 0.01, 0.001 M in 50 mL standard volumetric flask
2. To prepare 100 ppm of Manganese solution using $KMnO_4$ and carry out the further dilutions like 5, 10, 20 ppm in 50 mL standard volumetric flasks
3. To prepare 0.1 N $Na_2C_2O_4$ solution and use it to standardize the given $KMnO_4$ solution.

SEMESTER- II

COMPULSORY CORE MINOR PAPER

THEORY

Paper Title: General Organic and Inorganic Chemistry + Laboratory Course-2

Paper Code: CHE-I. C-2

Name of Faculty: Shri. N.G. Rivonkar; Mrs. Padmini C. Panjikar; Dr.Sandesh T. Bugde and Dr. R. K. Kunkalekar

Marks: 75

Credits: 3

Course Objectives:

1. The main objective of this course is to study the basics of Organic Chemistry, which includes the study of structure and reactivity of organic molecules. Also this course focuses on the detail study of alkanes and alkenes with respect to their method of formation and chemical reaction.

The special unit has been included to study IUPAC nomenclature of organic compounds.
2. To study the chemistry related to molecular structure in three dimensions (Stereochemistry), which includes the detail study representing stereo isomers on a 2 D surfaces
3. To provide a basic knowledge of the elements in the periodic table and their General Chemistry.

Learning outcome:
1. Students will learn about the basic concepts in Organic Chemistry like the hybridisation in organic molecules, molecular interaction.
2. Students will briefly learn about the types of reaction, reactive intermediates and reaction mechanism in organic chemistry.
3. Students will learn how to name different classes of organic compounds using IUPAC nomenclature.
4. Students will learn how to represent 3 D of organic molecule on 2 D surfaces. Also how the orientation of a molecule in space can give a compound different reactivity.
5. Students will learn two important classes of organic compounds like alkanes and alkenes.
6. Develop skills to carry out related experiments.

SECTION- I (ORGANIC CHEMISTRY)

1. IUPAC Nomenclature of Organic Compounds 02 L

Basic rules of IUPAC nomenclature, nomenclature of the compounds- alkanes, cycloalkanes, alkenes, alkynes, haloalkanes, acids, alcohols, ethers, aldehydes, ketones, nitriles, acid halides, esters, anhydrides, amides.

Nomenclature of aromatic compounds, mono and di substituted benzene with two functional groups, bridged cycloalkanes.

2. Structural Theories and Reactivities of Organic Compounds 10 L

Bond formation in organic compounds; sp sp^2, sp^3 with respect to methane, ethene and acetylene (hybridisation concept), discussion on shape, bond length, bond angles of organic molecules.

Polar covalent bonds, electronegativity and bond dipoles in organic molecules, introduction and examples of Van der Waal's forces, inductive effect, field effect, hyperconjugation and resonance, hydrogen bonding.

Curved arrows in organic chemistry, homolytic and heterolytic bond breaking, types of reagents, electrophiles and nucleophiles, types of organic reactions: addition, elimination, substitution, oxidation, reduction and rearrangement with examples. Introduction to reactive intermediates: carbocations, carbanions, free radicals, carbenes, arynes and nitrenes with shape, stabilities, methods of formation and reaction. Methods of determination of reaction mechanisms: Determination of structure, intermediates, isotope effects, kinetic and stereochemical studies.

3. Stereochemistry 08 L

Isomerism, types of isomers: constitutional, conformational and configurational isomerism. Chirality, chiral centre, enantiomers and diastereomers (with example of threo and erythro diastereomers, meso compounds). Representation of configuration by- 3D Projection (Wedge and dotted projection), Fischer projection, Newmann projection and Saw horse projection. R/S configuration (Can-Ingold-Prelog sequence rules to be exlained). E/Z nomenclature.

4. Study of alkanes, cycloalkanes and alkenes 10 L

Alkanes and Cycloalkanes**:** Physical properties of alkanes and cycloalkanes, sources of alkanes and cycloalkanes, chemical properties: combustion and pyrolysis of alkanes, methods of preparation: Corey-House reaction, Wurtz reaction.

Alkenes: Physical properties and relative stabilities of alkenes, preparation of alkenes, elimination reactions, dehydration of alcohols, regioselectivity in alcohol dehydration: The Zaitsev rule, rearrangement in alcohol dehydration, dehydrohalogenation: E1 and E2 mechanisms, reactions of alkenes: hydrogenation, addition of halides and hydrogen halides, regioselectivity of hydrogen halide addition, hydroboration and oxidation reactions, oxymercuration- demercuration reactions, epoxidation of alkenes, ozonolysis of alkenes.

SECTION- II (INORGANIC CHEMISTRY)

1. Chemistry of s- block elements **05 L**
General properties, comparative study within groups, diagonal relationship, salient features of hydrides, solvation and complexation tendencies and biological importance, introduction to alkyls and aryls

2. Chemistry of p- block Elements **10 L**
Comparative study within group and diagonal relationship of groups 13, 14, 15, 16, 17, Hydrides of Boron, diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), phosphazenes, tetra sulfur tetranitride, basic properties of halogens, inter halogens and polyhalides.

PRACTICALS

Paper Title: General organic and Inorganic Chemistry + Laboratory Course-2

Paper Code: CHE- I. C-2

Name of Faculty: Dr. L. R. Gonsalves; Shri. N.G. Rivonkar; Dr.Sandesh T. Bugde

Marks: 25

Credits: 1

ORGANIC CHEMISTRY

1. Purification techniques for organic solid compounds

A. **Crystallization:** a. Benzoic acid from water
b. m-Dinitrobenzene from ethanol
B. **Sublimations:** a. Naphthalene b. Anthracene c. Camphor **(Any 2)**

3. **Organic synthesis:** a. Benzoylation of β-naphthol and aniline. **(Any 2)**
b.Bromination of aromatic compounds using $KBrO_3$
c. Anthraquinone from anthracene (Oxidation reaction)

4. **Qualitative Analysis (Solids) (Any 4)**
Acids: Benzoic, salicylic, phthalic
Phenols: α-Naphthol, β-naphthol
Bases: p-Toluidine, diphenylamine, o-, m- and p-nitroanilines
Anilides: Acetanilide, benzanilide
Hydrocarbons: Naphthalene, anthracene
Amides: Benzamide, urea
Haloarenes: p-Dichlorobenzene
Nitro Compounds: m-Dinitrobenzene, p-nitrotoluene
Carbohydrates: Glucose, fructose, mannose

INORGANIC CHEMISTRY

1. To prepare 0.001 M EDTA and separately estimate the amount of Zn^{2+} ion from $ZnCO_3$, Mg^{2+} ion from MgO.
2. Volumetric estimation of Fe^{2+} using internal indicator by potassium dichromate method

3. Determination of alkali content in antacid tablet using Standard HCl solution

REFERENCES

PHYSICAL CHEMISTRY
TEXTB OOKS

1. Atkins, P., Paula, J. D. *Atkin's Physical Chemistry*, Oxford University Press.

ADDITIONAL READING

1. Bahl A., Bahl B.S. and Tuli, G.D. *Essentials of Physical Chemistry*, S. Chand & Company Ltd., New Delhi.
2. Puri B.R., Sharma L. R. and Pathania M. S. *Principles of Physical Chemistry*, Vishal Publishing Co.
3. Raj G. *Advanced Physical Chemistry*, Goel Publishing House, Meerut.

ORGANIC CHEMISTRY
TEXT BOOK

1. Morrison, R. T., Boyd, R. N. and Bhattacharjee, S. K. *Organic Chemistry,* Pearson India.

ADDITIONAL READING

1. Bruice, P. Y. *Organic Chemistry*, Pearson India.
2. Carey, F. C. and Giuliano, R. M. *Organic Chemistry*, Tata McGraw-Hill India.
3. Finar, I. L. *Organic Chemistry*, Pearson India.

INORGANIC CHEMISTRY
TEXT BOOKS

1. Lee, J. D. Concise Inorganic Chemistry, ELBS Publications.
2. Atkins, P., Overton, T., Rourke, J., Weller, M., Armstrong, F. *Shriver & Atkins' Inorganic Chemistry*, Oxford University Press.

ADDITIONAL READING

1. Greenwood, N. N., Earnshaw, A. *Chemistry of Elements,* Pergamon, Oxford.
2. Huheey, J. E., Keiter, E. A., Keiter, R. L., Medhi, O. K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson.
3. Cotton, F. A., Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley Publications.
4. Puri, B. R., Sharma, L. R., Kale, K. C. *Principles of Inorganic Chemistry*, Vallabh Publications.
5. Sharpe and Emilus, Inorganic Chemistry.
6. Housecroft, C. E. and Sharpe, A. G. *Inorganic Chemistry*, Prentice Hall.

ANALYTICAL CHEMISTRY
TEXT BOOK

1. Skoog, D. A., West D.M. and Holler, F. J. *Analytical Chemistry An Introduction*, Saunders College Publishing

BOOKS SUGGESTED FOR LABORATORY COURSE

1. Yadav, J. B. *Advanced Practical Physical Chemistry*, Krishna Prakashan Media (P) Ltd. Meerut.
2. Chondhekar, T. K. and Rajbhoj, S.W. *Systematic Experimental Physical Chemistry*, Anjali Publication, Aurangabad.
3. Furniss, B. Brian, S. *Vogel's textbook of practical organic chemistry*, Pearson education.
4. Vishnoi, N. K. *Advanced Practical Organic Chemistry*, Vikas Publishing House Pvt Ltd.
5. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Orient Longman.
6. Jeffery, G. H. Bassett, J. *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley & Sons Inc.

SEMESTER III

CORE COURSE
THEORY
Course Title: Comprehensive Chemistry - I
Course Code: CHE- III. C-5
Name of Faculty: Dr. S. B. Kakodkar and Dr. L. R. Gonsalves
Maximum Marks: 75
Credits: 3

Course Objectives:

1. To understand some important core topics in Physical Chemistry.
2. The topics in Inorganic Chemistry mainly deal with chemistry of the f-block elements, i.e the lanthanides and actinides and its compounds. It also involves a brief introduction to coordination compounds. The course also provides basic understanding of different types of ionic solids and the different types of defects that can occur in a crystal.
3. To understand the topics in the theory with practical knowledge.

Learning Outcome:

1. Will learn principles of Physical Chemistry and its applications in various processes.
2. Will obtain a comprehensive and detail understanding of the properties and compounds of the f-block elements i.e. the lanthanides and actinides.
3. Will gain a basic understanding of coordination compounds, their nomenclature and the types of coordination compounds.
4. Will be able to describe different crystal structures of ionic solids and the types of defects which can occur in a crystal.
5. Will be able to get a deeper understanding of the theory with practical knowledge.

SECTION –I (PHYSICAL CHEMISTRY)

1. Thermodynamics **10 L**

Second law of thermodynamics: Different statements of the law; Carnot cycle and its efficiency, Carnot theorem; Thermodynamic scale of temperature; Concept of entropy: entropy as a state function, entropy as a function of V and T, entropy as a function of P and T, entropy change in physical processes, entropy as a criteria of spontaneity and equilibrium; Entropy change for ideal gases. Third law of thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data; Gibbs and Helmholtz functions; A and G as criteria for thermodynamic equilibrium and spontaneity, their advantages over entropy change; Variation of G and A with P, V and T.

2. Chemical Equilibrium **05 L**

Reversible reactions, equilibrium constant, Equilibrium constant and free energy; Thermodynamic derivation of law of mass action; Reaction isotherm and reaction isochore - Clapeyron equation and Clausius - Clapeyron equation; Le Chatelier's principle and its applications to some industrial processes.

3. Electrochemistry **08 L**

Electrical transport-conduction in metals and in electrolyte solutions, weak and strong electrolytes; conductance, specific conductance and equivalent conductance and measurements; variation of specific and equivalent conductance with dilution; Arrhenius theory of electrolyte dissociation and its limitations; Ostwald's dilution law, its uses and limitations; Migration of ions and Kohlrausch law; Debye-Huckel-Onsager's equation for electrolytes; Transport number, determination of transport number by Hittorf's method, Applications of conductance measurements: degree of dissociation, dissociation constant of acids; Solubility and solubility product of a sparingly soluble salts; Conductometric titrations (e.g.

Strong acid and strong base).

SECTION –II (INORGANIC CHEMISTRY)

1. Chemistry of f-block elements **09 L**

Electronic structure, oxidation states and ionic radii; physical and chemical properties; occurrence and isolation of lanthanides from monazite ore; Lanthanide compounds; General properties and chemistry of actinides; Chemistry of extraction of Thorium and Uranium from its ore; Compounds of Th and U; comparison between lanthanides and actinides

2. Introduction to Coordination Compounds **08 L**

Werner's coordination theory; effective atomic number concept; nomenclature of coordination compounds; constitution and geometry; Isomerism and chirality in coordination compounds; chelates and macrocyclic effect

3. Acids, Bases and Non-aqueous solvents **05 L**

Arrhenius concept and Bronsted theory; Lewis concept of acid and bases; Physical properties of a solvent; Solvents and their general characteristics; Reactions in non aqueous solvent with respect to NH_3

PRACTICALS:
Course Title: Comprehensive Chemistry - I
Course Code: CHE- III. C-5
Name of Faculty: Dr. S. B. Kakodkar and Dr. L. R. Gonsalves
Maximum Marks: 25
Credit: 1

PHYSICAL CHEMISTRY EXPERIMENTS (Any 4 experiments to be performed)

1. To verify Ostwald's dilution law by determining the equivalent conductance of a weak monobasic acid at different concentrations
2. To determine the equivalent conductance of a strong electrolyte at several concentrations and hence verify Onsager's equation
3. To determine solubility product of sparingly soluble salt by conductometric method
4. To determine hydrolysis constant of sodium acetate by conductometric method
5. To determine ΔG, ΔH and ΔS of silver benzoate by solubility product method conductomtrically
6. To study the molecular condition of benzoic acid between toluene and water at room temperature by partition method
7. To study the solubility of benzoic acid in water at different temperatures and to calculate the heat of solution
8. To determine energy of activation for acid catalysed hydrolysis of methyl acetate

INORGANIC CHEMISTRY EXPERIMENTS

1. Preparation of Tetraamine copper (II) sulphate monohydrate
2. Estimation of Copper (II) from teraamine copper (II) sulphate by iodometry
3. Preparation of Hexamine nickel (II) chloride complex
4. Estimation of Nickel in hexamine nickel (II) chloride by EDTA method
5. Gravimetric estimation of Nickel as Ni-DMG
6. Volumetric Estimation of Calcium by EDTA method
7. Volumetric Estimation of dissolved oxygen in water sample

TEXT BOOK (PHYSICAL CHEMISTRY)**:**

Raj Gurdeep, Advanced Physical Chemistry; Goel Publishing House, Meerut, 27th Edition

REFERENCE BOOK:
Puri B.R., Sharma L.R., Pathania M. S., Principles of Physical Chemistry

TEXT BOOK (INORGANIC CHEMISTRY)**:**
Shriver D.F. and Atkins P. W., Inorganic Chemistry, 5th Edition, Oxford University Press

REFERENCE BOOKS (INORGANIC CHEMISTRY):
1. Cotton F. A. and Wilkinson G, Advanced Inorganic Chemistry, 5th Edition, John Wiley
2. Lee, J. D. Concise Inorganic Chemistry, 5th Edition, Wiley Blackwell Science Publications

SEMESTER III

ELECTIVE COURSES
THEORY
Course Title: Name reactions and Synthetic methodologies
Course Code: CHE-III. E-1
Name of Faculty: Mrs. Padmini Panjikar
Maximum Marks: 75
Credits: 3

Course Objectives:

1. The main objective of this course is to study the organic chemistry through name reactions.
2. This course includes important name reactions involved in different categories of organic reactions such as addition, substitution, rearrangement reactions.
3. This course also includes name reaction concerned with oxidation and reduction reaction.

Learning outcome:
1. Students will learn importance of name reactions in organic chemistry.
2. Students will learn different types of reactions in organic chemistry through name reactions.

1. Name reactions involving nucleophilic addition to carbonyl compounds 17 L
Structure and reactivity of carbonyl group; General mechanism of nucleophilic addition to carbonyl group; Introduction to condensation reactions; Reactions and mechanisms of: Aldol condensation, Claisen-Schmidt condensation, Claisen condensation, Dieckmann condensation, Perkin condensation, Knoevenagel condensation, Doebner modification, Stobbe condensation, Benzoin condensation, Michael addition.

2. Name reactions involving electrophilic aromatic substitutions 10 L
Introduction to general mechanism involved, reactivity of arenes, product distribution, ipso-attack and orientation in benzene with more than one substituent
Reactions and mechanisms of: Friedel-Crafts alkylation and acylation, Vilsmeier-Haack reaction, Gattermann-Koch reaction, Reimer-Tiemann reaction and Kolbe-Schmitt reaction.

3. Name reactions involving rearrangement 06 L
Reactions and mechanisms of: Beckmann rearrangement, Curtius rearrangement, Hofmann rearrangement, Pinacol-Pinacolone rearrangement, Wagner-Meerwin rearrangement, Claisen rearrangement.

4. Oxidation reactions 06 L

Oppenauer oxidation (with mechanism), aromatisation and dehydrogenation; Chromium and manganese compounds as oxidising agents: Preparation and applications of PCC and PDC, oxidation of alcohols, aldehydes, C-C double bonds and C-H bonds in hydrocarbons.

5. Reduction reactions **06 L**

Catalytic hydrogenation: Different catalysts, solvents and equipments; functional group reductions and homogeneous catalytic hydrogenation; Reductions by hydride transfer reagents and related reactions: $NaBH_4$ and LAH reduction (with mechanism); reductions with borane and dialkylboranes;
Other methods of reductions: Clemmensen's reduction, Wolff-Kishner reduction (with mechanism).

PRACTICALS
Course Title: Name reactions and Synthetic methodologies
Course Code: CHE-I. E-1
Name of Faculty: Mrs. Padmini Panjikar
Maximum Marks: 75
Credit: 1 (Any 8)

1. Preparation of chalcone using benzaldehyde and acetophenone.
2. Preparation of dibenzalacetone.
3. Preparation of nitrostyrene using nitromethane and benzaldehyde.
4. Preparation of benzoin using benzaldehyde and thiamine hydrochloride.
5. Oxidation of benzoin to benzil.
6. Preparation of 2,4-DNP hydrazone of acetophenone
7. Preparation of oxime of cyclohexanone
8. Preparation of PCC and PDC
9. Reduction of m-dinitrobenzene to m-nitroaniline
10. Nitration of nitrobenzene
11. Nitration of acetanilide
12. Preparation of Cinnamic acid
13. Preparation of Michael adduct between cyclohexanone and nitrostyrenes
14. Oxidation of alcohols using PCC
15. Oxidation of alcohol using PDC

TEXT BOOK:

1. Morrison, R. T., Boyd, R. N. and Bhattacharjee, S. K. Organic Chemistry, Pearson India.

REFERENCE BOOKS:

1. Bruice, P. Y. Organic Chemistry, Pearson India.
2. Carey, F. C. and Giuliano, R. M. Organic Chemistry, Tata McGraw-Hill India.
3. Finar, I. L. Organic Chemistry, Pearson India.
4. March Jerry, Advanced Organic Chemistry Reaction, Mechanism and Structure, 4th Edition, Wiley Publications.

PRACTICAL TEXT BOOK

Furniss, B. Brian, S. Vogel's Textbook of Practical Organic Chemistry, Pearson education

THEORY
Course Title: Industrial Chemistry
Course Code: CHE-III. E-2
Name of Faculty: Dr. Rohan K. Kunkalekar, Dr. Roopa Belurkar
Maximum Marks: 75
Credits: 3

Course Objectives: The main objective of this course is to study the industrial processes, pollution caused due to industries, some pharmaceutical preparations and preparation and properties of solid materials.

Learning outcome: students will learn about industrial processes, preparation and properties of solid materials, they will learn about the different types of pollutions caused by industries. Students will develop the laboratory skills about the synthesis and analysis of industrially important materials.

1. Pollution **12 L**

A. Segments of environment
   Air, Oxygen, nitrogen cycle, water, Biosphere, Flora and Fauna, Soil
B. Types of Pollution (i) Air Pollution: Introduction, classification of pollutants, sources, control, effect with respect to oxides of Nitrogen, Carbon and Sulphur, Photochemical smog, acid rain and Green House Effect. (ii) Water pollution: Organic /inorganic pollutants Sewage analysis (iii) Noise pollution.
C. Effluent treatment and waste management
   Principles and equipments for aerobic, anaerobic treatment, adsorption, filtration, sedimentation, Bag filters, electrostatic precipitators, mist eliminators, wet scrubbers, Absorbers, Solid Waste Management.
D. Pollution evaluation methods, Pollutants and their statutory limits.

2. Materials Science **15 L**

A. Mechanical properties of materials and change with respect to temperature
B. Metals and alloys – important metals and alloys
C. Corrosion – various types of corrosion relevant to chemical industry – Mechanism, Preventive methods.
D. Cement – Types of cement, composition, manufacturing processes, setting of cement.
E. Ceramics – Introduction, Types, Manufacturing processes, Applications, Refractories.
F. Glass – types, composition, manufacture, physical and chemical properties applications.

3. Pharmaceutical Drugs **10 L**

Classification of various types of drugs with examples; Raw materials, process of manufacture, effluent handling etc of the following bulk drugs:

A. Antimicrobial – chloramphenicol, furazolidone, isoniazid, Ethambutol
B. Analgesic/Anti-inflammatory / salicylic acid and its derivatives, Ibuprofen

4. Industrial fuels and chemicals **08 L**

A. Industrial fuels like coal gas, producer gas and water gas.
B. Physico chemical principles involved in the manufacture of HNO_3 (Ostwald's method) and NH_3 (Haber's method).

PRACTICALS
Course Title: Industrial Chemistry
Course Code: CHE-III. E-2
Name of Faculty: Dr. Rohan K. Kunkalekar, Dr. Roopa Belurkar
Maximum Marks: 25
Credit: 1

1. Volumetric estimation of amount of chloride present in given sample
2. To prepare crystals of potash alum, K_2SO_4. $Al_2(SO_4)_3$. 24 H_2O, from Aluminium foil
3. To estimate the amount of copper present in brass by colourimetric method
4. To separate and estimate the amount of magnesium ion and zinc ion present in the given magnesium-zinc mixture, using an anion exchange resin column (minimum 4 hours)

5. To estimate amount of zinc present in brass by complexometric titration (minimum 4 hours)
6. Ore analysis: Ca from Limestone (minimum 4 hours)
7. Ore analysis: Mn from Manganese ore (minimum 4 hours)
8. Synthesis of common industrial compounds involving two step reactions: Phthalic acid to Phthalic anhydride. (minimum 4 hours)
9. Complete pharmacopeia analysis of drugs: a) Paracetamol OR b) Ibuprofen (minimum 4 hours)

TEXT BOOK:
Sharma B. K., Industrial Chemistry, 6th Edition, Goel Publishing House, Meerut

REFERENCE BOOKS:

1. Lee, J. D., Concise Inorganic Chemistry, 5th Edition, Wiley Blackwell Science Publications
2. Cotton F. A., and G. Wilkinson G., Basic Inorganic Chemistry, 2nd Edition, Wiley Eastern Ltd,.
3. Iqbal S. A., and Mido,Y., Chemistry of Air and Air Pollution, Discovery Publishing House, New Delhi
4. Tyagi O. D. and Mehra M., A Text Book Of Environmental Chemistry, Anmol Publications, New Delhi
5. De, A. K., Environmental Chemistry, Wiley Eastern Limited
6. Bahl B. S., Comprehensive Inorganic Chemistry
7. Foye A. O., Principles of Medicinal Chemistry, Publication Philadephia
8. Wilson, Gisvold, Doerge, Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott -Toppan
9. Korolkovas and Burkhalter, Essentials of Medicinal Chemistry, Wiley- Interscience
10. Lednicer D., and Mitscher, L. A., Organic Chemistry of Drugs Synthesis, Wiley Interscience
11. Singh P. P. and Rangnekar, D.W., An Introduction to Synthetic Drugs, Himalaya Publication, Bombay

THEORY
Course Title: Surface Chemistry and Catalysis
Course Code: CHE- III. E-3
Name of Faculty: Dr. S. B. Kakodkar
Maximum Marks: 75
Credits: 3

Course Objectives:
1. To understand the surface features of solid surfaces and its importance in chemical processes.
2. To understand the process of adsorption and its types.
3. To understand catalytic processes and some important classes of catalysts.

Learning outcome:
1. Will have an understanding of chemistry of surfaces and be able to interpret various types of adsorption.
2. Will understand the mechanism and applications of catalytic processes.
3. Will have practical knowledge of synthesis and characterisation of catalysts.

1. Surfaces of solids **08 L**

Introduction, surface mobility of solids-sintering; effect of past history on condition of solid surfaces; Thermodynamics of crystals; Surface tension and surface free energy; equilibrium shape of a crystal; Kelvin equation; Theoretical estimates of surface energies and free energies in various types of crystals and metals; Factors affecting surface energies and surface tensions of actual crystals; experimental methods for determining surface structure, reactions of solid surfaces.

2. Adsorption **17 L**

Introduction, Differences between adsorption, absorption and sorption, Characteristics of adsorption, sorption and occlusion, Adsorption of gases on solids; Physisorption and chemisorptions; Adsorption isotherms, Types of adsorption isotherms: Freundlich adsorption isotherm, Langmuir adsorption isotherm, The BET equation (Derivation not needed); Determination of surface area: Harkin and Jura method, Benton and White method, The BET method, Point B method, From electrical potential of adsorbed layer, Using rate of dissolution, From heat of wetting; Importance of surface area; Heat of adsorption and its measurement; Adsorption isobars; Adsorption from solution, Gibbs adsorption equation(Derivation not needed), Adsorption by porous solids, Adsorption in mesopores and micropores

3. Catalysis **20 L**

Introduction, Types of catalysis, Characteristics of catalysts; Theory of Homogenous catalysis, Function of a catalyst in terms of Gibbs Free energy of activation; Theory of heterogeneous catalysis, Quantitative treatment of Adsorption theory, Kinetics of heterogeneous reactions, Effect of temperature on heterogeneous reactions, Absolute rate theory in heterogeneous gas reactions; Classification of catalysis, Enzyme catalysis, Characteristics of enzyme catalysis; Factors governing rate of enzyme catalysed reactions; Mechanism and kinetics of enzyme catalysed reactions, Michaelis-Menten equation; Acid-base catalysis, Mechanism and kinetics of acid-base catalysis, catalytic coefficients, Hammett and Bronsted equation(Derivation not needed); Acidity function; some important classes of catalysts

PRACTICALS (Any 8 experiments to be performed)
Course Title: Surface Chemistry and Catalysis
Course Code: CHE- III. E-3
Name of Faculty: Dr. S. B. Kakodkar
Maximum Marks: 25
Credits: 1

1. To study the adsorption of acetic acid on charcoal and to verify Freundlich isotherm.
2. To study the adsorption of oxalic acid on charcoal and to verify Langmuir adsorption isotherm.
3. To study acid catalysed inversion of cane sugar by polarimetry.
4. To determine the interfacial tension between two immiscible liquids (chloroform-water) at room temperature.
5. To determine the indicator constant of a given indicator by colourimetric measurements.
6. To synthesize ZnO from zinc nitrate by decomposition method and determine the amount of zinc in ZnO by titrimetry.
7. To synthesize CuO from copper nitrate and determine the amount of copper in CuO using titrimetry.
8. To study the kinetics of iodination of acetone.
9. To study the hydrolysis of methyl acetate and determination of energy of activation in presence of sulphuric acid.
10. To investigate the auto-catalytic reaction between potassium permanganate and oxalic acid.
11. To determine the Scherrer particle size of any three catalysts using their X-ray diffraction data.
12. To calculate band gap of any five catalysts using their UV-DRS data.
13. To determine the Hammett constant of a substituted benzoic acid by pH measurements
14. To study the adsorption of iodine from alcoholic solution using charcoal
15. To investigate the autocatalytic reaction between $KMnO_4$ and oxalic acid

TEXT BOOK:
Raj Gurdeep, Advanced Physical Chemistry, Goel Publishing House

REFERENCE BOOK:
Adamson A. W., Physical Chemistry of Surfaces, Interscience Publishers

PRACTICAL BOOK

Rajbho S.W., Chondhekar T. K., Systematic Experimental Physical Chemistry

THEORY
Corse Title: Bioinorganic Chemistry
Course Code: CHE- III. E-4
Name of Faculty: Dr. Lactina R. Gonsalves
Maximum Marks: 75
Credits: 3

Course Objectives:
This course will provide an understanding of the importance of metal in biology and the key role that metal ions play in biological processes. The course begins with the essential and trace elements in biochemical process; their function and bioavailability. As the course progresses, the role of alkali and alkaline earth metals and transition metals like Fe and Cu to carry out vital biological reactions will be studied. Also, this course will give an insight into the structure of important bimolecular and enzymes which contain metal centers. The course will also provide significant insight into the developments which utilize metal ions for medicine

Learning outcome:
On successful completion of the course, the student will be able to:
1. Describe the role of metal ions that are involved in different processes like oxygen transport, electron-transfer reactions etc. in biological systems.
2. Describe the most common metal centres for electron-transfer reaction which are based on copper and iron ions.
3. Summarize the role of metal centres in the enzymes that are involved in the catalysis of various biological reactions.
4. Will be proficient in the basic principles of bioinorganic chemistry and biochemistry.
5. Will develop skills to prepare model systems which mimic the role of metal ions in biological systems.

1. Introduction to Bioinorganic Chemistry 05 L
Essential and trace elements in biological processes; distribution of elements in biosphere; bio-availability and bio-stability; Biologically important compounds: sugars (carbohydrates), fatty acids (lipids), nucleotides (nucleic acids) and amino acids (proteins); Biological importance of water; Metallobiomolecules.

2. Alkali and Alkaline earth metals in biological systems 12 L
Structure and functions of biological membranes; mechanism of ion transport across membranes; sodium pump; Ionophores: valinomycin; Crown ether complexes of Na^+ and K^+; Photosynthesis: chlorophyll a, PS I and PS II; Role of calcium in muscle contraction and blood clotting.

3. Iron and Copper containing compounds in biology 15 L
Heme proteins: hemoglobin, myoglobin and cytochrome c; Non-heme proteins: hemerythrin and hemocyanin; Iron transport and iron storage proteins: Siderophores, transferrin and ferritin; Electron transfer: Iron-Sulphur clusters, cytochromes.

4. Metalloenzymes 07 L
Copper enzymes: superoxide dismutase, cytochrome oxidase and ceruloplasmin; Zinc enzymes: carbonic anhydrase, carboxy peptidase and interchangeability of zinc and cobalt in enzymes; Molybdenum enzyme: xanthine oxidase; Coenzymes: Vitamin B12 and B12 coenzymes

5. Chemistry of elements in medicine 06 L
Metals as diagnostic and therapeutic agents: chelation therapy, cancer treatment, anti-arthritis drugs; Platinum complexes as anticancer drugs; Pt-DNA binding; complexes of gold, copper, zinc, mercury, arsenic and antimony as drugs.

PRACTICALS:
Corse Title: Bioinorganic Chemistry

Course Code: CHE- III. E-4
Name of Faculty: Dr. Lactina R. Gonsalves
Maximum Marks: 25
Credit: 1

(Any 8 Experiments to be performed)

1. Preparation of acetylacetonato manganese (III) complex(minimum 3 hours)
2. Preparation of trisethylenediamine nickel (II) complex (minimum 3 hours)
3. Preparation of Tris(acetylacetonato) iron (III) (minimum 3 hours)
4. Estimation of Fe from the complex Tris(acetylacetonato) iron(III)
5. Preparation of tris(thiourea)copper(I)sulphate
6. Preparation of optical isomers, cis and trans dichloro(ethylenediamine)cobalt(III)chloride (minimum 3 hours)
7. Preparation of hexamine cobalt (III) chloride(minimum 3 hours)
8. Estimation of cobalt (III) from hexamine cobalt (III) chloride
9. Preparation of bis(dimethylglyoxime)cobalt (I) a Vitamin B12 model system(minimum 3 hours)
10. Determination of hardness of water by EDTA

TEXT BOOK:
Bertini I., Gray H. B., Lippard S. J. and Valentine J.S., Bioinorganic Chemistry, University Science Books

REFERENCE BOOKS:
1. Fausto da Siliva J. J. R. and Williams R. J. P., The Biological Chemistry of the Elements, Oxford University Press
2. Fenton D. E., Bio-coordination Chemistry, Oxford Chemistry Printers, Oxford University Press
3. Shriver and Atkins, Inorganic Chemistry, 5th Edition, Oxford University Press

PRACTICAL BOOK:
Bassett J., Denney R. C., Jeffrey G. H., Mendham J., Vogel's Text Book of Quantitative Inorganic Analysis .

SEMESTER IV

CORE COURSE

THEORY
Course Title: Comprehensive Chemistry-II
Course Code: CHE- IV. C- 6
Name of Faculty: Dr. Sandesh T. Bugde and Dr. G. K. Naik
Maximum Marks: 75
Credits: 3

Course Objectives:
1. The main objective of this course is to study the organic compounds containing CHO elements.
2. This course focuses on the study of ethers, aldehydes, ketones, acids and esters with respect to their structural and chemical properties, method of formation and chemical reaction.

Learning outcome: Students will learn about;
1. Important classes of organic compounds include CHO elements.
2. Preparations involved in different classes of organic compound having CHO elements.
3. Important reaction involved in each class of included compounds.

SECTION I (ORGANIC CHEMISTRY)

1. a. Studies of organic compound containing C, H and O **04 L**

Chemistry of organic compounds containing C, H, O elements; Alcohols, ethers, acids, ester, aldehydes and ketones

b. Ethers

Properties of ethers, Symmetric and asymmetric ethers, crown ethers, Preparations of ethers: Williamson ether synthesis, alkoxymercuration-demercuration, Reaction of ethers with acids (HX).

2. Aldehydes and Ketones **08 L**

Properties of aldehydes and ketones, Geometry and polarity of the carbonyl group, Preparation of aldehydes: Oxidation of alcohols, reduction of acid chlorides, Ozonolysis of alkene; Preparation of ketones: oxidation of alcohols, Friedel-Crafts acylation, Reaction of acid chloride with organocopper compounds; Reactions of aldehydes and ketones: General mechanism of nucleophilic addition at carbonyl group; Oxidation and reduction of aldehyde and ketones; Reaction with amine derivative (imine formation with mechanism); Cannizaro reaction and addition of Grignard reagents; Addition of carbanions (Aldol condensation).

3. Carboxylic Acids **06 L**

Properties of carboxylic acids, Preparation of acids: Oxidation of primary alcohols and alkyl benzenes, hydrolysis of nitriles with mechanism; Reaction of acids: Salt formation, conversion to different functional groups (esters, amides, acid chlorides and anhydrides), reduction of acids.

4. Esters **05 L**

Properties of esters; Preparation of esters: from acids, acid chlorides and anhydrides; Reactions of esters: Conversion to acids (Hydrolysis along with mechanism), conversion to amides, Trans-esterification, reduction to aldehydes and alcohols.

SECTION II (ANALYTICAL CHEMISTRY)

1. The Scope and Nature and of Analytical Chemistry **05 L**

Introduction; quantitative and qualitative analysis; qualitative analysis by classical and instrumental methods; analytical chemistry and analytical process (steps involved in chemical analysis): defining the problem, sampling, separation of desired components, actual analysis, presentation and interpretation of results; factors affecting the choice of analytical method.

1. Sampling Techniques **07 L**

Terms encountered in sampling: Sample, the population or the universe, sampling unit, increment, the gross sample, the sub sample, Analysis sample, bulk ratio, size to weight ratio, random sampling, systematic sampling, multistage sampling, sequential sampling; sampling of gases, liquids and solids; Preservation, storage and preparation of sample solution.

2. Statistical Treatment of Analytical Data **10 L**

Limitations of analytical methods, classification of errors, accuracy and precision; Errors: determinate and indeterminate error, constant and proportionate errors, minimization of errors; Significant figures and rounding off; mean, median, mode, range; standard deviation; histogram and frequency polygon; measures of central tendency and dispersion; Gaussian distribution curve; Confidence limit; Test of significance: F test, Students T; Rejection of the results: Q test, 2.5 d and 4.0 d rule; linear least squares/ method of averages.

PRACTICALS
Course Title: Comprehensive Chemistry-II
Course Code: CHE- IV. C- 6
Name of Faculty: Dr. Sandesh T. Bugde and Dr.G. K. Naik

Maximum Marks: 25
Credit: 1

ORGANIC CHEMISTRY EXPERIMENTS

1. Qualitative analysis of organic compounds: **(Any 2)**
   Solids (examples: Benzoic acid, Nitro-benzaldehyde, Benzophenone)
   Liquids (Acetone, methylacetate, benzaldehyde)
2. Identification of type and separation of mixture of organic compounds: **(Any 4)**
   Solid-solid (Soluble-insoluble, insoluble-insoluble), solid-liquid (Solid and low boiling liquid), liquid-liquid) (High boiling and low boiling liquid)

ANALYTICAL CHEMISTRY EXPERIMENTS

1. To estimate the NO_2^- in the given solution by $KMnO_4$ method by back titration
2. To determine the amount of HCl in the given solution by pH metric titration
3. To determine the specific rotation of the given solution and to determine the percentage composition of unknown solution using polarimeter
4. To estimate the amount of benzoic acid in the given solution by back titration
5. To estimate the amount of vitamin C in the given solution
6. To estimate the amount of Aspirin present in the given tablet
7. To calibrate the burette and pipette using statistical treatment of data
8. To calibrate the volumetric flask of different volume capacity
9. To determine the hardness of water by EDTA method and to take at least five readings and apply the statistical data treatment to calculate mean, median, range, standard deviation and Q test. (Any six experiments to be performed)

ORGANIC CHEMISTRY
TEXT BOOK:

1. Morrison, R. T., Boyd, R. N. and Bhattacharjee, S. K., Organic Chemistry, Pearson India.

REFERENCE BOOKS:

1. Bruice, P. Y. Organic Chemistry, Pearson India
2. Carey, F. C. and Giuliano, R. M. Organic Chemistry, Tata McGraw-Hill India
3. Finar, I. L. Organic Chemistry, Pearson India

PRACTICAL TEXT BOOK:
Furniss, B. Brian, S., Vogel's Textbook of Practical Organic Chemistry, Pearson education

ANALYTICAL CHEMISTRY
TEXT BOOK:

1. Skoog, D. A., West, D. M., Holler F. J. and Crouch, S. R., Fundamentals of Analytical Chemistry, 8th Edition,

REFERENCE BOOKS:

1. Willard, H. H., Merritt, L. L., Dean, J. A., Settle, F. A., Instrumental Methods of Analysis, CBS Publishing, New Delhi, 7th Edition
2. Vogel's Text Book of Quantitative Inorganic Analysis - J. Bassett, R. C. Denney, G. H. Jeffrey, J. Mendham.
3. Christian, G. D., Analytical Chemistry, Analytical Chemistry, John Wiley, 5th Edition

PRACTICAL TEXT BOOK:
Yadav J. B. Advanced Practical Physical Chemistry, Goel Publishing House, 14th Edition

SEMESTER IV

ELECTIVE COURSES
THEORY
Course Title: Pharmaceutical Chemistry
Course Code: CHE- IV. E-5
Name of Faculty: Dr. Sandesh T. Bugde
Maximum Marks: 75
Credits: 3

Course Objectives:

1. The main objective of this course is to study the Chemistry involved in pharmaceutical industries.
2. This course gives blend of chemical and pharmaceutical principles necessary for understanding structure–activity relationships and molecular mechanisms of drug action.
3. This course also includes synthesis of some important drugs.

Learning outcome:

1. Students will learn about important aspects with respect to pharmaceutical Chemistry.
2. Students will develop understanding in structure-activity relationship.
3. Students will learn efficient chemical synthesis involved in important drug.

1. Introduction to pharmaceutical Chemistry and its scope **05 L**

Introduction to pharmaceutical Chemistry; Scope of pharmaceutical Chemistry; General terminologies used in pharmaceutical Chemistry: Pharmacoepia, Pharmacokinetics, Pharmacodynamics.

2. Drug design strategies and general pathways of drug metabolism **10 L**

Drug designing; General pathways of drug metabolism: Oxidative reactions, reductive reactions, hydrolytic reactions, Phase II or conjugation reactions.

3. Anti-infective agents **10 L**

Antifungal agents: Haloprogin and Flucytosine. (Definition, structures, Mechanism of action and uses); Antibacterial agents: Ciprofloxacin and Furazolidone (Definition, structures and uses); Anti protozoal agents: Metronidazole (Definition, structure and uses); Antihelmintics: Thiabendazole (Definition, structure and uses); Antibacterial agents: Linezolid (Definition, structure and uses); Synthesis of Flucytosine.

4. Central nervous system stimulant and depressant **10 L**

Analeptics: Pentylenetetrazole (Definition, structure and uses); Central sympathomimetic agents (psychomotor stimulants): Pentylenetetrazole (Definition, structure and uses); Antidepressants: Desipramine Hydrochloride and Clomipramine Hydrochloride (Definition, structure and uses); Anxiolytic: Paroxetine (Definition, structure and uses); Sedative and hypnotic agents: Propofol, Methaquolone (Definition, structure and uses); Synthesis of clomipramine.

5. Cardiovascular agents **06 L**

Antianginal Agents and Vasodilators: Nitroglycerin, Nifedipine (Definition, structures and uses); Antiarrhythmic Drugs: Quinidine sulfate (Definition, structure and uses); Antihypertensive Agents: Prazosin (Definition, structure and uses); Synthesis of Nifedipine by Hantsch synthesis, Prazosin.

6. An introduction to the Medicinal Chemistry of plants **04 L**

Historical background; Type of plant, active ingredient structure and their medicinal properties: Capsicum, Garlic, turmeric.

PRACTICALS
Course Title: Pharmaceutical Chemistry
Course Code: CHE- IV. E-5
Name of Faculty: Dr. Sandesh T. Bugde
Maximum Marks: 25
Credit: 1 (Any 8)

1. Synthesis of Aspirin
2. Synthesis of Benzocaine
3. Synthesis of Paracetamol
4. Synthesis of Acetaminophen
5. Synthesis of benzophenone oxime.
6. Synthesis of phenytoin
7. Synthesis of benzimidazole
8. Estimation of acetyl salicylic acid in the given aspirin tablet by titrating against 0.1N alcoholic KOH potentiometrically.
9. Determination of purity of paracetamol spectrophotometrically.
10. Determination of optical rotation of pharmaceutical compounds.
11. UV Absorbance Standard Curve of Salicylic Acid
12. Assay by titration of the following: Ibuprofen, aspirin.
13. Hydroxyzine dihydrochloride (HDH) determination by titrimetry.
14. Assay of Nitrazepam potentoimetrically.
15. Quantitative estimation of aspirin in tablets using metformin hydrochloride.

TEXT BOOK:

1. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, 12th Edition

REFERENCES BOOKS:

1. Foye, W.O., Medicinal Chemistry
2. A. Pengelly, The Constituents of Medicinal plants
3. Lednicer and Meischer, Organic Chemistry of Drug Synthesis

THEORY
Course Title: Polymer and Colloid Science
Course Code: CHE- IV. E-6
Name of Faculty: Dr. G. K. Naik
Maximum Marks: 75
Credits: 3

Course Objectives:

1. To understand the classification, properties and applications of colloids.
2. To understand the classification, synthesis and molecular weight determination of polymers.
3. To study the mechanism of polymer synthesis.

Learning outcome:

1. Will be able to classify colloids.
2. Will be able to calculate molar mass of polymers.
3. Will learn to synthesise some polymers in the laboratory

1. Colloidal Science

a. Introduction: 10 L

Colloidal state; colloidal solution; classification of colloids; lyophobic and lyophilic colloids; true solution, colloidal solution and suspension; preparation of sols; purification of sols; stability of colloids; protective action; Hardy- Schulze Law; gold number

b. Properties of colloids: 07 L

General properties; electrical properties; electrical double layers

c. Emulsions and gels: 06 L

Definition; types of emulsions, preparation; gels: definition; classification, preparation and properties, inhibition; kinetics of coagulation; general applications of colloids on size of colloidal particles

2. Polymer Chemistry:

a. Introduction to Polymer Science 06 L

Classification of polymers: thermoplastics and thermosetting, classification based on polymerization scheme, polymer structure: copolymers, tacticity, geometric isomerism; molecular weight: molecular weight distribution, molecular weight averages; chemical structure and thermal transitions.

b. Synthesis of high polymers 07 L

Step growth polymerization: molecular weight in a step growth polymerization, step growth polymerization kinetics; chain growth polymerization: free redical polymerization and copolymerization, ionic polymerization and copolymerization; polymerization technique; bulk polymerization, solution polymerization, suspension polymerization, emulsion polymerization, solid state- gas phase and plasma polymerization.

c. Solution properties, thermodynamics and molecular weight determination 05 L

Polymer conformation and chain dimensions; thermodynamics of polymer solution: Flory-Huggins theory, Flory-Krigbaum and Flory-Huggins theory, Equation of state theory; calculation of molecular weight: osmometry, light scattering method, intrinsic viscosity method

d. Solid state properties of polymer 04 L

Amorphous state: chain enlargements and reputation, the glass transition, secondary relaxation processes; the crystalline state: ordering of polymer chains, crystalline-melting temperature, crystallization kinetics, technique to determine crystallinity.

TEXT BOOK:

Raj Gurdeep, Advanced Physical Chemistry; Goel Publishing House, Meerut, 27th Edition

REFERENCE BOOKS:

1. Puri B.R., Sharma L.R., Pathania M. S., Principles of Physical Chemistry
2. Fried J. R., Polymer Science and Technology; Prentice Hall of India private limited
3. Bhatnagar M.S., A Text Book of Polymer Science, Volume 1

PRACTICALS
Course Title: Polymer and Colloid Science
Course Code: CHE- IV. E-6
Name of Faculty: Dr.G. K. Naik
Maximum Marks: 25
Credit: 1

1. To determine the flocculation value of univalent and divalent electrolyte for ferric hydroxide sol
2. To prepare colloidal solutions of cadmium sulphide and ferric hydroxide
3. To study the coagulation value of As_2S_3 sol with $AlCl_3$

4. To study the mutual coagulation value of ferric hydroxide sol
5. To determine the critical micelle concentration of a soap by surface tension method
6. To determine the viscosity of a given liquid using Ostwald's viscometer (minimum two liquids)
7. To determine the molar mass of a polymer using Ostwald's viscometer
8. To determine the viscosity of mixture A and B and test the validity of Kendalls equation
9. To determine the viscosity of mixture of A and B and determine the composition of the two liquids
10. To study the variation of the viscosity of a given liquid with temperature using Ostwald's viscometer
11. To determine the surface tension of a liquid by drop number method
12. To determine the composition of mixture of two liquids by surface tension method
13. To determine the molecular weight of a given polymer by turbidimetry
14. To separate the amino acids from the mixture by electrophoresis
15. To separate the inorganic cations by paper electrophoresis

THEORY
Course Title: Spectroscopic Techniques
Course Code: CHE-IV. E-7
Name of Faculty: Dr.G. K. Naik
Maximum Marks: 75
Credits: 3

Course Objectives:
1. To learn the basic principles on interaction of electromagnetic radiation with matter and instrumentation basics.
2. To understand principles, instrumentation and applications of UV-Visible spectroscopy and atomic spectrometric methods.
3. To provide a practical approach to understand UV-Visible spectroscopy.

Learning outcome:
1. Will be able to understand the basic components of instruments and the choice of solvents for spectrometry.
2. Will be able to perform qualitative and quantitative analysis using principles of spectrometry.
3. Will be able to operate an UV-visible spectrophotometer.

1. General Introduction **15 L**

Overview of spectroscopy; meaning of electromagnetic radiation; interaction of electromagnetic radiation with matter; wave properties of electromagnetic radiation; particle properties of electromagnetic radiation; the electromagnetic spectrum; regions of spectrum; atomic and molecular spectra; representation of spectra; photons as a signal source; basic components of spectroscopic instruments; sources of energy; sources of electromagnetic radiation; sources of thermal energy; chemical sources of energy; wavelength selection; wavelength selection using filters; wavelength selection using monochromators; interferometers; detectors; photon transducers; thermal transducers; signal processors; solvents for spectrometry; quantitative calculations; spectrometric errors in measurements

2. UV Visible Spectroscopy: **20 L**

Beer's Law; Lambert's Law; Beer-Lambert's Law; Deviations from Beer-Lambert's Law; validity and limitations of Beer- Lambert's law; principles of instrumentation: Sources, monochromators, cells; types of instruments; photoelectric colorimeters: single and double beam photoelectric colorimeters; single and double beam spectrophotometers; comparison between colorimeter and spectrophotometer; analytical applications of colorimeter and spectrophotometer: λ_{max}, quantitative analysis, identification of structural groups in a molecule, study of co-ordination compound; photometric titrations; Theory of electronic (UV) spectroscopy; Electronic transitions in a molecule; Chromophores and auxochromes; Bathochromic, hypsochromic, hyperchromic and hypochromic shifts; solvent effect; effect of temperature; applications of UV and visible spectroscopy: identification of structural groups, cis-trans isomerism, chemical kinetics, qualitative and quantitative analysis; limitations of UV and visible spectroscopy.

3. Atomic Spectroscopy **10 L**

Origins of atomic spectra, production of atoms and ions; Atomic Emission Spectrometry: Introduction, principle, instrumentation, applications, advantages and limitations of flame photometry and Inductively coupled plasma spectroscopy; Atomic Absorption Spectrometry: Introduction, principle, instrumentation, applications, internal standard and standard addition calibration, limitations

Atomic Fluorescence Spectrometry: Introduction, principles, instrumentation and applications.

PRACTICALS
Course Title: Spectroscopic Technique/ Method
Course Code: CHE-IV. E-7
Name of Faculty: Dr.G. K. Naik
Maximum Marks: 25
Credit: 1

1. To test the validity of Beer-Lambert Law using spectrophotometer and determine the unknown concentration of a solution
2. To calibrate the UV- Visible spectrophotometer for control of absorbance and limit of stray light
3. Determination of Mn^{2+} ion concentration by periodate method using spectrophotometer
4. Determination of Fe^{3+} ion concentration by salicylic acid method using spectrophotometer
5. To verify the law of additivity of absorbance ($KMnO_4$ and $K_2Cr_2O_7$) at λ_{max} of $K_2Cr_2O_7$ and determine molar absorptivity
6. To verify the law of additivity of absorbance ($KMnO_4$ and $K_2Cr_2O_7$) at λ_{max} of $KMnO_4$ and determine molar absorptivity
7. To determine the amount of K_2CrO_4 present in given sample by using UV-Visible spectrophotometer
8. Spectrophotometric methods for determining the stoichiometry of a complex formed between iron and 1,10- phenanthroline by continuous variation method
9. Spectrophotometric methods for determining the stoichiometry of a complex formed between iron and 1,10- phenanthroline by mole ratio method
10. To determine the phosphate concentration in a soft drink by spectrophotometric method
11. To determine the dissociation constant of methyl red indicator by spectrophotometric method
12. To estimate the amount of nitrite in water sample by spectrophotometric method
13. To estimate the amount of paracetamol in tablet by spectrophotometric method
14. To estimate the amount of aspirin in the given tablet by spectrophotometric method
15. To determine the amount of Cr (VI) in the given solution as dichromate by least square method spectrophotometrically

TEXT BOOK:

Skoog, D. A., West, D. M., Holler F. J., Crouch, S. R., Fundamentals of Analytical Chemistry, 8th Edition

REFERENCE BOOKS:

1. Holler F. J., Skoog, D. A., Crouch, S. R., Principles of Instrumental Analysis, 6th Edition, Thomson Books
2. Willard, H.H., Merritt, L.L., Dean, J. A., Settle, F. A., Instrumental Methods of Analysis, CBS Publishing New Delhi, 7th Edition
3. Christian, G. D., Analytical Chemistry, John Wiley, 5th Edition
4. Ewing, G.W., Instrumental Methods of Chemical Analysis, 5th Edition, Mc-Graw Hill International Edition.

5. Bassett J., Denney R. C., Jeffrey G. H., Mendham J., Vogel's Text Book of Quantitative Inorganic Analysis, 4th Edition, ELBS and Longman

PRACTICAL BOOK:
Yadav, J. B., Advanced Practical Physical Chemistry, 14th Edition, Goel Publishing House

THEORY
Course Title: Chemistry of Natural Products
Course Code: CHE- IV. E-8
Name of Faculty: Dr. Sandesh T. Bugde
Maximum Marks: 75
Credits: 3

Course Objectives:

1. The main objective of this course is to study the Chemistry of Natural products.
2. This course focuses on different classes of natural products, their importance, properties, biogenesis and chemical synthesis.
3. This course will also focus on the techniques involve in natural product separation and characterisation in brief.

Learning outcome:

1. Students will learn about importance of natural product in day today life.
2. Students will learn different techniques used in isolation and characterisation of natural products.
3. Students will learn important chemical synthesis involved in natural product.

1. Introduction to Natural Product Chemistry **02 L**
Introduction to natural products and classifications of natural products

2. Isolation, purification and characterization techniques in natural products Chemistry **15 L**
Extraction methods in isolation/purification of natural products; Distillation techniques, Column chromatography for separation of natural products; Chromatographic techniques in natural products characterization: TLC, Mass spectrometry, spectroscopic techniques: IR, UV-Visible (Introduction, basic principle, utilization of techniques in identification of organic compounds).

3. Terpenes **10 L**
Occurrence, classification and isolation of terpenes; Menthol, Geraniol- Biogenesis, biosynthesis and chemical synthesis and Structure elucidation

4. Alkaloids **09 L**
Occurrence, Classification and isolation of alkaloids; Chemical synthesis and structure elucidation of selected alkaloids: Morphine and Nicotine.

5. Biomolecules of life **09 L**
Fats: Occurrence and composition; Hydrolysis of fats; Carbohydrates: Classification, nomenclature and uses; Amino acids: Classification, nomenclature and uses. Structures and classes of peptides and proteins; Nucleic acids: different types of nucleic acids, Nucleosides, nucleotides and structure of DNA.

PRACTICALS
Course Title: Chemistry of Natural Products
Course Code: CHE- IV. E-8
Name of Faculty: Dr. Sandesh T. Bugde

Maximum Marks: 25
Credit: 1

1. Synthesis of dilantin natural product from benzyl
2. Synthesis of 2-phenyl-3,1-benzoxazin-4-on from anthranilic acid
3. Identification of citric acid in lemon juice as calcium citrate
4. Conversion of calcium citrate to citric acid
5. Synthesis of Benzylideneacetophenone
6. Carotenoid extraction from tomato using a green solvent
7. Carotenoid extraction from carrot using a green solvent
8. To prepare isopentyl acetate from isopentyl alcohol and acetic acid by the Fischer esterification reaction
9. To prepare octyl acetate from octyl alcohol and acetic acid by the Fischer esterification reaction
10. To prepare ethyl butyrate from ethyl alcohol and butyric acid by the Fischer esterification reaction
11. To synthesize salicylic acid from methyl salicylate in wintergreen oil
12. To identify the natural products using Spectroscopic techniques such as Mass spectrometry, IR, UV spectroscopy
13. Synthesis of dihydropyrimidinone
14. Preparation of caffiec acid from 3, 4 dihydroxy benzaldehyde
15. Isolation of caffeine from tea leaves

TEXT BOOKS:

1. Nakanishi K., Natural Product Chemistry, Academic Press

REFERENCE BOOKS:

1. Manitto P., Biosynthesis of Natural Products, Horwood Ltd
2. Finar I. L., Textbook of organic Chemistry, Volume II
3. Finar I. L., Organic Chemistry: Stereochemistry and the Chemistry of Natural Products, ELBS Edition

SEMESTER V

CORE COURSE

THEORY
Course Title: Advanced Chemistry I: Physical and Inorganic Chemistry
Course Code: CHE- V. C-7
Marks: 75
Credits: 03

Course Objectives:

1. To provide a basic understanding of the core areas of Physical Chemistry based on the theme of electrochemistry, spectroscopy etc.

2. To obtain a comprehensive understanding of the basic concepts in Inorganic Chemistry.
3. To generally provide practical skills to correlate with the theory.

Learning outcome

1. Will have a working knowledge of the main areas of Physical Chemistry, will develop critical thinking abilities and be able to work in chemical or related fields.
2. Will help to get better understanding about the basics of Physical and Inorganic Chemistry.
3. Will be able to carry out experiments with required skills.

SECTION I (PHYSICAL CHEMISTRY)

UNIT I: Molecular Spectroscopy 7L

Definition of spectrum. Electromagnetic radiation, quantization of different forms of energies in molecules : translational, rotational and electronic, Born Oppenheimer approximation, factors affecting line width and intensity.

Infrared spectroscopy

Hook's law, energy levels and transitions: Simple harmonic oscillator, anharmonic oscillator (derivations expected), Calculation of force constant, Stretching and bending vibrations, modes of vibration of diatomic, linear triatomic (CO_2) and non linear triatomic (H_2O) molecules, applications of IR spectroscopy.

Raman spectroscopy- Rayleigh and Raman scattering, Stokes and Antistokes lines. Mutual exclusion principle. Differences between Raman and IR spectroscopy

Numerical problems expected

UNIT II: Photochemistry 4L

Interaction of radiation with matter, difference between thermal and photochemical processes, Laws of photochemistry: Grothus – Drapper law, Stark – Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non- radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions.

Numerical problems expected

UNIT III: Electrochemistry 7L

EMF of a cell and its measurements, concentration cells: electrode and electrolyte with and without transport, liquid junction potential and its measurement; applications of concentration cell: determination of ionic product of water, transport number of ions, solubility and solubility product.

Numerical problems expected

UNIT IV: Nuclear Chemistry 5L

Natural Radioactivity: kinetics of radioactive decay, half-life and average life of radioelements (derivations expected),

Measurement of radioactivity: GM counter, Scintillation counter

Artificial radioactivity: Chain reaction and conditions for its control.

Radioisotopes and their applications; radiolabelled reactions, radiocarbon dating, medicinal and agricultural field, hazards of radiation.

Numerical problems expected

SECTION II (INORGANIC CHEMISTRY)

UNIT V: Metal-Ligand Bonding in Transition Metal Complexes 11L

Principles and limitations of Valence bond theory, Crystal field theory (CFT) splitting of d- orbitals in octahedral, tetrahedral and square planar complexes. Crystal Field Stabilization Energy (CFSE), Measurement of 10 Dq for $[Ti(H_2O)_6]^{3+}$ complex, Factors affecting 10 Dq, Spectrochemical series, Effect of crystal field splitting on properties of Octahedral complexes: Magnetic, Spectral.

UNIT VI: Electronic spectra of Transition Metal Complexes: 11L

Introduction, types of electronic transitions: The d-d transitions (d^1/d^9 and d^2/d^8), charge transfer transitions and ligand-ligand transitions, selection rules (Laporte orbital and spin), applications (ligand field strength, colour of complexes, *cis*-, *trans*- isomerism and geometry of complexes).

PRACTICALS
Course Title: Advanced Chemistry I: Physical and Inorganic Chemistry
Course Code: CHE- V. C-7
Marks: 25
Credits: 01

List of experiments:
Physical Experiments: (Any three may be performed)

1. To determine the percent composition of acid mixture (weak acid and salt of weak base and strong acid) by titrating against standard 0.1N NaOH solution conductometrically.
2. To determine the strength of mixture containing weak acid (CH_3COOH) and weak base (NH_4OH) by titrating against standard 0.1N NaOH solution conductometrically.
3. To determine the formal redox potential of Fe^{2+}/Fe^{3+} system using standard 0.1N $K_2Cr_2O_7$ solution potentiometrically.
4. To determine the percent composition and amount of halide ions from their mixture (any two halides) using standard 0.1N $AgNO_3$ solution potentiometrically.
5. To determine the dissociation constant of weak monobasic acid (CH_3COOH) by titrating against standard 0.1N NaOH solution using pH meter.
6. To study the acid hydrolysis of ethyl acetate at two different temperatures and calculate the energy of activation.

Inorganic experiments: (Any three may be performed)

1. Preparations of the following complexes. (2hours each)
   a) $[Ni(NH_3)_6]Cl_2$
   b) $[Co(NH_3)_3(NO_2)_3$ Cl_3
   c) $K_3[Al(C_2O_4)_3].H_2O$
   d) Preparation and estimation of Ti in $[Ti(H_2O)_6]^{3+}$ complex.
2. Estimation of Ni in $[Ni(NH_3)_6]Cl_2$ gravimetrically
3. Estimation of Co in a cobalt complex gravimetrically

REFERENCE BOOKS:
Physical Chemistry
TEXTBOOK:

1. Bahl B.S, et.al, 2004, "Essentials of Physical Chemistry" S. Chand & Co., New Delhi

ADDITIONAL READING:

2. Arnikar H.J.,1995, "Essentials of Nuclear Chemistry", Wiely-Eastern Ltd., New Delhi
3. Atkins P, et.al, 2006,"Physical Chemistry", Oxford University Press, New Delhi
4. Castellan, G.W,2002, "Physical Chemistry", Narosa Publishing House, New Delhi,
5. Kundu K. et.al,2003, "Physical Chemistry", S. Chand & Co., Ltd., New Delhi
6. Puri B.R et.al,2008,"Principles of Physical Chemistry",Vishal Publishing Company, Jalandhar
7. Raj Gurdeep, 2000 ,"Advanced Physical Chemistry", Goel Publishing House, Meerut
8. Srivastava A.K, et.al, 1989,"Essential of Nuclear Chemistry", S.Chand & Co, New.Delhi

Inorganic Chemistry

TEXTBOOK:

1. Atkins P, Overton T, Rourke J et.al, *Shriver and Atkins' Inorganic Chemistry*, 5th Edition, Oxford University Press.

ADDITIONAL READING:

2. Cotton F.A and Wilkinson G, *Basic Inorganic Chemistry*,Wiley Eastern Ltd.
3. Huheey J.E, Keiter E.A, Keiter R.L, Medhi O.K, *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Edu.
4. Lee J.D, *Concise Inorganic Chemistry*, Wiley-India

SEMESTER V

ELECTIVE COURSES
THEORY
Course Title: Heterocyclic Chemistry
Course Code: CHE- V. E-9
Maximum Marks: 75
Credits: 03

Course Objectives:

4. The main objective of this course is to study the chemistry of heterocyclic compounds.
5. This course gives an overview of different classes of heterocyclic compounds.
6. It includes physical, chemical properties and synthesis of most of the heterocyclic compounds.

Learning outcome:

4. Students will learn about important aspects with respect to heterocyclic chemistry.
5. Students will develop understanding with regards to reactivity of heterocyclic chemistry.
6. Students will learn efficient chemical synthesis involved in heterocyclic compounds.

UNIT I: Introduction to heterocyclic compounds 03L

Classification and Nomenclature of aliphatic and aromatic heterocycles.

UNIT II: Aliphatic heterocycles **10L**

Structure and reactivity of nitrogen and oxygen containing aliphatic heterocycles. Methods of preparation and reactions of oxiranes, aziridines, tetrahydrofuran, pyrrolidine.

UNIT III: Five and six membered aromatic heterocycles **17L**

Structure and reactivity of five and six membered heterocycles: furan, pyrrole, thiophene and pyridine; comparison of basicity of pyrrole, pyridine & piperidine. Electrophilic substitution reactions of five and six membered heterocycles: General mechanism, mechanism of halogenation, nitration and reaction using acids (HCl, H_2SO_4 and HNO_3). Methods of preparation of furan, pyrrole, thiophene and pyridine. Nucleophilic substitution reactions of aromatic heterocycles.

UNIT IV: Condensed heterocycles **15L**

Structure and reactivity of condensed heterocycles like benzofuran, Indole, benzothiophene, quinoline and isoquinoline. Electrohilic and nucleophilic substitution reactions of condensed heterocyles: General mechanism and with examples. Oxidation and reduction of condensed hetero cylcles. Methods of preparation of benzofuran, Indole, benzothiophene, quinoline and isoquinoline.

PRACTICALS
Course Title: Heterocyclic Chemistry
Course Code: CHE- V. E-9
Marks: 25
Credits: 01

List of experiments: (Any 6)

1. Epoxidation of chalcones (2steps)
2. Synthesis of the Coumarins via Pechmann condensation
3. Synthesisof 3,4- dihydropyrimidin-2(1H)-ones by a one-pot three component cyclocondensation reaction of 1,3 dicarbonyl compound, aldehyde, and urea via Biginelli reaction
4. Synthesis of 1,3,5-trisubstituted pyrazoles (2steps)
5. Synthesis of benzimidazole from o-phenylenediammine and formic acid
6. Synthesis of 2-substituted benzoxazoles from 2-amino phenol and aromatic aldehydes.
7. Synthesis of quinoxaline derivatives
8. Synthesis of flavones via Baker-Venkataraman rearrangement (3steps)
9. Preparation of 2-phenyl indole via fischer indole synthesis

REFERENCES:

TEXT BOOK

1. Joule J. A. and Mills K. **2010.** "*Heterocyclic Chemistry*". Wiley publications

ADDITIONAL READING:

1. Carey, F. C. and Giuliano, R. M. **2000.** "*Organic Chemistry"* Tata McGraw-Hill India.
2. Gilchrist T. **2007.** "*Heterocyclic Chemistry"*. Pearson Education India
3. Smith, M. B and March, J . **2012.** " March's Advance organic Chemistry" Wiley publications.

THEORY
Course Title: Nanomaterials and Solid State Chemistry
Course Code: CHE-V. E-10
Maximum Marks: 75
Credits: 3

Course Objectives:
The main objective of this course is to study the chemistry of nanomaterials, their synthesis, properties and applications. It also provides fundamental knowledge of solid state chemistry which involves reaction of solids and their electrical and magnetic properties.

Learning outcome:
1. Students will have a basic and concise knowledge of nanomaterials.
2. Students will develop skills in nanomaterial synthesis.
3. Will be able to understand characterization techniques in solid state chemistry.

UNIT I: Introduction and properties of nanomaterials 6L
Fundamentals: terminology and history, classification of nanomaterials, properties of nanomaterials: optical, magnetic, electronic, surface area, catalytic and mechanical.

UNIT II: Synthesis and characterization of nanomaterials 10L
Synthesis Approach with at least one example of each: Chemical methods (sol-gel, hydrothermal, sonochemical, microwave, precursor). Top down and bottom up, physical methods (mechanical methods, methods based on evaporation, sputter deposition, chemical vapour deposition), biological methods (using microorganism and plant extract).
Characterization techniques: electron microscopic techniques (SEM/TEM), diffraction techniques, spectroscopic (UV-Visible, magnetic measurement), BET surface area.

UNIT III: Applications of nanomaterials 6L
Energy, automobiles, sports, textile, cosmetics, medicinal, space, defence, engineering and catalytic.
Toxicity of nanomaterials

UNIT IV: Solid state chemistry 11L
Reactions of solids: tarnish reactions, decomposition reaction, solid-solid reactions, addition reactions, double decomposition reaction, electron transfer reaction, solid-gas reactions. Sintering.
Phase transformations in solids: structural change in phase transformation, Martensite transformation, temperature and pressure induced transformations, order-disorder transitions.

UNIT V: Electrical and magnetic properties of solids 12L
Electrical conductivity, insulators, semiconductor and conductors. Band theory of semiconductors, photo conductivity and ionic conductivity.

Piezoelectric, ferroelectric materials and applications.

Introduction to magnetism, behavior of substance in a magnetic field, magnetic moments, diamagnetism, paramagnetism, experimental determinations of susceptibility, ferromagnetism, antiferromagnetism, ferrimagnetism, magnetizations of a ferromagnetic substance.

PRACTICALS
Course Title: Nanomaterials and Solid State Chemistry
Course Code: CHE-V. E-10
Maximum Marks: 25
Credits: 01

List of Practicals: (Any 8 practicals)

1. Synthesis of silver nanoparticles by chemical method.
2. Synthesis of ZnO nanomaterials.
3. Synthesis of CdS nanomaterials.
4. Synthesis of nanoparticles using plant extract (metal/ metal oxides).
5. To find out particle size using SEM/TEM data.
6. To study the X-ray diffraction pattern of given sample (Phase and particle size).
7. Preparation of zinc oxalate dihydrate and analysis of its TG/DTA pattern.
8. To prepare mixed metal oxide of Zn and Fe using co-precipitation technique.
9. To prepare mixed metal oxide of Zn and Fe using precursor technique.
10. Measurements of electrical and magnetic properties of pure and mixed metal oxides.

REFERENCE BOOKS:
TEXTBOOK:

1. Atkins P. W., Overton T. L., Rourke J. P., Weller M. T. and Armstrong F. A., *Shriver and Atkins Inorganic Chemistry*, Oxford University press.

ADDITONAL READING:

1. Keer H. V., *Principles of Solid State Chemistry*, New Age International Publishers,
2. Kulkarni S. K., *Nanochemistry, Principles and Practices*, Capital publishers.
3. Poole C. P. and Owens F. J., *Introduction to Nanotechnology*, John-Wiley and Sons.
4. Rao M. B. and Reddy K. K., *Introduction to Nanotechnology*, Campus books International.
5. West A. R., *Solid State Chemistry and its Applications*, John-Wiley and Sons.

THEORY
Course Title: Organometallic Chemistry
Course Code: CHE- V. E-11
Maximum Marks: 75
Credits: 03

Course Objectives:

To provide knowledge of fundamental content in the area of organometallic chemistry and impart practical skills so that the student will be able to integrate the knowledge with critical thinking to solve problems.

Learning outcome: Upon completion of the course, the student will be able to:

4. Use the basic principles of chemistry and molecular orbital theory to describe chemical bonding and structure of organometallic compounds and describe the structure and behaviour of organometallic compounds.
5. Explain and predict the chemical behavior and reactivity of organometallic compounds.
6. Describe and explain catalytic processes using an organometallic compound as a catalyst and explain how organometallic compounds are used as catalysts in organic synthesis.

UNIT I: Introduction to organometallic chemistry **08L** Definition, classification of organometallic compounds, Nomenclature, ligands, concept of hapticity of organic ligands, 18 electron rule, EAN concept, electron counting and oxidation states in complexes. General methods of preparation with one example of each (direct combination, reductive carbonylation, thermal and photochemical decomposition) and general properties of organometallic compounds of 3d series.

UNIT II: Metal carbonyls **10L** Classification of metal carbonyls; Mononuclear metal carbonyls: Preparation, properties, structure and bonding of $Ni(CO)_4$, $Fe(CO)_5$, $Cr(CO)_6$ using VBT; Polynuclear metal carbonyls: Preparation, properties, structure and bonding of $Co_2(CO)_8$, $Mn_2(CO)_{10}$, $Fe_2(CO)_9$ and $Fe_3(CO)_{12}$. π-acceptor behaviour of CO (MO diagram of CO), synergic effect and use of IR data to explain structure and bonding in metal carbonyls.

UNIT III: Metallocenes **09L** Sandwich compounds, Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation etc.). Structure and aromaticity, comparison of aromaticity and reactivity with benzene. Synthesis and reactivity of cyclopentadienyl compounds, bonding in bis(cyclopentadienyl) complexes, Fluxional behaviour of metallocenes. Metal-metal bonding and metal clusters: structure of clusters, electron counting in clusters, synthesis of clusters.

UNIT IV: Organometallic compounds of Main group elements **09L**
Preparation, properties, reactions and structure of alkyls and aryls of Group 1 elements (Li, Na); Group 2 elements (Be, Mg); Group 13 elements (B, Al)

UNIT V: Reactivity of organometallic compounds **09L**
Reactions of organometallic compounds: Ligand substitution, Oxidative addition and reductive elimination, σ-bond metathesis, 1,1-migratory insertion reactions, 1,2-insertions and β-hydride elimination. Catalysis by organometallic compounds: Alkene hydrogenation with Wilkinson's catalyst.

PRACTICALS
Course Title: Organometallic Chemistry
Course Code: CHE- V. E-11
Maximum Marks: 25
Credit: 01

List of practicals:
1. Synthesis of chloro(quinoline)cobaloxime
2. Synthesis of (phenyl)(pyridine)cobaloxime
3. Preparation of chloro(pyridine) *bis* (dimethylglyoximato) cobalt(III)
4. Preparation of bromo (pyridine) bis (dimethylglyoximato) cobalt (III)
5. Structure analysis of metal-carbonyls based on IR data.(4 hrs)
6. Metal complexes with triphenyl phosphine (minimum 4 hrs)
i. $Co(PPh_3)Cl_2.\ 2H_2O$
ii. $Ni(PPh_3)Cl_2.2H_2O$

REFERENCE BOOKS:

TEXTBOOK:

1. Atkins P, Overton T, Rourke J et.al, *Shriver and Atkins' Inorganic Chemistry*, 5^{th} Edition, Oxford University Press.

ADDITIONAL READING:

2. Cotton F.A and Wilkinson G, *Basic Inorganic Chemistry*,Wiley Eastern Ltd.
3. Huheey J.E, Keiter E.A, Keiter R.L, Medhi O.K, *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Edu.
4. Lee J.D, *Concise Inorganic Chemistry*, Wiley-India

SEMESTER VI

CORE COURSE

THEORY
Course Title: Advanced Chemistry II: Organic and Analytical Chemistry
Course Code: CHE- VI. C-8
Marks: 75
Credits: 03

Course Objectives:
1. To provide a basic understanding of the core areas of Organic and Analytical Chemistry.
2. To understand principles, techniques and applications of separation techniques
3. To use separation techniques for qualitative and quantitative analysis.

Learning outcome
1. Will learn to write mechanisms with stereochemistry.
2. Will learn principles of separation and its applications.
3. Will have practical knowledge of chromatographic techniques.
4. Will be able to carry out experiments with required skills.

SECTION I (ORGANIC CHEMISTRY)

UNIT I: Mechanism and stereochemistry of addition, substitution and elimination reactions 7L

Mechanism and stereochemistry of (i) Addition of halogens acids (HX) and halogen (X_2) to open chain alkenes. Markownikoff's and anti-Markownikoff's addition. (ii) S_N1, S_N2, S_Ni , substitutions and (iii) E1, E2 and E1cb elimination reactions.

UNIT II: Organic Compounds containing Nitrogen 6L

Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media. Picric acid: preparation and properties. Structure and nomenclature of amines, physical properties. Structural features affecting basicity of amines. Preparation of alkyl and aryl amines by reduction of nitro compounds and nitriles, reductive amination of carbonyl compounds, Gabriel phthalimide reaction and Hofmann rearrangement.

UNIT III: Carbohydrates 6L

Classification and nomenclature. Monosaccharides: General reactions. Configuration of monosaccharides with reference to glucose. d(+)/l(-) and D/L systems of nomenclature. Interconversion of glucose to fructose and glucose to mannose. Cyclic structure of D(+)glucose. Mechanism of mutarotation. Formation of glycosides, ethers and esters. Structure of sucrose and inversion of cane sugar.

UNIT IV: Chemistry of Organosulfur and organophosphorus compounds 4L

Nomenclature and classification of Organosulfur compounds. Methods of preparation and chemical reactions of thiols, disulfides and sulphonic acids. Nomenclature and classification of organophosphorus compounds. Preparation of phosphines. Phosphorous ylides and their general methods of preparation. Wittig reaction and its synthetic applications.

SECTION II (ANALYTICAL CHEMISTRY)

UNIT V: Solvent Extraction 05L

Principle, efficiency of extraction, percentage extraction, complexing agents in solvent extraction, separation factor, types of extraction, applications of solvent extraction

(Numericals expected)

UNIT VI: Chromatographic techniques 17L

Principle, classification of chromatographic techniques
Theory of chromatographic separation
Column Chromatography: Principle, technique and applications
Paper chromatography: Principle, technique and applications
Thin layer chromatography: Principle, technique and applications
Ion exchange chromatography: Principle, classification of ion exchangers. Factors affecting the distribution of ions between the resin and the solution, ion exchange capacity, applications of ion exchange chromatography
Gas chromatography: Principle, instrumentation, and applications. Comparison of GSC and GLC
HPLC: Principle, instrumentation and applications
Hyphenated techniques: GC-MS and LC-MS
(Numericals expected)

PRACTICALS
Course Title: Advanced Chemistry II: Organic and Analytical Chemistry
Course Code: CHE- I. C-8
Marks: 25
Credits: 01

List of experiments:

ORGANIC CHEMISTRY EXPERIMENTS:
Organic mixture separation, purification of individual compounds and qualitative analysis of separated compound. **(Any 06)**
Solid-solid, 03 mixtures
Solid-liquid, 02 mixtures
Liquid-liquid, 01 mixtures

Note: 0.5 gm of solid-solid mixture to be analyzed on small scale. 3-4 ml of liquid to be added in mixture.

ANALYTICAL CHEMISTRY EXPERIMENTS: (Any 4 experiments to be performed)
1. To separate metal ions by paper chromatography and determine retardation factor (4 hours)
2. To study separation of organic compounds by TLC (4 hours)
3. To estimate magnesium from Zn^{2+}/Mg^{2+} mixture by using an anion exchanger resin
4. To estimate zinc from Zn^{2+}/Mg^{2+} mixture by using an anion exchanger
5. To determine the equilibrium constant for the reaction $KI + I_2 = KI_3$ (4 hours)
6. To separate a mixture of carboxylic acid and neutral compound by using solvent extraction technique (4 hours)

REFERENCE BOOKS:
Organic Chemistry
TEXT BOOK

1. Morrison, R. T., etal. **2010.** "Organic Chemistry". Pearson Publications, Noida India.

ADDITIONAL READING

1. Bruice, P. Y. **2015**. “Organic Chemistry”. Pearson Publications, Noida India.
2. Carey, F. C., etal. **2012.** “Organic Chemistry”. Tata McGraw-Hill India.
3. Finar, I. L. **2013**. “Organic Chemistry”. Volume 1. Pearson Publications, Noida India.

ANALYTICAL CHEMISTRY

1. Christian, G. D. “Analytical Chemistry”. 5^{th} edition. John Wiley publications
2. Skoog D.A., West D. M. and Holler F. J.; Fundamentals of Analytical Chemistry, 4^{th} Saunders College Publishing

SEMESTER V

CORE COURSE

THEORY
Course Title: Advanced Chemistry I: Physical and Inorganic Chemistry
Course Code: CHE- V. C-7
Marks: 75
Credits: 03

Course Objectives:
1. To provide a basic understanding of the core areas of Physical Chemistry based on the theme of electrochemistry, spectroscopy etc.
2. To obtain a comprehensive understanding of the basic concepts in Inorganic Chemistry.
3. To generally provide practical skills to correlate with the theory.

Learning outcome
1. Will have a working knowledge of the main areas of Physical Chemistry, will develop critical thinking abilities and be able to work in chemical or related fields.
2. Will help to get better understanding about the basics of Physical and Inorganic Chemistry.
3. Will be able to carry out experiments with required skills.

SECTION I (PHYSICAL CHEMISTRY)

UNIT I: Molecular Spectroscopy **7L**
Definition of spectrum. Electromagnetic radiation, quantization of different forms of energies in molecules : translational, rotational and electronic, Born Oppenheimer approximation, factors affecting line width and intensity.
Infrared spectroscopy
Hook’s law, energy levels and transitions: Simple harmonic oscillator, anharmonic oscillator (derivations expected), Calculation of force constant, Stretching and bending vibrations, modes of vibration of diatomic, linear triatomic (CO_2) and non linear triatomic (H_2O) molecules, applications of IR spectroscopy.
Raman spectroscopy- Rayleigh and Raman scattering, Stokes and Antistokes lines. Mutual exclusion principle. Differences between Raman and IR spectroscopy
Numerical problems expected

UNIT II: Photochemistry **4L**

Interaction of radiation with matter, difference between thermal and photochemical processes, Laws of photochemistry: Grothus – Drapper law, Stark – Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non- radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions.
Numerical problems expected

UNIT III: Electrochemistry **7L**

EMF of a cell and its measurements, concentration cells: electrode and electrolyte with and without transport, liquid junction potential and its measurement; applications of concentration cell: determination of ionic product of water, transport number of ions, solubility and solubility product.

Numerical problems expected

UNIT IV: Nuclear Chemistry **5L**

Natural Radioactivity: kinetics of radioactive decay, half-life and average life of radioelements (derivations expected),
Measurement of radioactivity: GM counter, Scintillation counter
Artificial radioactivity: Chain reaction and conditions for its control.
Radioisotopes and their applications; radiolabelled reactions, radiocarbon dating, medicinal and agricultural field, hazards of radiation.

Numerical problems expected

SECTION II (INORGANIC CHEMISTRY)

UNIT V: Metal-Ligand Bonding in Transition Metal Complexes **11L**

Principles and limitations of Valence bond theory, Crystal field theory (CFT) splitting of d- orbitals in octahedral, tetrahedral and square planar complexes. Crystal Field Stabilization Energy (CFSE), Measurement of 10 Dq for $[Ti(H_2O)_6]^{3+}$ complex, Factors affecting 10 Dq, Spectrochemical series, Effect of crystal field splitting on properties of Octahedral complexes: Magnetic, Spectral.

UNIT VI: Electronic spectra of Transition Metal Complexes: **11L**

Introduction, types of electronic transitions: The d-d transitions (d^1/d^9 and d^2/d^8), charge transfer transitions and ligand-ligand transitions, selection rules (Laporte orbital and spin), applications (ligand field strength, colour of complexes, *cis*-, *trans*- isomerism and geometry of complexes).

PRACTICALS
Course Title: Advanced Chemistry I: Physical and Inorganic Chemistry
Course Code: CHE- V. C-7
Marks: 25
Credits: 01

List of experiments:
Physical Experiments: (Any three may be performed)

7. To determine the percent composition of acid mixture (weak acid and salt of weak base and strong acid) by titrating against standard 0.1N NaOH solution conductometrically.

8. To determine the strength of mixture containing weak acid (CH_3COOH) and weak base (NH_4OH) by titrating against standard 0.1N NaOH solution conductometrically.
9. To determine the formal redox potential of Fe^{2+}/Fe^{3+} system using standard 0.1N $K_2Cr_2O_7$ solution potentiometrically.
10. To determine the percent composition and amount of halide ions from their mixture (any two halides) using standard 0.1N $AgNO_3$ solution potentiometrically.
11. To determine the dissociation constant of weak monobasic acid (CH_3COOH) by titrating against standard 0.1N NaOH solution using pH meter.
12. To study the acid hydrolysis of ethyl acetate at two different temperatures and calculate the energy of activation.

Inorganic experiments: (Any three may be performed)

4. Preparations of the following complexes. (2hours each)
    e) $[Ni(NH_3)_6]Cl_2$
    f) $[Co(NH_3)_3(NO_2)_3\ Cl_3$
    g) $K_3[Al(C_2O_4)_3].H_2O$
    h) Preparation and estimation of Ti in $[Ti(H_2O)_6]^{3+}$ complex.
5. Estimation of Ni in $[Ni(NH_3)_6]Cl_2$ gravimetrically
6. Estimation of Co in a cobalt complex gravimetrically

REFERENCE BOOKS:

Physical Chemistry

TEXTBOOK:

9. Bahl B.S, et.al, 2004, "Essentials of Physical Chemistry" S. Chand & Co., New Delhi

ADDITIONAL READING:

10. Arnikar H.J.,1995, "Essentials of Nuclear Chemistry", Wiely-Eastern Ltd., New Delhi
11. Atkins P, et.al, 2006,"Physical Chemistry", Oxford University Press, New Delhi
12. Castellan, G.W,2002, "Physical Chemistry", Narosa Publishing House, New Delhi,
13. Kundu K. et.al,2003, "Physical Chemistry", S. Chand & Co., Ltd., New Delhi
14. Puri B.R et.al,2008,"Principles of Physical Chemistry",Vishal Publishing Company, Jalandhar
15. Raj Gurdeep, 2000 ,"Advanced Physical Chemistry", Goel Publishing House, Meerut
16. Srivastava A.K, et.al, 1989,"Essential of Nuclear Chemistry", S.Chand & Co, New.Delhi

Inorganic Chemistry

TEXTBOOK:

5. Atkins P, Overton T, Rourke J et.al, *Shriver and Atkins' Inorganic Chemistry*, 5th Edition, Oxford University Press.

ADDITIONAL READING:

6. Cotton F.A and Wilkinson G, *Basic Inorganic Chemistry*,Wiley Eastern Ltd.
7. Huheey J.E, Keiter E.A, Keiter R.L, Medhi O.K, *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Edu.
8. Lee J.D, *Concise Inorganic Chemistry*, Wiley-India

SEMESTER V

ELECTIVE COURSES
THEORY
Course Title: Heterocyclic Chemistry
Course Code: CHE- V. E-9
Maximum Marks: 75
Credits: 03

Course Objectives:

7. The main objective of this course is to study the chemistry of heterocyclic compounds.
8. This course gives an overview of different classes of heterocyclic compounds.
9. It includes physical, chemical properties and synthesis of most of the heterocyclic compounds.

Learning outcome:

7. Students will learn about important aspects with respect to heterocyclic chemistry.
8. Students will develop understanding with regards to reactivity of heterocyclic chemistry.
9. Students will learn efficient chemical synthesis involved in heterocyclic compounds.

UNIT I: Introduction to heterocyclic compounds **03L**

Classification and Nomenclature of aliphatic and aromatic heterocycles.

UNIT II: Aliphatic heterocycles **10L**

Structure and reactivity of nitrogen and oxygen containing aliphatic heterocycles. Methods of preparation and reactions of oxiranes, aziridines, tetrahydrofuran, pyrrolidine.

UNIT III: Five and six membered aromatic heterocycles **17L**

Structure and reactivity of five and six membered heterocycles: furan, pyrrole, thiophene and pyridine; comparison of basicity of pyrrole, pyridine & piperidine. Electrophilic substitution reactions of five and six membered heterocycles: General mechanism, mechanism of halogenation, nitration and reaction using acids (HCl, H_2SO_4 and HNO_3). Methods of preparation of furan, pyrrole, thiophene and pyridine. Nucleophilic substitution reactions of aromatic heterocycles.

UNIT IV: Condensed heterocycles **15L**

Structure and reactivity of condensed heterocycles like benzofuran, Indole, benzothiophene, quinoline and isoquinoline. Electrohilic and nucleophilic substitution reactions of condensed heterocyles: General mechanism and with examples. Oxidation and reduction of condensed hetero cylcles. Methods of preparation of benzofuran, Indole, benzothiophene, quinoline and isoquinoline.

PRACTICALS
Course Title: Heterocyclic Chemistry
Course Code: CHE- V. E-9
Marks: 25
Credits: 01

List of experiments: (Any 6)

10. Epoxidation of chalcones (2steps)
11. Synthesis of the Coumarins via Pechmann condensation
12. Synthesisof 3,4- dihydropyrimidin-2(1H)-ones by a one-pot three component cyclocondensation reaction of 1,3 dicarbonyl compound, aldehyde, and urea via Biginelli reaction
13. Synthesis of 1,3,5-trisubstituted pyrazoles (2steps)
14. Synthesis of benzimidazole from o-phenylenediammine and formic acid
15. Synthesis of 2-substituted benzoxazoles from 2-amino phenol and aromatic aldehydes.
16. Synthesis of quinoxaline derivatives
17. Synthesis of flavones via Baker-Venkataraman rearrangement (3steps)
18. Preparation of 2-phenyl indole via fischer indole synthesis

REFERENCES:

TEXT BOOK

2. Joule J. A. and Mills K. **2010.** "*Heterocyclic Chemistry*". Wiley publications

ADDITIONAL READING:

4. Carey, F. C. and Giuliano, R. M. **2000.** "*Organic Chemistry"* Tata McGraw-Hill India.
5. Gilchrist T. **2007.** "*Heterocyclic Chemistry"*. Pearson Education India
6. Smith, M. B and March, J . **2012.** " March's Advance organic Chemistry" Wiley publications.

THEORY
Course Title: Nanomaterials and Solid State Chemistry
Course Code: CHE-V. E-10
Maximum Marks: 75
Credits: 3

Course Objectives:
The main objective of this course is to study the chemistry of nanomaterials, their synthesis, properties and applications. It also provides fundamental knowledge of solid state chemistry which involves reaction of solids and their electrical and magnetic properties.

Learning outcome:
1. Students will have a basic and concise knowledge of nanomaterials.
2. Students will develop skills in nanomaterial synthesis.
3. Will be able to understand characterization techniques in solid state chemistry.

UNIT I: Introduction and properties of nanomaterials 6L
Fundamentals: terminology and history, classification of nanomaterials, properties of nanomaterials: optical, magnetic, electronic, surface area, catalytic and mechanical.

UNIT II: Synthesis and characterization of nanomaterials 10L
Synthesis Approach with at least one example of each: Chemical methods (sol-gel, hydrothermal, sonochemical, microwave, precursor). Top down and bottom up, physical

methods (mechanical methods, methods based on evaporation, sputter deposition, chemical vapour deposition), biological methods (using microorganism and plant extract).
Characterization techniques: electron microscopic techniques (SEM/TEM), diffraction techniques, spectroscopic (UV-Visible, magnetic measurement), BET surface area.

UNIT III: Applications of nanomaterials **6L**
Energy, automobiles, sports, textile, cosmetics, medicinal, space, defence, engineering and catalytic.
Toxicity of nanomaterials

UNIT IV: Solid state chemistry **11L**
Reactions of solids: tarnish reactions, decomposition reaction, solid-solid reactions, addition reactions, double decomposition reaction, electron transfer reaction, solid-gas reactions. Sintering.
Phase transformations in solids: structural change in phase transformation, Martensite transformation, temperature and pressure induced transformations, order-disorder transitions.

UNIT V: Electrical and magnetic properties of solids **12L**
Electrical conductivity, insulators, semiconductor and conductors. Band theory of semiconductors, photo conductivity and ionic conductivity.
Piezoelectric, ferroelectric materials and applications.
Introduction to magnetism, behavior of substance in a magnetic field, magnetic moments, diamagnetism, paramagnetism, experimental determinations of susceptibility, ferromagnetism, antiferromagnetism, ferrimagnetism, magnetizations of a ferromagnetic substance.

PRACTICALS
Course Title: Nanomaterials and Solid State Chemistry
Course Code: CHE-V. E-10
Maximum Marks: 25
Credits: 01

List of Practicals: (Any 8 practicals)
1. Synthesis of silver nanoparticles by chemical method.
2. Synthesis of ZnO nanomaterials.
3. Synthesis of CdS nanomaterials.
4. Synthesis of nanoparticles using plant extract (metal/ metal oxides).
5. To find out particle size using SEM/TEM data.
6. To study the X-ray diffraction pattern of given sample (Phase and particle size).
7. Preparation of zinc oxalate dihydrate and analysis of its TG/DTA pattern.
8. To prepare mixed metal oxide of Zn and Fe using co-precipitation technique.
9. To prepare mixed metal oxide of Zn and Fe using precursor technique.
10. Measurements of electrical and magnetic properties of pure and mixed metal oxides.

REFERENCE BOOKS:

TEXTBOOK:

2. Atkins P. W., Overton T. L., Rourke J. P., Weller M. T. and Armstrong F. A., *Shriver and Atkins Inorganic Chemistry*, Oxford University press.

ADDITONAL READING:

6. Keer H. V., *Principles of Solid State Chemistry*, New Age International Publishers,
7. Kulkarni S. K., *Nanochemistry, Principles and Practices*, Capital publishers.
8. Poole C. P. and Owens F. J., *Introduction to Nanotechnology*, John-Wiley and Sons.
9. Rao M. B. and Reddy K. K., *Introduction to Nanotechnology*, Campus books International.
10. West A. R., *Solid State Chemistry and its Applications*, John-Wiley and Sons.

THEORY
Course Title: Organometallic Chemistry
Course Code: CHE- V. E-11
Maximum Marks: 75
Credits: 03

Course Objectives:
To provide knowledge of fundamental content in the area of organometallic chemistry and impart practical skills so that the student will be able to integrate the knowledge with critical thinking to solve problems.

Learning outcome: Upon completion of the course, the student will be able to:

7. Use the basic principles of chemistry and molecular orbital theory to describe chemical bonding and structure of organometallic compounds and describe the structure and behaviour of organometallic compounds.
8. Explain and predict the chemical behavior and reactivity of organometallic compounds.
9. Describe and explain catalytic processes using an organometallic compound as a catalyst and explain how organometallic compounds are used as catalysts in organic synthesis.

UNIT I: Introduction to organometallic chemistry **08L** Definition, classification of organometallic compounds, Nomenclature, ligands, concept of hapticity of organic ligands, 18 electron rule, EAN concept, electron counting and oxidation states in complexes. General methods of preparation with one example of each (direct combination, reductive carbonylation, thermal and photochemical decomposition) and general properties of organometallic compounds of 3d series.

UNIT II: Metal carbonyls **10L** Classification of metal carbonyls; Mononuclear metal carbonyls: Preparation, properties, structure and bonding of $Ni(CO)_4$, $Fe(CO)_5$, $Cr(CO)_6$ using VBT; Polynuclear metal carbonyls: Preparation, properties, structure and bonding of $Co_2(CO)_8$, $Mn_2(CO)_{10}$, $Fe_2(CO)_9$ and $Fe_3(CO)_{12}$. π-acceptor behaviour of

CO (MO diagram of CO), synergic effect and use of IR data to explain structure and bonding in metal carbonyls.

UNIT III: Metallocenes **09L** Sandwich compounds, Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation etc.). Structure and aromaticity, comparison of aromaticity and reactivity with benzene. Synthesis and reactivity of cyclopentadienyl compounds, bonding in bis(cyclopentadienyl) complexes, Fluxional behaviour of metallocenes. Metal-metal bonding and metal clusters: structure of clusters, electron counting in clusters, synthesis of clusters.

UNIT IV: Organometallic compounds of Main group elements **09L**
Preparation, properties, reactions and structure of alkyls and aryls of Group 1 elements (Li, Na); Group 2 elements (Be, Mg); Group 13 elements (B, Al)

UNIT V: Reactivity of organometallic compounds **09L**
Reactions of organometallic compounds: Ligand substitution, Oxidative addition and reductive elimination, σ-bond metathesis, 1,1-migratory insertion reactions, 1,2-insertions and β-hydride elimination. Catalysis by organometallic compounds: Alkene hydrogenation with Wilkinson's catalyst.

PRACTICALS
Course Title: Organometallic Chemistry
Course Code: CHE- V. E-11
Maximum Marks: 25
Credit: 01

List of practicals:
1. Synthesis of chloro(quinoline)cobaloxime
2. Synthesis of (phenyl)(pyridine)cobaloxime
3. Preparation of chloro(pyridine) *bis* (dimethylglyoximato) cobalt(III)
4. Preparation of bromo (pyridine) bis (dimethylglyoximato) cobalt (III)
5. Structure analysis of metal-carbonyls based on IR data.(4 hrs)
6. Metal complexes with triphenyl phosphine (minimum 4 hrs)
i. $Co(PPh_3)Cl_2 . 2H_2O$
ii. $Ni(PPh_3)Cl_2 . 2H_2O$

REFERENCE BOOKS:

TEXTBOOK:

5. Atkins P, Overton T, Rourke J et.al, *Shriver and Atkins' Inorganic Chemistry*, 5th Edition, Oxford University Press.

ADDITIONAL READING:

6. Cotton F.A and Wilkinson G, *Basic Inorganic Chemistry*,Wiley Eastern Ltd.

7. Huheey J.E, Keiter E.A, Keiter R.L, Medhi O.K, *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Edu.
8. Lee J.D, *Concise Inorganic Chemistry*, Wiley-India

SEMESTER VI

ELECTIVE COURSE
THEORY
Course Title: Spectroscopic Methods in Organic Chemistry
Course Code: CHE-VI. E-13
Maximum Marks: 75
Credits: 03

Course Objectives:

4. To understand the importance of spectroscopy in organic chemistry.
5. To understand principles and applications of UV-Visible spectroscopy, IR Spectroscopy, Nuclear Magnetic Resonance and Mass Spectrometry.
6. To learn structure elucidation of organic compounds based on spectral data.

Learning outcome:

4. Will be able to do spectral analysis of organic compounds.
5. Will learn theory of important spectroscopic techniques.
6. Will be able to elucidate structures of organic compounds based on spectral data.
7. Will be able to operate an UV-visible spectrometer.

UNIT I: Introduction to spectroscopy **3L**

Nature of electromagnetic radiation: wave length, frequency, energy, amplitude, wave number, and their relationship, different units of measurement of wavelength frequency, different regions of electromagnetic radiations, Regions of electromagnetic radiation. Interaction of radiation with matter: absorption, emission, fluorescence and scattering, types and advantages of spectroscopic methods.

UNIT II: UV-Visible Spectroscopy **07L**

Ultraviolet (UV) absorption spectroscopy: Absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophores and auxochromes, bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated dienes and enones, Woodward-Fieser rules for calculation of UV maxima of the above two systems.
Numerical problems expected

UNIT III: Infra Red (IR) absorption spectroscopy **09L**

Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, functional group region, finger print region and its use to establish identity, applications to determine purity, to study progress of chemical reactions and hydrogen bonding. Characteristic absorptions bands of various functional groups and interpretation of IR spectra of organic compounds. Structure elucidation by using UV and IR spectral data is expected.

UNIT IV: Proton Magnetic Resonance (^{1}H NMR) spectroscopy 13L

Introduction to NMR Spectroscopy, types of protons: equivalent, non-equivalent, homotopic, enantiotopic and diastereotopic protons, NMR Spectrometer (block diagram), nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, intensity of peaks, interpretation of ^{1}H NMR spectra of simple organic molecules. Structure elucidation of organic compounds using ^{1}H NMR spectral data is expected.

UNIT V: ^{13}C Nuclear Magnetic Resonance 06L

Number of signals, splitting of signals, proton coupled and decoupled spectra, off resonance decoupled spectra. ^{13}C NMR chemical shifts, identification of hybridization of carbons and nature of functionalization. Structure elucidation of organic compounds using ^{13}C NMR spectral data is expected.

UNIT VI: Mass Spectrometry 07L

Instrumentation, definitions of parent or molecular ion peak and base peak. Isotope effect with respect to alkyl halides. Fragmentation of ketones: α-cleavage and Mc-Lafferty rearrangement.
[Structure elucidation of organic compounds using Mass, UV, IR, ^{1}H NMR and ^{13}C NMR spectral data is expected]

PRACTICALS
Course Title: Spectroscopic Methods in Organic Chemistry
Course Code: CHE-VI. E-13
Maximum Marks: 25
Credits: 01

List of experiments: (Any 10)

1. Calculate UV maxima for given organic structure and match it with the given spectra of organic compounds.
2. Match the given set of organic compounds with the given set of spectra. List: Alkane, alkene, alcohol, ether, amine, carboxylic acid, ester and amides.
3. Verify Bathochromic, hypsochromic, hyperchromic and hypochromic shifts in phenol and aniline using UV-Vis spectrometer.
4. Identification of organic compounds based on given IR spectra of organic compounds.
5. On basis of IR spectra, distinguish between the given set of organic compounds. (set of 2 compounds × 3).
6. Identify the compounds based on given Mass Spectra. List: Alkane, alkene, alcohol, ether, amine, carboxylic acid, ester and amides.
7. Give the fragmentation patterns for the given mass spectra of organic compounds.
8. Compare relative abundance of isotopes of halogen containing compound.
9. Determination of organic compound using given set of ^{1}H NMR data.
10. Determination of organic compound using given ^{1}H NMR spectrum.

11. Assigning the chemical shift values to the peaks of given ^{1}H NMR spectrum of organic compounds.
12. Determination of organic compound using given set of ^{13}C NMR data.
13. Assigning the chemical shift values to the peaks of given ^{13}C NMR spectrum of organic compounds.
14. Assigning the chemical shift values to the peaks of given ^{1}H NMR spectrum of organic compounds.
15. Identification of organic compounds based on given spectroscopic information.

REFERENCE BOOKS:

TEXTBOOKS:

1. Silverstein, R. M., et. al. **2015.** **"***Identification of Organic Compounds*". Wiley publications

REFERENCE:

1. Kalsi, P. S. **2007.** **"***Spectroscopy of Organic compounds*". New Age International (P) Ltd. New Delhi.
2. Morrison, R. T., et. al. **2010.** **"***Organic Chemistry*". Pearson Publications, Noida India.
3. Pavia, D. L., et. al. **2008**. "*Introduction to Spectroscopy"*. Cengage Learning.
4.

THEORY
Course Title: Environmental Chemistry
Course Code: CHE-VI. E-14
Maximum Marks: 75
Credits: 03

Course Objectives:
1. To provide a basic interdisclipinary introduction to environmental challenges
2. To obtain a comprehensive understanding of the basic concepts in analytical instrumental techniques
3. To generally provide practical skills to correlate with the theory.

Learning outcomes
The course provides understanding how:
1. pollution affects our environment
2. knowledge of chemistry can be used to solve problems.
3. instrumental techniques can be used for chemical analysis of pollutants.

UNIT I: Introduction **7L**
Atmosphere: Composition, Structure, properties vertical temperature behavior, lapse rate and temperature inversion.

a) **Air pollution**: Introduction, classification of pollutants, sources, control, effect w.r.t. oxides of Nitrogen, Carbon and Sulphur, Photochemical smog, acid rain and Green House effect
b) **Water pollution**: Chemical, physical and biological characteristics of water pollution, sp ecific and Nonspecific characterization of water. DO, BOD, COD and chlorine demand, typical water treatment and waste water treatment. Importance of buffer and buffer index in waste water treatments.

UNIT II: Sampling of Pollutants 5L

Sampling of air pollutants**:**

a) Absorption in liquids
b) Adsorption on solids: cold trapping adsorption and collection of particulates.

Sampling of water pollutants: sampling and sample preservation.
Sampling of solids: sample size, equipment and methods of sampling, Auger sampler, tube sampler.

UNIT III: Chemistry of atmosphere and soil 7L

Reactions in the atmosphere: a) formation in the atmosphere b) reaction of hydroxyl radical with trace gases and as sources of hydroperoxy radical and hydrogen peroxide.
The methane cycle.
Macro- and micro-nutrients in soil (N, P,K), chemistry of minerals of soil forming rocks.
Toxic elements in soil including those are in trace quantities.
Pollutants in soil

UNIT IV: Adverse effects of specific pollutants 3L

Effects of Hg, Pb and nitrites on humans and other living organisms.
Oil Spill: Biological and physical effects.
Acid, mine and drainage: Reactions of FeS_2 (pyrites), Cr, As and F.

UNIT V: Ozone Chemistry 06L

Major atmospheric species involved in ozone formation and destruction.
Some major chemical reactions in the troposphere associated with ozone.
Stratospheric ozone: pollutants destroying stratospheric ozone layer
Species destroying ozone layer: a) catalytic NO, b) photo dissociation of CFCs, c) catalytic role of chlorine, and d) combined chain reaction
The ozone holes

UNIT VI: Techniques of water treatment and solid waste management 7L

a) Treatment of water for municipal purpose: important process involved in purification of water.
b) Treatment of water for Industries: removal of hardness of water Clark's method, use of ion exchange resins. Solid waste management
c) Classification of solid wastes, types of waste of origin.
d) Solid waste management method: (i) Utilisation, (ii) Recovery, (iii) Reuse (iv) Recycling of wastes/ residues, (v) Recycling avoidance of solid waste.
e) Use of Remote Sensing in Environmental Management**.**

UNIT VII: Optical and radiochemical techniques **3L**

1. Turbidimetry and Nephelolmetry: introduction, basic principle
2. Isotope dilution analysis: principle and applications
3. Neutron activation analysis: principle and applications

UNIT VIII: Application of instrumental techniques in environmental and chemical analysis **7L**

1. Air analysis: (a) SO_2, (b) H_2S, c) CO d) CO_2 and (e)NOx
2. Water analysis: a) determination of organic loadings b) determination of toxic metal ions c) C.O.D d) B.O.D and e) D.O.
3. Soil/Sediment analysis:
   a) Bulk density, b)Specific gravity, c) Moisture content d) Water holding capacity e) Conductivity f) Alkalinity, and g) detection of Sulphate, calcium and iron

PRACTICALS
Course Title: Environmental Chemistry
Course Code: CHE-VI. E-14
Maximum Marks: 25
Credits: 01

List of Practicals: (Any TEN may be performed)

1. Determination of sodium in water: ion exchange method
2. Determination of Total solids, Total dissolved solids and total suspended solids and its significance.
3. Determination of chloride content in tap water samples: Mohr's method
4. Determination of acidity and alkalinity in water samples.
5. Determination of total, permanent and temporary hardness of water sample
6. Determination of DO of water sample
7. Determination of polluting elements such as Pb, Hg and As in water.
8. Analysis of Mn in a water sample by visual titrimetry/Spectrophotometry.
9. Analysis of different types of soil- pH, conductivity, alkalinity
10. Determination of nitrite in water : colorimetric method
11. Determination of COD of water samples
12. Determination of BOD of water samples
13. Determination of phosphate: Colorimetric method

REFERENCE BOOKS:

1. Christan G. D., 5th edition ,"Analytical Chemistry ", Wiley publication
2. De, A. K,1995 "Environmental Chemistry", Wiley eastern Ltd.
3. Iqbal,S.A.et.al,1995," Chemistry of Air and Air Pollution", Discovery Publishing House, New Delhi
4. Katyal Jimmy et.al, 1993,"Environmental Pollution", Anmol Publications, New Delhi
5. Manahan, S.E. 1994,"Environmental Chemistry" Lewis Publishers
   Neil,P. O 2007,"Environmental Chemistry", Blackie Academic & Professional
6. Raghuraman, K.et al,4th edition," Basic Principles of Analytical Chemistry",sheth publishers

7. Schroede, E.D,1997, "Water & waste water treatment", Mc. Graw Hill
8. Skoog et.al, 4th International edition ,"Principles of Analytical Chemistry"
9. Trivedi P.R. et.al, 1st edition"Environmental Water and Soil Analysis",
10. Akashdeep Publishing House, New Delhi
11. Tyagi, O.D. et.al, 1992,"A Text Book Of Environmental Chemistry" Anmol Publications, New Delhi
12. Vanloon G.W. et.al, 2003,"Environmental Chemistry", Oxford University Press

THEORY
Course Title: Selected Topics in Inorganic Chemistry
Course Code: CHE- VI. E-15
Maximum Marks: 75
Credits: 03

Course Objectives:
To provide knowledge of fundamental content in various areas of inorganic chemistry and impart practical skills so that the student will be able to integrate the knowledge with critical thinking to solve problems.

Learning outcome: Upon completion of the course, the student will be able to:

10. encourage students to analyze and integrate concepts relevant to graduate level Inorganic chemistry.
11. understand the bond formation of compounds with special reference to MOT and CFT.

UNIT I: Inorganic Polymers **8L**
Definition, properties, classification (condensation, addition and coordination), preparation, structure and bonding and applications of polymers containing Boron (borazine), phosphorous (phosphazenes), silicon (silicones), sulfur (S_4N_4, thiazyl halides).

UNIT II: Magnetic Properties of Transition Metal Complexes **7L** Types of magnetic behaviour, magnetic susceptibility, effect of temperature on magnetic properties, Curie temperature, Neel temperature, Curie-Weiss law. Methods of determining magnetic susceptibility, Guoy's balance, spin only formula, calculation of magnetic moment of transition metal ions, application of magnetic moment data for 3d-metal complexes.

UNIT III: Thermodynamic and Kinetic Aspects of Metal Complexes **12L**

Thermodynamic and kinetic stability of metal complexes, equilibrium constants, formation constants, lability, inert complexes, factors affecting the stability, substitution reactions in tetrahedral and octahedral complexes. Electron transfer reactions- inner sphere mechanism and outer sphere mechanism, Trans effect with respect to square planar complexes.

UNIT IV: Materials Chemistry **10L**
Zeolites: types, structure and applications.
Composite materials: Metal-organic frameworks (MOF's); structure, ligands, applications.
Molecular materials: Fullerides, liquid crystals, molecular magnets.

Superconductors: discovery, critical temperature, Meissner effect, types of superconductors. Corrosion: response of material to chemical environments, galvanic corrosion and other forms of corrosion. Prevention methods.

UNIT V: Molecular Symmetry **8L**

Symmetry elements and operations: Centre of symmetry, Rotation axis, Mirror plane, rotation-reflection axis, Identity element. Point groups, Identifying symmetry elements and point group in molecules. (examples to be solved)

PRACTICALS
Course Title: Selected Topics in Inorganic chemistry
Course Code: CHE- VI. E-15
Maximum Marks: 25
Credit: 01

List of practicals

1. Separation and Determination of transition metal ions
    a) Separation of Mg^{2+} and Zn^{2+} by ion exchange and its estimation (4 hrs)
    b) Separation of Cd^{2+} and Zn^{2+} by ion exchange and its estimation (4 hrs)
2. Determination of stability constant of complex ions in solution
    a) Fe(III) – salicylic acid complex (Job's Method)
    b) Fe(II) – 1,10-phenanthroline
3. Determination of instability constant for the reaction between Ag^{+} and NH_3
4. Determination of instability constant for the reaction between Cu^{2+} and en
5. Estimation of Ca in compounds containing calcium.
6. Estimation of Ni in compounds containing nickel.
7. Estimation of Cu in compounds containing copper.
8. Estimation of metal ions in mixed metals compound.

REFERENCE BOOKS:

TEXTBOOKS:

1. Atkins P, Overton T, Rourke J et.al, *Shriver and Atkins Inorganic Chemistry*, Oxford University Press.

ADDITIONAL READING:

1. Lee J.D, *Concise Inorganic Chemistry*, Wiley-India
2. Huheey J.E, Keiter E.A, Keiter R.L, Medhi O.K, *Inorganic Chemistry: Principles of structure and reactivity*, Pearson Edu., 1993
3. Cotton F.A and Wilkinson G, *Basic Inorganic Chemistry*,Wiley Eastern Ltd, 1993
4. Puri B.R, Sharma L.R, Kale K.C, *Principles of Inorganic Chemistry*, Vallabh Publications.

Parvatibai Chowgule College of Arts and Science
(Autonomous)

DEPARTMENT OF CHEMISTRY

COURSE STRUCTURE

THREE YEAR B.Sc. DEGREE COURSE IN CHEMISTRY

SEMESTER	CORE COURSES		ELECTIVE COURSES				SKILL ENHANCEMENT COURSE
I	CHE-I. C-1 General Physical and Inorganic Chemistry	CHE-I. C-2 General Organic and Inorganic Chemistry	---	---	---	---	
II	CHE-II. C-3 Concepts in Physical and Analytical Chemistry	CHE-II. C-4 Concepts in Organic and Inorganic Chemistry	---	---	---	---	
III	CHE-III. C-5 Comprehensive Chemistry –I (Physical & Inorganic Chemistry)	---	CHE-III. E-1 Name Reactions and Synthetic Methodologies	CHE-III. E-2 Industrial Chemistry	CHE-III. E-3 Surface Chemistry and Catalysis	CHE-III. E-4 Bioinorganic Chemistry	CHE-III.SEC-1 Skill Development in Chemistry
IV	CHE-IV. C-6 Comprehensive Chemistry –II (Organic and Analytical chemistry)	---	CHE-IV. E-5 Pharmaceutical Chemistry	CHE-IV. E-6 Polymer and Colloid Science	CHE-IV. E-7 Spectroscopic Techniques	CHE-IV. E-8 Chemistry of Natural Products	
V	CHE-V. C-7 Advanced Chemistry – I (Physical & Inorganic Chemistry)	---	CHE-V. E-9 Heterocyclic Chemistry	CHE-V. E-10 Nanomaterials and Solid State Chemistry	CHE-V. E-11 Organometallic Chemistry		
VI	CHE-VI. C-8 Advanced Chemistry – II (Organic and Analytical chemistry)	---	CHE-VI. E-13 Spectroscopic Methods in Organic Chemistry	CHE-VI. E-14 Environmental Chemistry	CHE-VI. E-15 Selected Topics in Inorganic Chemistry		

ELECTIVE COURSE

THEORY
Course Title: Introduction to Industrial Chemistry
Course Code: CHE-III.E-2
Maximum Marks: 75
Credits: 3
Theory: 45 Lectures

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Describe the importance of catalysts in industrial processes.
CO2: Explain the composition of various materials such as alloys, glass, etc. and understand the process of corrosion and its prevention.
CO3: Discuss several common industrial processes such as halogenations, nitration and sulphonation.
CO4: Classify and discuss boilers, heat exchangers and paints.
CO5: Describe diverse effluent treatments for waste management and apply the knowledge of safety in industries.

Learning Objectives: The main objective of this course is to study the selected key industrial processes, waste management, properties of selected solid materials and industrial safety.

Unit I: Fundamentals of industrial chemicals and need for greener processes **04L**
Relevance of catalysis in modern industrial processes.

Unit II: Materials Science **08L**
A. Mechanical properties of materials and change with respect to temperature
B. Metals and alloys – important metals and alloys
C. Glass – types, composition, manufacture, physical and chemical properties applications.
D. Corrosion – various types of corrosion relevant to chemical industry – Mechanism, Preventive methods.

Unit III: Introduction to electroplating **04L**
Introduction: definition, fundamental principles- Faraday's laws, mechanism of deposition, surface preparation for electroplating of Zinc and Tin. Testing of electrodeposits: for thickness, adhesion, stress and corrosion. Use of Hull cell in plating.

Unit IV: Selected key industrial processes **08L**
Halogenation: Introduction, type of halogenation reactions, halogenating agents, kinetics and mechanism of halogenation, manufacturing of chloroethane, chlorobenzene, chloral.
Nitration: Introduction, type of nitration reaction, nitrating agents, kinetics and mechanism of nitration, manufacturing of nitrobenzene and p-nitroacetanilide.
Sulphonation: Introduction, type of sulphonation reaction, sulphonating agents, mechanism of sulphonation reaction, commercial sulphonation of benzene and alkyl benzene.
Physico chemical principles involved in the manufacture of HNO_3 (Ostwald's method) and NH_3 (Haber's method).

Unit V: Boilers and heat exchangers **04L**
Introduction, classification and applications of boilers and heat exchangers.

Unit VI: Paint chemistry **03L**
Introduction, general classification, composition, characteristics and applications of paints.

Unit VII: Industrial Safety and Conducts **08L**
Meaning of industrial safety, industrial accidents, industrial hazards, MSDS and safety programme.
Process Safety: a) Chemical reaction hazards: Fundamental understanding, various instruments used to understand chemical reaction hazards. b) Fire and Explosion Hazards: Fundamental understanding, various instruments used to understand fire and explosion hazards.

Unit VIII: Effluent treatment and waste management **06L**
Principles and equipments for aerobic, anaerobic treatment, adsorption, filtration, sedimentation, bag filters, electrostatic precipitators, mist eliminators, wet scrubbers, absorbers, solid waste management and reverse osmosis.

PRACTICALS
Course Title: Introduction to Industrial Chemistry
Course Code: CHE-III.E-2
Maximum Marks: 25
Credits: 1

List of experiments: (Any 6)
1. Preparation of 1-nitronaphthalene from naphthalene (Nitration)
2. Preparation of 2,4,6-tribromophenol from phenol (Bromination)
3. Preparation of 4-hydroxybenzenesulphonic acid from phenol (Sulphonation)
4. Electroplating of Ni or Cu
5. Electroless plating of Ni or Cu
6. Effect of pH and salinity on rate of corrosion of iron/steel
7. Formation of thin films of metals or alloys
8. Synthesis of common industrial compounds involving two step reactions: phthalic acid to phthalic anhydride (minimum 4 hours)
9. To prepare crystals of potash alum, $K_2SO_4.Al_2(SO_4)_3.24\ H_2O$, from Aluminium foil
10. Ore analysis: calcium from limestone (minimum 4 hours)
11. To estimate the amount of copper by spectrophotometric method

TEXT BOOK:

1. Sharma, B. K. *Industrial Chemistry* (06 Ed.). Goel Publishing House, Meerut.

REFERENCE BOOKS:

1. Bentley, J. et. al. **2011** *Introduction to paint chemistry and principles of paint technology* (04 Ed.). Springer Nethetlands.
2. Cotton, F. A. et. al. *Basic Inorganic Chemistry* (02 Ed.). Wiley Eastern Ltd.
3. De, A. K. *Environmental Chemistry* Wiley Eastern Limited.
4. Foye, A. O. *Principles of Medicinal Chemistry* Publication Philadephia.
5. Frederick, A. L. **1974** *Modern Electroplating* (03 Ed.). J. Wiley and sons Inc. New York.
6. Iqbal, S. A. et. al. *Chemistry of Air and Air Pollution* Discovery Publishing House, New Delhi.
7. Korolkovas, A. et. al. *Essentials of Medicinal Chemistry* Wiley - Interscience.
8. Lednicer, D. et. al. *Organic Chemistry of Drugs Synthesis* Wiley Interscience.
9. Lee, J. D. *Concise Inorganic Chemistry* (05 Ed.). Wiley Blackwell Science Publications.
10. Naseer, K. **2004** *Electroplating- Basic Principles, Processes and Practice* (01 Ed.). Elsevier.
11. Singh, P. P. et. al. *An Introduction to Synthetic Drugs* Himalaya Publication, Bombay.
12. Terrance, H. I. **1970** *The Chemical Analysis of Electroplating Solutions* Chemical Publishing Co. New York 1970.
13. Tyagi, O. D. et. al. *A Text Book of Environmental Chemistry* Anmol Publications, New Delhi.
14. Wilson, C. O. et. al. *Textbook of Organic Medicinal and Pharmaceutical Chemistry*
Lippincott - Toppan.

Note: Wherever possible, latest edition of the prescribed books are to be used.

ELECTIVE COURSE

THEORY
Course Title: Pharmaceutical Chemistry
Course Code: CHE- IV. E-5
Maximum Marks: 75
Credits: 3
Theory: 45 lectures

Course Outcomes:
On successful completion of the course, the student will be able to**:**
1. Outline the significance of terminologies and regulation in Pharmaceutical chemistry.
2. Classify pharmacological drugs.
3. Delineate the medicinal chemistry in plants.
4. Define and apply different types of chromatographic techniques in pharmaceutical industry.
5. Understand the working of quality control and quality.
6. Discuss Safety in Pharmaceutical laboratories.

Learning outcomes:
1. Students will learn about important aspects with respect to pharmaceutical Chemistry.
2. Students will develop understanding in structure-activity relationship.
3. Students will learn efficient chemical synthesis involved in important drug.

Unit I: General Introduction **05 L**
Importance of Chemistry in Pharmacy, Definition of terminologies: Pharmacology: Pharmacokinetics, Pharmacodynamics; Pharmacognosy, Dosage forms and Routes of administration, Advantages and disadvantages. Pharmacopoeia

Unit II: Regulation and Authorities **05 L**
Introduction to different regulatory bodies and their role: WHO, Therapeutic Goods Administration(TGA), Medicines and Health care products Regulatory Agency (MHRA), Central Drugs Standard Contol Organisation (CDSCO),UNICEF, USFDA, Food and Drug act 1945, Good Automated Manufacturing Practices (GAMP), State Licensing Authority
Requirement of regulation: 21CFR part 11, Electronic Signature and Password control, ICH, (Different guideline and scope), CGMP & Schedule M

Unit III: Pharmacological classification of Drugs **04 L**
Anti-Infective agents, anti-diabetic agents, anti-cancer agents, anti-pyretic agents, antipsychotic agents, Antacids, Analgesics, CNS Depressants, CNS stimulants, Anti histaminic agents, Diuretics, anti-malarial, antibiotics, adrenergic agents, cholinergic agents, Cardiovascular drugs, Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) (Definition of each class, any two examples with structure)

Unit IV: An introduction to the Medicinal Chemistry of plants **04 L**
Historical background; Type of plant, active ingredient structure and their medicinal properties: Capsicum, Garlic, turmeric.

Unit V: Introduction to Chromatography **06 L**
Column chromatography, Paper Chromatography, HPLC, Gas chromatography

Unit VI: Quality Control **10 L**
Introduction, Quest for Quality, Role of QC, Good Laboratory Practices (GLP), Standards: Reference Standard, Primary standard, Working standard.
Raw Material Testing: Solubility, Acidity /Alkalinity, Chloride, Sulphate, LOD, Sulphated ash, Loss on ignition, Heavy metals, Karl-fischer titration.
Finished Product Testing: Dimension, Weight variation, Hardness, Dissolution, Identification, Assay, Uniformity of content, Stability Testing, Different conditions for stability testing, Dissolution, Related substances Handling of “Out Of Specifications”, ‘Out Of Trend’, Laboratory Incidences, Root cause analysis, Corrective action and Preventive Action. Facing audits: Roles, Responsibilities and ensuring compliances.
Data integrity and its challenges

Archiving of results – introduction

Unit VII: Quality Assurance **08 L**

Introduction: Role of QA, Standard Operating procedure, Change control, Deviation, Market complaints, Master production record (Batch card) , Audit, Drug Master File (DMF), Complaints & adverse reactions, Labels & printed materials, Documentation & records, Distribution records

Validation: Method Validation, Types of Analytical Procedures to be Validated; Accuracy, Precision (Repeatability, Intermediate Precision, Reproducibility), Specificity, Detection Limit, Quantitation Limit, Linearity, Range, Robustness.

Process validation,

Unit VIII: Safety in Pharmaceutical laboratories **03 L**

Introduction, Risks in a pharmaceutical Laboratory, Personal Protective Equipment (PPE), General preparation for Emergencies, Laboratory Emergencies: Spills and Fires.

PRACTICALS
Course Title: Pharmaceutical Chemistry
Course Code: CHE- IV. E-5
Maximum Marks: 25
Credits: 1

List of experiments:(Any 7-8 practicals may be conducted)

1. Complete Pharmacopoeial analysis of drugs: a) Paracetamol b) Ibuprofen c) Aspirin
2. Synthesis of Benzocaine
3. Synthesis of benzophenone oxime.
4. Synthesis of phenytoin
5. Estimation of acetyl salicylic acid in the given aspirin tablet by titrating against 0.1N alcoholic KOH potentiometrically.
6. UV Absorbance Standard Curve of Salicylic Acid
7. Assay of Nitrazepam potentoimetrically.
8. Estimation of Ascorbic acid in tablets by iodometry.
9. Calibration of UV-visible spectrophotometer
10. Estimation of Penicillin – G.
11. Estimation of Chloramphenicol.

TEXT BOOK:

1. Skoog Douglas A., Leary James J. (1992). *Principles of Instrumental Analysis* (04 ed.). Philadelphia: Saunders College Publishing.
2. Beale John Jr., Block John (2010). *Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry* (12 ed.). Baltimore: Lippincott Williams and Wilkins.

REFERENCES:

1. Indian Pharmacopoeia Commission. (2007). Indian Pharmacopoeia 2007.
2. Prichard Elizabeth, B. V. (2007). *Quality Assurance in Analytical Chemistry*. John Wiley & Sons.
3. Beckett A.H., Stenlake J.B.(2001). *Practical Pharmaceutical Chemistry* (04 ed.). London: The Athlone Press.
4. Christian, G. D. (2004). *Analytical Chemistry* (06 ed.). New Jersey: John-Wiley & Sons, Inc.
5. Prabhu D.V, Raghuraman K, (2014). *Basic Principles of Analytical Chemistry* (05 ed.). Mumbai: Sheth Publishers.
6. Lednicer Daniel, Mitscher Lester (2008). *The Organic Chemistry of Drug Synthesis* (01 ed.). New Jersey: John-Wiley & Sons, Inc.
7. Gennaro, A. R. (1995). *Remington: The Science and Practice of Pharmacy* (19 ed.). London: Mack Publishing Company.
8. Sharma, D. B. (2005). *Instrumental Methodsof Chemical Analysis* (24 ed.). Meerut: Goel Publishing House. Higuchi T., E. B.-H. (1961). *Pharmaceutical Analysis.* New York: Interscience Publishers.

SKILL ENHANCEMENT COURSE

Course Title: Skill Development in Chemistry
Course Code: CHE-III.SEC-1
Maximum Marks: 60
Credits: 4

Course outcomes: On successful completion of the course the students will be able to:

CO1: Determine the saponification value, iodine value and acid values of oils and test the adulterants in food items.

CO 2: Apply the skills for the preparation of white phenyl and liquid soap.

CO 3: Apply the knowledge for the safe disposal of white phenyl.

CO4: Understand the chemistry of soaps, synthetic detergents, alkyl and aryl sulphonates and Floor cleaners.

CO5: Determine the pH of soft drinks and other beverages.

CO6: Understand the chemistry of food additives and adulterants and apply the knowledge for detecting and testing foods items for adulterants.

Learning objectives:

1. To understand the chemistry of fats, oils and the process involved in preparing soaps, detergents and disinfecting agents and provide necessary skills for the preparation.

2. To study the composition and chemical parameters of commonly consumed beverages like soft drinks and packed fruit juices, the process involved in their preservation and their long term effects on human health.

3. To study the various food additives like food colours, taste enhancers, preservatives, etc. and their effects on food and health. Food adulteration of commonly used kitchen ingredients like wheat, rice, dal, milk, butter, etc. and the tests involved to detect the adulterants will be studied.

1. Fats & Oils, **(03L)**
Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides. Hydrogenation of unsaturated oils. Saponification value, iodine value and acid value of oils.

2. Soaps, Detergents & Disinfecting agents **(04L)**
Soaps, synthetic detergents, alkyl and aryl sulphonates, floor cleaners- preparation, storage and disposal of white phenyl.

3. Beverages **(02L)**
Soft drinks, soda, fruit juices and alcoholic beverages (Types and content of alcohol). Composition of soft drinks, and its excessive use leading to urinary bladder stones. Preservation in tetrapack. Nitrogen preservation and packing of fruit juices.

4. Food Additives and Adulterants **(06L)**
Food additives: Artificial sweeteners-saccharin, cyclomate, asparatame; food flavours-esters, aldehydes and heterocyclic compounds. Food colours-Restricted use, spurious colours. Emulsifying agents, preservatives and leavening agents- Baking powder, Yeast. Taste enhancers- MSG, vinegar.
Food Adulteration: Contamination of wheat, rice, dal, milk, butter, etc. with clay, sand, stone,

water and toxic chemicals. Food poisons: natural poisons (alkaloids, nephrotoxins), pesticides (DDT, BHC, Follidol), Heavy metal (Hg, Pb, Cd) contamination of sea food.

Practicals: (45 hours)

1. Preparation of household/floor cleaner. (12 hrs)

2. Preparation of detergent powder or liquid soap. (13 hrs)

3. Determination of Iodine number and saponification value of oils. (6 hrs)

4. To analyze the pH of different soft drinks using pH meter (6hrs)

5. Test for adulterants in food items (turmeric powder, chilli powder, vanaspati in ghee,starch in milk, etc.) (8 hrs)

References:

1. Battershall, J. P. **(2017).** *Food Adulteration and its detection*, ebook.

2. Belitz, H. D. etal. (2009). *Food Chemistry*. 4th edition, Springer.

3. Branen, A. L. etal. **(2002).** *Food Additives*. 2nd edition, Marcel Dekker, Inc.,

4. Fennema, O. R. **(1996).** *Food Chemistry*, Marcel Decker Inc., New York.

5. Madan, R. L. **(2011)**. *Chemistry for Degree Students: T.Y.BSc. Students*, 2nd edition. S. Chand Publications.

PROGRAMME OUTCOMES

Programme Outcomes (PO)	Short Title of the POs	Description of the Programme Outcomes Graduates will be able to :
PO-1	Problem Analysis and Solutions	Think critically, identify, analyze problems/ situations and further attempt to design/ develop solutions that meet the specified goals.
PO-2	Use of Technology	Apply appropriate IT tools efficiently in their daily activities of communication and academics.
PO-3	Environment and Sustainability	Analyze and attempt solutions to environmental issues and commit themselves to sustainable development in the local/ national and global context.
PO-4	Ethics	Recognize and understand professional ethics /human values and be responsible for the same.
PO-5	Individual and Team work	Function effectively at various levels, capacities and situations.
PO-6	Communication	Communicate proficiently (oral and written) as a responsible member of society.
PO-7	Research Aptitude	Understand general research methods and be able to analyse, interpret and derive rational conclusions.
PO-8	Life Skills	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of domain specific change.

PROGRAMME SPECIFIC OUTCOMES (PSO)

On Successful completion of the BSc Chemistry programme, the students will be able to

PSO-1	Acquire the skills in preparation of chemical solutions, inorganic complexes, planning the procedures and performing experiments in the laboratory.
PSO-2	Handle scientific instruments like spectrophotometer, pH meter, Conductometer, Potentiometer, etc.
PSO-3	Develop basic theoretical principles of chemistry and writing skills applicable for higher studies and research
PSO-4	Operate efficiently within a group during their project and assignments and hence develop important skills such as communication, negotiation, influence, advising and interpreting
PSO-5	Appreciate the central role of chemistry in our society by understanding the safe handling of chemicals, environmental issues and key issues faced in energy, health and medicine.
PSO-6	Elucidate various spectra, X Ray Diffractograms, TG-DTA curves and identify surface morphology by SEM/TEM images.

On successful completion of the course, the student will be able to

	Course Code	Course Title	Course Outcomes
1.	CHE-I.C-1	General Physical and Inorganic Chemistry	**CO1 :** Demonstrate and evaluate the rate and order of a reaction. **CO2 :** Utilize mathematical concepts to solve chemical problems. **CO3 :** Develop expertise in the preparation of chemical solutions based on normality, molarity and molality. **CO4 :** Interpret the PV isotherms of gases and identify the critical temperature. **CO5 :** Delineate atomic structure, periodic table and covalent bonding. **CO6 :** Sketch hybridization and molecular orbital diagrams.
2.	CHE-I.C-2	General Organic and Inorganic Chemistry	On successful completion of the course, the student will be able to: **CO1 :** Name the organic compounds using IUPAC nomenclature. **CO2 :** Identify and classify the different organic reactions. **CO3 :** Apply the theoretical knowledge to synthesize alkanes and alkenes. **CO4 :** Write 3D structures of organic molecules using 2D surface. **CO5 :** Identify the given unknown organic compound by carrying out various chemical tests.
3.	CHE-II.C-3	Concepts in Physical and Analytical Chemistry	On successful completion of the course, the student will be able to: **CO1:** Describe the basic concepts of thermodynamics and its applications. **CO2 :** Interpret the pressure temperature diagrams in unary and binary systems. **CO3 :** Explain the concept of surface tension and viscosity in liquids. **CO4 :** Explain role of analytical chemistry in sciences, calculations based on chemical stoichiometry. **CO5 :** Sketch titration curves and solve numericals. **CO6 :** Explain theory on precipitation and complex formation titrations.
4.	CHE-II.C-4	Concepts in Organic and Inorganic chemistry	On successful completion of the course, the student will be able to: **CO1 :** Categorize the compounds as aromatic, non-aromatic and anti-aromatic. **CO2 :** Apply the theoretical knowledge to write the synthesis of alkynes, alkyl halides, aromatic compounds. **CO3 :** Discuss and describe the steps involved in the mechanism of nitration, sulphonation, halogenation and Friedel Crafts reactions of aromatic compounds. **CO4 :** Explain and outline the different properties of transition elements. **CO5 :** Compare 4d and 5d analogues.

			CO6 : Describe crystalline solids in terms of their structure, ionic radii and coordination. **CO7 :** Interpret crystal structures. **CO8 :** Describe lattice energy, Born-Haber's cycle, Fajan's rule and defects in solids. **CO9 :** Explain trends in periodic properties of d-block elements with respect to their ionic radii, oxidation state, spectral properties, magnetic properties. **CO10 :** Describe crystalline solids in terms of their structure, ionic radii and coordination there by able to interpret crystal structure.
5.	CHE-III.C-5	Comprehensive Chemistry-I (Physical & Inorganic Chemistry)	On successful completion of the course, the student will be able to: **CO1 :** Understand Second and Third law of Thermodynamics **CO2 :**Calculate equilibrium constant and formulate conditions for maximum yield in industrial processes **CO3 :** Explain theory of strong and weak electrolytes. **CO4 :** Explain trends in periodic properties of f-block elements with respect to its size of atoms or ions, reactivity, oxidation state, complex formation, colour, magnetic properties. **CO5 :** Name coordination compounds and to able to draw the structure based on its name. **CO6 :** Describe the shape and structures of coordination complexes based on different coordination numbers. **CO7 :** Explain merits and demerits of different theories of acids and bases and to explain the properties of a solvent that determines their utility.
6.	CHE-IV.C-6	Comprehensive Chemistry-II (Organic & Analytical Chemistry)	On successful completion of the course, the student will be able to: **CO1 :** Identify and classify diverse organic compounds containing C, H and O elements. **CO2 :** Predict the chemical reactivities of several organic compounds containing CHO elements. **CO3 :** Outline the preparations of several compounds belonging to different classes of organic compounds having CHO elements. **CO4 :** Apply the important reactions involved in each class of organic compounds with CHO elements. **CO5 :** Design scheme for an analytical process. **CO6 :** Use proper techniques of sampling of solids, liquids & gases. **CO7 :** Apply statistical treatment to analytical data.
7.	CHE-V.C-7	Advanced Chemistry-I: Physical and Inorganic Chemistry	On successful completion of the course, the student will be able to: **CO1:** Understand the interactions of electromagnetic radiation and matter in IR and Raman spectroscopy and their applications. **CO2 :** Explain applications and harmful effects of nuclear radioisotopes.

			CO3 : Demonstrate a sound knowledge of the photochemistry principles and their application. **CO4 :** Employ the theories that govern metal ligand bonding. **CO5 :** Interpret the types of crystal field splitting and calculate the crystal field stabilization energy. **CO6 :** Discuss the types of d-d transitions and its theory.
8.	CHE-VI.C-8	Advanced Chemistry-II: Organic and Analytical chemistry	On successful completion of the course, the student will be able to: **CO1 :** Assess conditions for obtaining maximum efficiency of extraction. **CO2 :** Classify chromatographic methods. **CO3 :** Apply chromatographic method for separation, qualitative and quantitative estimation. **CO4 :** Predict the stereochemistry of products for various reactions using the mechanisms involved in the course. **CO5 :** Explain the reactivity of organic compounds containing nitro, amino and cyano functional groups. **CO6 :** Name and classify the carbohydrates and analyze its chemical reactivities. **CO7 :** Name and classify the organosulfur and organophosphorous compounds and analyze its chemical reactivities. **CO8 :** Apply the important reactions involved for the synthesis of other similar compounds.
9.	CHE-III.E-1	Name Reactions and Synthetic Methodologies	On successful completion of the course, the student will be able to: **CO1 :** Describe condensation reactions involving nucleophilic addition to carbonyl compounds. **CO2 :** Define and describe various name reactions and rearrangements along with their mechanisms. **CO3 :** Predict the product for various reactions involving these name reactions/rearrangements. **CO4 :** Apply these mechanisms towards the formation of complex molecules. **CO5 :** Discuss and describe the steps involved in the mechanism of Friedel-Crafts reactions, Reimer-Tiemann reaction, Vilsmeier-Haack reaction, Gattermann-Koch reaction and Kolbe-Schmidt reaction. **CO6 :** List the different oxidising and reducing agents. **CO7 :** Apply the theoretical knowledge to identify the reagents used to bring about a particular chemical reaction.
10.	CHE-III.E-3	Surface Chemistry and Catalysis	**Course Objectives:** On successful completion of the course, the student will be able to: **CO1 :** Understand the behavior of solid surfaces. **CO2 :** Differentiate between surface energy and surface tension in case of solids. **CO3 :** Classify and interpret various types of adsorption isotherms. **CO4 :** Estimate surface area of a solid.

			CO5 : Predict the mechanistic behavior of catalytic reactions. **CO6 :** Evaluate conditions under which a catalysed reaction changes rate dependence.
11.	CHE-III.E-4	Bioinorganic Chemistry	On successful completion of the course, the student will be able to: **CO1 :** Elucidate the role of metal ions that are involved in different processes like oxygen transport, electron-transfer reactions etc. in biological systems. **CO2 :** Apply the concepts of coordination chemistry to metallobiomolecules which are based on iron and copper ions. **CO3 :** Evaluate the role of metal centres in the metalloenzymes that are involved in the catalysis of various biological reactions and thus predict the reaction mechanisms. **CO4 :** Develop skills to prepare model systems which mimic the role of metal ions in biological systems. **CO5 :** Discuss the importance of essential and trace elements in biological processes and evaluate their role in biology. **CO6 :** Explain the biologically important compounds like proteins, carbohydrates etc. and to interpret their biological importance. **CO7 :** Compare different mechanisms of ion transport across cell membrane and classify different biomolecules which help in the transport of ions and to illustrate PS-I and PS-II approach of photosynthesis. **CO8 :** Analyze how metals are used as diagnostic agents and application of Au, Cu, Zn, Pt-complexes as anti-cancer drug and in medicine.
12.	CHE-IV.E-5	Pharmaceutical Chemistry	On successful completion of the course, the student will be able to: **CO1 :** Understand the significance of chemistry in Pharmaceutical chemistry. **CO2 :** Develop an understanding of the physico-chemical properties of drugs. **CO3 :** Explain molecular mechanism of drug action and metabolism. **CO4 :** Draw comparison between medicinal chemistry and pharmaceutical chemistry. **CO5 :** Synthesize some of the important drugs reported in literature. **CO6 :** Identify and define the drug classes and some pharmacological properties.
13.	CHE-IV.E-6	Polymer and Colloid Science	On successful completion of the course, the student will be able to: **CO1 :** Distinguish between different types of solutions in terms of solute dimensions. **CO2 :** Evaluate properties of colloids. **CO3 :**.Explain properties of gels and emulsions. **CO4 :** Calculate molecular weight of a polymer. **CO5 :** Design synthesis of a polymer. **CO6 :** Measure molecular weight of a polymer. **CO7 :** Understand solid state properties of

			polymers.
14.	CHE-IV.E-7	Spectroscopic Techniques	On successful completion of the course, the student will be able to: **CO1 :** Outline and interpret the deviation from Beer-Lambert's Law and to identify the validity and limitations. **CO2:** Interpret the spectroscopic methods for qualitative and quantitative analysis; discuss the principle instrumentation; compare the Colorimeter and Spectrophotometer and employ UV-Visible Spectrophotometer. **CO3:** Outline the principle on which inductively coupled plasma spectroscopy works and illustrate the instrumentation involved in the technique. **CO4:** Employ inductively coupled plasma spectroscopy technique and identify its limitations.
15.	CHE-V.E-9	Heterocyclic Chemistry	On successful completion of the course, the student will be able to: **CO1 :** Identify, name and classify the various heterocyclic compounds. **CO2 :** Describe the structure, different reactions and preparations of selected nitrogen and oxygen containing aliphatic heterocycles. **CO3 :** Describe the structure, diverse reactions and syntheses of pyrrole, furan, thiophene and pyridine heterocycles. **CO4 :** Describe the structure, diverse reactions and synthetic routes with mechanisms of numerous condensed heterocycles. **CO5 :** Predict the reactivities of complex heterocyclic compounds containing the structural motif of these simple heterocycles. **CO6 :** Apply the synthetic methodologies for the synthesis of complex heterocycles.
16.	CHE-V.E-10	Nanomaterials and Solid State Chemistry	On successful completion of the course, the student will be able to: **CO1 :** Recall the history, occurrence and technological development of nanomaterials and classify them. **CO2 :** Compare different synthesis techniques of nanoparticles like biological, chemical and physical and design various nanomaterials. **CO3 :** Evaluate XRD data, and calculate its parameters; carry out analysis of TG-DTA curves; assess morphology and particle size from SEM/TEM images. **CO4 :** Express the physical and chemical properties of solids like magnetic, electrical and dielectric and interpret the applications of materials in various field like catalysis, ferrofluids, etc.
17.	CHE-V.E-11	Organometallic Chemistry	On successful completion of the course, the student will be able to: **CO1 :** Illustrate metal-ligand interaction in formation of different metal carbonyls based on valence bond theory. **CO2 :** Explain and rationalize the synthesis,

			structure, bonding, properties of organometallic compounds of main group elements. **CO3 :** Apply the EAN concept and Wade's rules to any organometallic system and predict its stability, structure and bonding. **CO4 :** Understand the chemical behavior and predict the reaction mechanism of organometallic compounds. **CO5 :** Illustrate the catalytic cycles using an organometallic compound as a catalyst for industrial synthesis of some organic compounds. **CO6 :** Interpret IR spectra of metal carbonyls and predict their structure.
18.	CHE-VI.E-13	Spectroscopic Methods in Organic Chemistry	On successful completion of the course, the student will be able to: **CO1 :** Describe the principles of IR, UV and Mass spectroscopy. **CO2 :** Calculate UV maxima of any given organic compound using Woodward-Fieser rules. **CO3 :** Predict the presence of various functional groups in a given organic compound using IR spectroscopy. **CO4 :** Interpret the mass spectra of various organic compounds. **CO5 :** predict the structures of organic compounds based on the given ^{1}H NMR and ^{13}CMR data. **CO6 :** interpret the ^{1}H NMR and ^{13}CMR spectra of organic compounds.
19.	CHE-VI.E-14	Environmental Chemistry	On successful completion of the course, the student will be able to: **CO1 :** Delineate how pollutants are transported and accumulated in the environment. **CO2 :** Recognize different types of toxic substances and analyze toxicology. **CO3 :** Describe water purification and waste treatment processes. **CO4 :** Apply knowledge of chemical and biochemical principles of fundamental environmental processes in air, water, and soil. **CO5 :** Apply basic chemical concepts to analyze chemical processes involved in different environmental problems. **CO6 :** Develop skills in procedures and few instrumental methods applied in analysis of soil and water pollution.
20.	CHE-VI.E-15	Selected Topics in Inorganic Chemistry	On successful completion of the course, the student will be able to: **CO1 :** Differentiate between thermodynamic stability and kinetic stability and apply it to transition metal complexes. **CO2 :** Apply the concepts to determine the reaction mechanism of transition metal complexes. **CO3 :** Determine the factors that govern the stability and lability of transition metal complexes. **CO4 :** Illustrate the chemistry and function of some of the technologically useful materials like liquid crystals, superconductors and fullerides.

			CO5 : Understand the properties and classify the polymers **CO6 :** Explain the preparation, structure and bonding and applications of polymers comprising of B, P, Si and S. **CO7 :** Analyze the magnetic properties of the transition metal complexes as well as interpret the effect of temperature on magnetic properties. **CO8 :** Determine the magnetic susceptibility by using Guoy's balance. **CO9 :** Identify and apply the symmetry elements in molecules and to evaluate the Point groups in molecules with appropriate examples.

ANNEXURE A

(Summary of changes incorporated in the syllabus)

Semester	Course Title	Existing (Indicate only the unit where the change is proposed)	Changes Proposed	Specify the reason for the change
III	Industrial Chemistry	All units	Redesigning of the syllabus	Suggested by the academic council to meet the requirements of the Industry
IV	Pharmaceutical Chemistry	All units	Redesigning of the syllabus	Suggested by the academic council to meet the requirements of the Industry

Parvatibai Chowgule College of Arts and Science
(Autonomous)

DEPARTMENT OF CHEMISTRY

COURSE STRUCTURE 2019 - 2020

THREE YEAR B.Sc. DEGREE COURSE IN CHEMISTRY

SEMESTER	CORE COURSES		ELECTIVE COURSES				SKILL ENHANCEMENT COURSE
I	CHE-I. C-1 General Physical and Inorganic Chemistry	CHE-I. C-2 General Organic and Inorganic Chemistry	---	---	---	---	---
II	CHE-II. C-3 Concepts in Physical and Analytical Chemistry	CHE-II. C-4 Concepts in Organic and Inorganic Chemistry	---	---	---	---	---
III	CHE-III. C-5 Comprehensive Chemistry –I (Physical & Inorganic Chemistry)	---	CHE-III. E-1 Name Reactions and Synthetic Methodologies	CHE-III. E-2 Introduction to Industrial Chemistry	CHE-III. E-3 Surface Chemistry and Catalysis	CHE-III. E-4 Bioinorganic Chemistry	CHE.SEC-1 Skill Development in Chemistry
IV	CHE-IV. C-6 Comprehensive Chemistry –II (Organic and Analytical chemistry)	---	CHE-IV. E-5 Pharmaceutical Chemistry	CHE-IV. E-6 Polymer and Colloid Science	CHE-IV. E-7 Spectroscopic Techniques	CHE-IV. E-8 Chemistry of Natural Products	CHE. SEC-2 Plating and corrosion CHE. SEC-3 Laboratory Techniques in Organic Chemistry
V	CHE-V. C-7 Advanced Chemistry – I (Physical & Inorganic Chemistry)	---	CHE-V. E-9 Heterocyclic Chemistry	CHE-V. E-10 Nanomaterials and Solid State Chemistry	CHE-V. E-11 Organometallic Chemistry	---	---
VI	CHE-VI. C-8 Advanced Chemistry – II (Organic and Analytical chemistry)	---	CHE-VI. E-13 Spectroscopic Methods in Organic Chemistry	CHE-VI. E-14 Environmental Chemistry	CHE-VI. E-15 Selected Topics in Inorganic Chemistry	---	---

The Syllabi of the following undergraduate courses:

SEMESTER- I

CORE COURSE

THEORY

Course Title: General Physical and Inorganic Chemistry (Theory) [with effect from June 2020].
Course Code: CHE- I. C-1
Marks: 75
Credits: 3
Duration: 45 hours

Course Objectives:
1. Will have a working knowledge of the main areas of Physical Chemistry, will develop critical thinking abilities and be able to work in chemical or related fields.
2. Will help to get better understanding about the basics of Physical and Inorganic Chemistry.
3. Will be able to carry out experiments with required skills.

Course Outcomes:
CO1: Demonstrate and evaluate the rate and order of a reaction.
CO2: Utilize mathematical concepts to solve chemical problems.
CO3: Develop expertise in the preparation of chemical solutions based on normality, molarity and molality and study kinetics of chemical reactions.
CO4: Interpret the PV isotherms of gases and identify the critical temperature.
CO5: Delineate atomic structure, periodic table and covalent bonding.
CO6: Sketch hybridization and molecular orbital diagrams.

SECTION- I (PHYSICAL CHEMISTRY)

Unit I: Mathematical Preparations for Chemists **06 hours**
Logarithmic relations curve sketching: linear graphs, and calculation of slopes. Differentiation of functions: Kx, e^x (exponential), sin x, log x, maxima and minima. Integration of some useful functions.

Unit II: Chemical Kinetics **08 hours**
Rate of reaction, factors influencing rate of the reaction- concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates. Zero, first, second order kinetics. Half life and average life. Determination of order of reaction: Integrated rate equation method, graphical method, differential method, half-life method and isolation method. Effect of temperature on the rate of the reaction, Arrhenius equation and concept of activation energy.
(Numerical expected)

Unit III: Solid State **08 hours**
Introduction, difference between crystalline and amorphous solids, laws of crystallography: law of constancy of interfacial angles, law of symmetry and law of rationality of indices, Symmetry and crystal systems, elements of symmetry, introduction to point groups, lattice and unit cells, The Bravais lattices, the seven crystal systems, Miller and Weiss indices. Bragg's equation, Inter planar distance.
(Numerical expected)

Unit IV: Gaseous State **08 hours**
Gas laws (to introduce), Ideal gas equation, compressibility factor, PV isotherms of real gases. kinetic molecular theory of gases, its postulates and derivation of kinetic gas equation. the van der Waal's equation of state. Berthelot Equation (derivation not expected). qualitative discussion of the Maxwell's distribution of molecular velocities. Critical phenomena: relationship between critical constants and van der Waal's constants, the law of corresponding states and reduced equation of state, Joule-Thomson effect Liquefaction of gases
(Numerical expected)

SECTION- II (INORGANIC CHEMISTRY)

Unit V: Atomic Structure and the Periodic Table **05 hours**

Atomic spectra of hydrogen, Bohr's model of hydrogen atom, probability picture of electron, dual nature of electrons, Heisenberg uncertainty principle, Schrodinger wave equation, quantum numbers, shapes of s, p, d, orbitals, Aufbau and Pauli exclusion principles, Hund's rule of maximum multiplicity, sequence ofenergy levels and arrangement of elements in groups in the periodic table, periodic trends and effective nuclear charge.

Unit VI: Covalent Bonding **10 hours**

Covalent bond: Valence Bond Theory (VBT) and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions, Valence Shell Electron Pair Repulsion Theory (VSEPR) applied to NH_3, H_3O^+, SF_4, ClF_3, ICl_2^- and H_2O, Molecular Orbital Theory, homonuclear and heteronuclear diatomic molecules(CO and NO), multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

PRACTICALS
Course Title: General Physical and Inorganic Chemistry (Practicals) [with effect from June 2020].
Course Code: CHE- I. C-1
Marks: 25
Credits: 1
Duration: 30 hours

List of experiments:
PHYSICAL CHEMISTRY

1. Preparation of standard solutions based on normality, molarity, molality. Also further dilutions from a standard solution to a volume of 50 mL.
2. To investigate the order of the reaction between $K_2S_2O_8$ and KI using equal initial concentrations of both the reactants.
3. To study hydrolysis of Methyl acetate using two different initial concentrations in presence of mineral acid **(**HCl) as catalyst
4. To determine the relative strength of two acids i.e. HCl and H_2SO_4 by using them as catalysts for the hydrolysis of methyl acetate.
5. To study the solubility of benzoic acid at room and below room temperature by volumetric method.
6. To study the molecular condition of benzoic acid in toluene-water system.
7. To study distribution of acetic acid between water and cyclohexane.

INORGANIC CHEMISTRY

1. Preparation of standard 0.1M $K_2Cr_2O_7$ solution and carry out the dilution to 0.05, 0.01, 0.001 M in 50 mL standard volumetric flask.
2. To prepare 100 ppm of Manganese solution using $KMnO_4$ and carry out the further dilutions like 5, 10, 20 ppm in 50 mL standard volumetric flasks.
3. To prepare 0.1 N $Na_2C_2O_4$ solution and use it to standardize the given $KMnO_4$ solution.
4. Preparation of lead carbonate.
5. Preparationof ferrousammonium sulphate.

PHYSICAL CHEMISTRY
TEXTBOOK:

Atkins, P., Paula, J. D. *Atkin's Physical Chemistry*, Oxford University Press.

ADDITIONAL READING:

1. Bahl A., Bahl B.S. and Tuli, G.D. *Essentials of Physical Chemistry,* S. Chand & Company Ltd., New Delhi.
2. Puri B.R., Sharma L. R. and Pathania M. S. *Principles of Physical Chemistry*, Vishal Publishing Co.
3. Raj G. *Advanced Physical Chemistry*, Goel Publishing House, Meerut.

PRACTICAL BOOK:

Khosla B.D., Garg V.C., Gulati A., *Senior Practical Physical Chemistry*, R Chand & Co., New Delhi

WEB REFERENCES:
1. http://alpha.chem.umb.edu/chemistry/ch115/Mridula/CHEM%20116/documents/chapter_14auLectureSlides_000.pdf
2. https://www.livescience.com/53304-gases.html
3. https://www.slideshare.net/kumar_vic/solid-state-chemistry-17237117
4. https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Physical_Properties_of_Matter/States_of_Matter/Properties_of_Gases/Kinetic_Theory_of_Gases/Basics_of_Kinetic_Molecular_Theory

INORGANIC CHEMISTRY
TEXT BOOKS:
1. Lee, J. D. Concise Inorganic Chemistry, ELBS Publications.
2. Atkins, P., Overton, T., Rourke, J., Weller, M., Armstrong, F.,*Shriver & Atkins' InorganicChemistry*, Oxford University Press.

PRACTICAL BOOK:
MendhamJ., Barnes J.D., Denney R.C., ThomasM.J., Sivasankar B.,*Vogel'sTextbook of Quantitative Chemical Analysis*, Pearson.

ADDITIONAL READING:
1. Greenwood, N. N., Earnshaw, A. *Chemistry of Elements,*Pergamon, Oxford.
2. Huheey, J. E., Keiter, E. A., Keiter, R. L., Medhi, O. K. *Inorganic Chemistry: Principles ofStructure and Reactivity*, Pearson.
3. Cotton, F. A., Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley Publications.
4. Puri, B. R., Sharma, L. R., Kalia, K. C. *Principles of Inorganic Chemistry*, Vishal Publishing Co.
5. Sharpe and Emilus, Inorganic Chemistry.
6. Housecroft, C. E. and Sharpe, A. G. *Inorganic Chemistry*, Prentice Hall.

WEB REFERENCES:
1. https://www.thoughtco.com/valence-shell-electron-pair-repulsion-theory-605773
2. https://www.britannica.com/science/covalent-bond
3. https://www.electrical4u.com/schrodinger-wave-equation/
4. http://www.chem4kids.com/files/atom_structure.html
5. https://pubchem.ncbi.nlm.nih.gov/periodic-table/

CORE COMPULSORY MAJOR PAPER

THEORY
Course Title: General Organic and Inorganic Chemistry (Theory) [with effect from June 2020].
Course Code: CHE-I. C-2
Marks: 75
Credits: 3
Duration: 45 hours

Course Objectives:
1. Students will learn about the basic concepts in Organic Chemistry like the hybridization in organic molecules, molecular interaction.
2. Students will briefly learn about the types of reaction, reactive intermediates and reaction mechanism in organic chemistry.
3. Students will learn how to name different classes of organic compounds using IUPAC nomenclature.
4. Students will learn how to represent 3 D of organic molecule on 2 D surfaces. Also how the orientation of a molecule in space can give a compound different reactivity.
5. Students will learn two important classes of organic compounds like alkanes and alkenes.
6. Develop skills to carry out related experiments.

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Name the organic compounds using IUPAC nomenclature.

CO2: Identify and classify the different organic reactions.
CO3: Apply the theoretical knowledge to synthesize alkanes and alkenes.
CO4: Write 3D structures of organic molecules using 2D surface.
CO5: Identify given unknown organic compounds (solid) by carrying out various chemical tests.
CO6: Predict available oxidation states for s- and p-block elements.
CO7: Identify which halides, oxides and hydrides are covalent, which are ionic, and why.
CO8: Apply the knowledge of Normality and Molarity in preparation of different solutions.

SECTION- I (ORGANIC CHEMISTRY)

UNIT I: IUPAC Nomenclature of Organic Compounds **02 hours**
Basic rules of IUPAC nomenclature, nomenclature of the compounds- alkanes, cycloalkanes, alkenes, alkynes, haloalkanes, acids, alcohols, ethers, aldehydes, ketones, nitriles, acid halides, esters, anhydrides, amides.
Nomenclature of aromatic compounds, mono and di substituted benzene with two functional groups, bridged cycloalkanes.

UNIT II: Structure and Reactivity of Organic Compounds **10 hours**
Bond formation in organic compounds; sp sp^2, sp^3 with respect to methane, ethene and acetylene (hybridisation concept), discussion on shape, bond length, bond angles of organic molecules.
Polar covalent bonds, electronegativity and bond dipoles in organic molecules, introduction and examples of Van der Waal's forces, inductive effect, field effect, hyperconjugation and resonance, hydrogen bonding.
Different arrows usedin organic chemistry, homolytic and heterolytic bond breaking, types of reagents, electrophiles and nucleophiles, types of organic reactions: addition, elimination, substitution, oxidation, reduction and rearrangement with examples. Introduction to reactive intermediates: carbocations, carbanions, free radicals, carbenes, arynes and nitrenes with shape, stabilities, methods of formation and reaction. Methods of determination of reaction mechanisms: Determination of structure, intermediates, isotope effects, kinetic and stereochemical studies.

UNIT III: Stereochemistry **08 hours**
Isomerism, types of isomers: constitutional, conformational and configurational isomerism. Chirality, chiral centre, enantiomers and diastereomers (with example of threo and erythrodiastereomers, meso compounds). Representation of configuration by- 3D Projection (Wedge and dotted projection), Fischer projection, Newmann projection and Saw horse projection. R/S configuration (Can-Ingold-Prelog sequence rules to be explained). E/Z nomenclature.

UNIT IV: Study of alkanes, cycloalkanes and alkenes **10 hours**
Alkanes and Cycloalkanes**:** Physical properties of alkanes and cycloalkanes, sources of alkanes andcycloalkanes, chemical properties: combustion and pyrolysis of alkanes, methods of preparation: Corey-House reaction, Wurtz reaction.
Alkenes: Physical properties and relative stabilities of alkenes, preparation of alkenes, eliminationreactions, dehydration of alcohols, regioselectivity in alcohol dehydration: The Zaitsev rule, rearrangement in alcohol dehydration, dehydrohalogenation: E1 and E2 mechanisms, reactions of alkenes: hydrogenation, addition of halides and hydrogen halides, regioselectivity of hydrogen halide addition, hydroboration and oxidation reactions, oxymercuration- demercuration reactions, epoxidation of alkenes, ozonolysis of alkenes.

SECTION- II (INORGANIC CHEMISTRY)

UNIT V: Chemistry of s- block elements **05 hours**
General properties, comparative study within groups, diagonal relationship, salient features of hydrides, solvation and complexation tendencies and biological importance, introduction to alkyls and aryls
UNIT VI:Chemistry of p- block Elements **10 hours**
Comparative study within group and diagonal relationship of groups 13, 14, 15, 16, 17, Hydrides of Boron, diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), phosphazenes, tetra sulfur tetranitride, basic properties of halogens, inter halogens and polyhalides.

PRACTICALS
CourseTitle: General Organic and Inorganic Chemistry (Practicals) [with effect from June 2020].
Course Code: CHE- I. C-2
Marks: 25
Credits: 1
Duration: 30 hours
List of experiments:

ORGANIC CHEMISTRY

1. Purification techniques for organic solid compounds
   A. **Crystallization:** a. Benzoic acid from water
      b. m-Dinitrobenzene from ethanol
   B. **Sublimation:** a. Naphthalene b. Anthracene c. Camphor
2. **Organic synthesis:** a. Benzoylationofβ-naphthol and aniline.
   b. Bromination of aromatic compounds using $KBrO_3$
   c. Anthraquinone from anthracene (Oxidation reaction)
3. **Qualitative Analysis (Solids)**
   Acids: Benzoic, salicylic, phthalic
   Phenols: α-Naphthol, β-naphthol
   Bases: p-Toluidine, diphenylamine, o-, m- and p-nitroanilines
   Anilides: Acetanilide, benzanilide
   Hydrocarbons: Naphthalene, anthracene
   Amides: Benzamide, urea
   Haloarenes: p-Dichlorobenzene
   Nitro Compounds: m-Dinitrobenzene, p-nitrotoluene
   Carbohydrates: Glucose, fructose, mannose

INORGANIC CHEMISTRY

1. To prepare 0.001 M EDTA and separately estimate the amount of Zn^{2+} ion from $ZnCO_3$, Mg^{2+} ion from MgO.
2. Volumetric estimation of Fe^{2+} using internal indicator by potassium dichromate method.
3. Determination of alkali content in antacid tablet using Standard HCl solution.
4. Volumetric estimation of Calcium.

ORGANIC CHEMISTRY
TEXT BOOK:

Morrison, R. T., Boyd, R. N. and Bhattacharjee, S. K. *Organic Chemistry,* Pearson India.

ADDITIONAL READING:

1. Bruice, P. Y. *Organic Chemistry,* Pearson India.
2. Carey, F. C. and Giuliano, R. M. *Organic Chemistry*, Tata McGraw-Hill India.
3. Finar, I. L. *Organic Chemistry*, Pearson India.
4. Vogel, A.I.,Tatchell, A.R., Furnis, B.S., Hannaford, A.J. and Smith, P.W.G. *Vogel's Textbook of Practical Organic Chemistry*Pearson .

WEB REFERENCES:

1. https://www.khanacademy.org/science/organic-chemistry/bond-line-structures-alkanes-cycloalkanes
2. https://www.khanacademy.org/science/organic-chemistry/gen-chem-review
3. https://www.khanacademy.org/science/organic-chemistry/substitution-elimination-reactions
4. https://www.khanacademy.org/science/organic-chemistry/stereochemistry-topic
5. https://www.khanacademy.org/science/organic-chemistry/alkenes-alkynes

INORGANIC CHEMISTRY
TEXT BOOKS:

1. Lee, J. D.,*Concise Inorganic Chemistry*, ELBS Publications.
2. Atkins, P., Overton, T., Rourke, J., Weller, M., Armstrong, F.,*Shriver & Atkins' InorganicChemistry*, Oxford University Press.

PRACTICAL BOOK:

Mendham,J., Barnes, J.D., Denney, R.C., Thomas,M.J., Sivasankar, B., *Vogel's textbook of Quantitative Chemical Analysis*, Pearson.

ADDITIONAL READING:

1. Greenwood, N. N., Earnshaw, A. *Chemistry of Elements*,Pergamon, Oxford.
2. Huheey, J. E., Keiter, E. A., Keiter, R. L., Medhi, O. K. *Inorganic Chemistry: Principles ofStructure and Reactivity*, Pearson.
3. Cotton, F. A., Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley Publications.
4. Puri, B. R., Sharma, L. R., Kalia, K. C. *Principles of Inorganic Chemistry*, Vishal Publishing Co.
5. Sharpe and Emilus, Inorganic Chemistry.
6. Housecroft, C. E. and Sharpe, A. G. *Inorganic Chemistry*, Prentice Hall.

WEB REFERENCES:

1. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/complexing-agent
2. https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Supplemental_Modules_(Inorganic_Chemistry)/Descriptive_Chemistry/Main_Group_Reactions/The_s-Block_Elements_in_Biology
3. https://classnotes.org.in/class11/chemistry/p-block-elements/boron-hydrides/
4. https://www.toppr.com/guides/chemistry/the-p-block-elements/interhalogen-compounds/
5. https://www.sciencedirect.com/topics/materials-science/fullerene

SEMESTER- II

CORE COURSE

THEORY
Course Title: Concepts in Physical and Analytical Chemistry (Theory) [with effect from June 2020].
Course Code: CHE-II. C-3
Marks: 75
Credits: 3
Duration: 45 hours

Course Objectives:
1. Will have knowledge of the main areas of Physical Chemistry, will develop critical thinking abilities and be able to work in chemical or related fields.
2. Will be able to understand the principles of titrimetric methods.
3. Attain practical skills in some classical and instrumental techniques.

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Describe the basic concepts of thermodynamics and its applications.
CO2: Interpret the pressure temperature diagrams in unary and binary systems.
CO3: Explain the concept of surface tension and viscosity in liquids.
CO4: Explain role of analytical chemistry in science, stoichiometric calculations and apply for numerical.
CO5: Sketch titration curves and solve numerical.
CO6: Explain theory of precipitation and complex formation titrations.
CO7: Perform non-instrumental and instrumental quantitative analysis.

SECTION- I (PHYSICAL CHEMISTRY)

Unit I: Thermodynamics **10 hours**
Thermodynamic terms: system, surrounding, types of systems, intensive and extensive properties, State and path functions and their differentials, Thermodynamic process, Concept of work and heat, First law of thermodynamics: Definition and statements of internal energy and enthalpy, Heat capacities at constant volume and pressure and their relationships, Joule's law, Joule Thomson coefficient and inversion temperature, Calculation of w, q, dU, dH, for the expansion of ideal gases under isothermal and adiabatic conditions for reversible processes Thermochemistry: Standard state, standard enthalpy of formation, Hess's law of heat summation and its applications, Heat of reaction at constant pressure and at constant volume, Enthalpy of neutralisation, bond dissociation energy and its calculation from thermodynamic data, Temperature dependence of enthalpy, Kirchoff's equation. (Numerical expected)

Unit II: Liquid State and Applications **07 hours**
The Intermolecular forces, structure of liquids (qualitative description), structural differences between solids, liquids and gases, Physical properties of liquids: vapour pressure, surface tension, surface tension by capillary rise method, drop number method using stalagmometer, Viscosity of liquids, Poiseuille equation, determination of viscosity using Ostwald's viscometer, Introduction to liquidcrystals.(Numerical expected)

Unit III: Phase Equilibria **06 hours**
Statement, meaning of terms: phase, components, degrees of freedom, Gibbs phase rule, derivation of Gibbs phase rule, Phase equilibria of one component system: water system, sulphur system, Phase equilibria of two component system, simple eutectic system, Pb/Ag system. Nernst distribution law, deviations from Nernst distribution law, applications of the law.

SECTION- II (ANALYTICAL CHEMISTRY)

Unit IV: Introduction to Analytical Chemistry and some basic concepts **04 hours**
Analytical Chemistry and its role in sciences. some important units of measurement, solutions and theirconcentrations, stoichiometric calculations.(Numerical expected)

Unit V: Titrimetric methods of analysis **05 hours**

Some general aspects of volumetric titrimetry, standard solutions, volumetric calculations. Variables that influence the magnitude of salt effect, activity coefficients, titration curves in titrimetric methods. (Numerical expected)

Unit VI: Theory and applications of neutralization titrations **05 hours**

Solutions and indicators for acid/base titrations, titration curves for strong acids and strong bases, buffer solutions, titration curves for weak acids, titration curves for weak bases, composition of buffer solutions as a function of pH. Reagents for neutralization titrations, applications of neutralization titrations. (Numerical expected)

Unit VII: Titration curves for polyfunctional acids and polyfunctional bases **04 hours**

Polyfunctional acids and polyfunctional bases, titration curves for polyfunctional acids, titration curves for polyfunctional bases, composition of solutions of a polyprotic acid as a function of pH. (Numerical expected)

Unit VIII: Precipitation and Complex formation titrations **04 hours**

Titration curves, end points for argentometric titrations, applications of standard silver nitrate solutions.Complex formation reactions, titrations with aminopolycarboxylic acids.
(Numerical expected)

PRACTICALS
Course Title: Concepts in Physical and Analytical Chemistry (Practicals) [with effect from June 2020].
Course Code: CHE- II. C-3
Marks: 25
Credits: 1
Duration: 30 hours

List of experiments:
PHYSICAL CHEMISTRY
1. To determine the partition coefficient of I_2 between $C_2H_4Cl_2$ and H_2O.
2. To determine the amount of strong acid (HCl) present in the given solution by conductometric titration using standard NaOH solution.
3. To determine the amount of weak acid (CH_3COOH) present in the given solution by conductometric titration using standard NaOH solution.
4. To determine viscosity of a given liquid using Ostwald's Viscometer.
5. To determine the heat of neutralization of strong acid with strong base.
6. To determine the heat of neutralization of weak acid with weak base.

ANALYTICAL CHEMISTRY
1. To standardize hydrochloric acid against sodium carbonate.
2. To standardize sodium hydroxide against potassium hydrogen phthalate.
3. To determine hardness in water.
4. To standardize sodium thiosulphate solution against copper.
5. To determine the amount of boric acid in the given solution using conductometry.
6. To determine the amount of lead ions in the given solution using conductometry.

PHYSICAL CHEMISTRY
TEXTBOOK:
Atkins, P., Paula, J. D.,*Atkin's Physical Chemistry*, Oxford University Press.

ADDITIONAL READING:
1. Bahl, A., Bahl, B.S. and Tuli, G.D.,*Essentials of Physical Chemistry*, S. Chand & Company Ltd., New Delhi.
2. Puri B.R., Sharma L. R. and Pathania M. S.,*Principles of Physical Chemistry*, Vishal Publishing Co.
3. Raj G.,*Advanced Physical Chemistry*, Goel Publishing House, Meerut.

WEB REFERENCES:
1. https://www.livescience.com/50881-first-law-thermodynamics.html
2. https://www.thoughtco.com/surface-tension-definition-and-experiments-2699204
3. https://www.chem.uci.edu/~lawm/263%206.pdf

ANALYTICAL CHEMISTRY
TEXT BOOK:
Skoog, D. A., West D.M. and Holler, F. J., *Analytical Chemistry: An Introduction*, Saunders College Publishing

ADDITIONAL READING:
1. Greenwood,N. N., Earnshaw, A.,*Chemistry of Elements,*Pergamon, Oxford.
2. Huheey, J. E., Keiter, E. A., Keiter, R. L., Medhi, O. K.,*Inorganic Chemistry: Principles ofStructure and Reactivity*, Pearson.
3. Cotton,F. A. and Wilkinson, G., *Advanced Inorganic Chemistry*, Wiley Publications.
4. Puri, B. R., Sharma, L. R., Kalia, K. C.,*Principles of Inorganic Chemistry*, Vishal Publishing Co.
5. Housecroft, C. E. and Sharpe, A. G.,*Inorganic Chemistry*, Prentice Hall.

WEB REFERENCES:
1. http://ion.chem.usu.edu/~sbialkow/Classes/3600/Overheads/Titration/Volumetric.html
2. https://facultystaff.richmond.edu/~rdominey/301/local/Titrimetry_Methods.pdf

CORE COURSE

THEORY
Course Title: Concepts in Organic and Inorganic Chemistry (Theory) [with effect from June 2020].
Course Code: CHE-II. C-4
Marks: 75
Credits: 3
Duration: 45 hours

Course Objectives:
1. Students will learn important classes of organic compound: Alkynes.
2. Students will briefly learn about the aromatic chemistry involving different types of reaction can aromatic compounds undergoes. Also they will learn about the mechanism involve in reactions having aromatic compounds.
3. Students will also learn chemistry of alcohols and alkyl halides
4. Will have an understanding of crystalline solids in terms of their structure, ionic radii and coordination there by able to predict crystal structure.

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Categorize the compounds as aromatic, non-aromatic and anti-aromatic.
CO2: Apply the theoretical knowledge to write the synthesis of alkynes, alkyl halides, aromatic compounds.
CO3: Discuss and describe the steps involved in the mechanism of nitration, sulphonation, halogenation and Friedel Crafts reactions of aromatic compounds.
CO4: Explain and outline the different properties of transition elements.
CO5: Compare 4d and 5d analogues.
CO6: Describe crystalline solids in terms of their structure, ionic radii and coordination and interpret crystal structures.
CO7: Describe lattice energy, Born-Haber’s cycle, Fajan’s rule and defects in solids.
CO8: Explain trends in periodic properties of d-block elements with respect to their ionic radii, oxidation state, spectral properties, magnetic properties.
CO9: Describe crystalline solids in terms of their structure, ionic radii and coordination there by able to interpret crystal structure.
CO10: Identify the given organic compounds (liquids) by carrying out various chemical tests.

SECTION- I (ORGANIC CHEMISTRY)

Unit I: Study of alkynes **03 hours**
Alkynes: Sources of alkynes, physical properties of alkynes, acidity of acetylene and terminal alkynes, preparation of alkynes by elimination reactions, alkylation of acetylene and terminal alkynes, reactions of alkynes: hydrogenation, metal-ammonia reduction, addition of hydrogen halides, hydration of alkynes.

Unit II: Arenes and Aromaticity **08 hours**
The aryl group, structure of benzene: Molecular formula and Kekule structure, stability and carbon-carbon bond lengths of benzene, resonance structure, molecular orbital picture, Huckel's rule, polycyclic aromatic hydrocarbons, physical properties of arenes, electrophilic aromatic substitution reactions-reactions and mechanisms of nitration, halogenations, sulphonation and Friedel Craft's reactions, activating and deactivating substituents, orientation and ortho/para ratio, side chain reactions of benzene derivatives, Birch reduction.

Unit III: Study of Alcohols and Alkyl Halides **12 hours**
Alcohols: Classification, structure and bonding, physical properties, methods of preparation- catalytic hydrogenation, metal hydride reduction, Grignard reaction (using formaldehyde, other aldehydes, ketones, esters, nitriles and epoxides), reactions of alcohols- oxidation reactions using chromic acid, $KMnO_4$, PCC and PDC (structures of PCC and PDC), conversion of alcohols to ethers, Fischer Esterification.
Diols: Classification, methods of preparation (syn and anti diols), reactions of vicinal diols-Pinacol-Pinacolone rearrangement and periodic oxidative cleavage.
Alkyl Halides: Classification, structure and bonding, physical properties, methods of preparation- using alcohols and hydrogen halides, $SOCl_2$, PCl_3, halogenation of alkanes, mechanism for chlorination of methane, relative reactivity and selectivity with respect to chlorination and bromination, mechanisms of nucleophilic substitution reactions of alkyl halides, S_N1 and S_N2 reactions with energy profile diagrams.

SECTION- II (INORGANIC CHEMISTRY)

Unit IV: Chemistry of transition elements **12 hours**
UNIT I: Chemistry of elements of the first transition series: properties, their binary compounds, oxidation states and their stability, coordination number and geometry, comparative study with 4d and 5d analogues with respect to their ionic radii, magnetic behaviour, oxidation states and spectral properties.

Unit V: Ionic Solids: Structure and Bonding **10 hours**
Introduction to bonding in solids, types of bonds, properties of ionic substances, structure of ionic solids (NaCl, CsCl, ZnS, CaF_2, TiO_2- rutile), lattice energy and Born- Haber's Cycle, factors affecting radii of ions, packing efficiency, radius ratio and coordination number, limitations of radius ratio, Fajan's rules, defects in solids: point defects, color centres, extended defects, non-stoichiometric defects, conductivity in ionic solids;

PRACTICALS
Course Title: Concepts in Organic and Inorganic Chemistry (Practicals) [with effect from June 2020].
Course Code: CHE- II. C-4
Marks: 25
Credits: 1
Duration: 30 hours

List of experiments:
ORGANIC CHEMISTRY

1. Purification techniques for organic compounds (Liquids) and determination of physical constant.
   Distillation: a. Separation of acetone and toluene
   b. Separation of ethyl acetate and nitrobenzene
2. Organic synthesis: a. p-Bromo acetanilide from aniline
   b.oxidising agent PCC (PyridiniumChlorochromate)
   c. Oxime from cyclohexanone

3. Qualitative Analysis (Liquids)

Haloalkane and haloarene: Chloroform, carbon tetrachloride, chlorobenzene, bromobenzene
Nitro Compounds: Nitrobenzene
Alcohols: Methanol, ethanol, 2-propanol, cyclohexanol
Phenols: Phenol
Carbonyl compounds (Neutral compounds): Benzaldehyde, acetone
Esters: Methyl acetate, ethyl acetate, ethyl benzoate, methyl salicylate
Bases: Aniline, N-methylaniline

INORGANIC CHEMISTRY

1. Semi-micro qualitative analysis: To analyse inorganic mixtures containing four ions only (two cations and two anions).
   Cations:Pb^{2+}, Cu^{2+}, Cd^{2+}, Sn^{2+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Ni^{2+}, Co^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+},Mg^{2+}, $(NH4)^{+}$, K^{+}
   Anions: Cl^{-}, Br^{-}, I^{-}, NO_2^{-}, NO_3^{-}, SO_3^{2-}, CO_3^{2-}, SO_4^{2-}, PO_4^{3-}
2. Gravimetric estimation of Ba as $BaSO_4$
3. Gravimetric estimation of Fe as Fe_2O_3

ORGANIC CHEMISTRY
TEXT BOOK:

Morrison, R. T., Boyd, R. N. and Bhattacharjee, S. K.,*Organic Chemistry,* Pearson India.

ADDITIONAL READING:

1. Bruice, P. Y.,*Organic Chemistry,* Pearson India.
2. Carey, F. C. and Giuliano, R. M. *Organic Chemistry*, Tata McGraw-Hill India.
3. Fina,r I. L.,*Organic Chemistry*, Pearson India.

WEB REFRENCES:

1. https://www.khanacademy.org/science/organic-chemistry/alkenes-alkynes
2. https://www.khanacademy.org/science/organic-chemistry/substitution-elimination-reactions
3. https://www.khanacademy.org/science/organic-chemistry/aromatic-compounds
4. https://www.khanacademy.org/science/organic-chemistry/alcohols-ethers-epoxides-sulfides
5. https://nptel.ac.in/content/storage2/courses/104101005/downloads/LectureNotes/chapter%2013.pdf
6. https://nptel.ac.in/content/storage2/courses/104101005/downloads/LectureNotes/chapter%2011.pdf

INORGANIC CHEMISTRY
TEXT BOOKS:

1. Lee, J. D.,*Concise Inorganic Chemistry*, ELBS Publications.
2. Atkins, P., Overton, T., Rourke, J., Weller, M., Armstrong, F. *Shriver & Atkins' InorganicChemistry*, Oxford University Press.

PRACTICAL BOOK:

Svehla, G. and Sivasankar,B.,*Vogel's Qualitative Inorganic Analysis,* Pearson

ADDITIONAL READING:

6. Greenwood, N. N., Earnshaw, A.,*Chemistry of Elements,*Pergamon, Oxford.
7. Huheey, J. E., Keiter, E. A., Keiter, R. L., Medhi, O. K.,*Inorganic Chemistry: Principles ofStructure and Reactivity*, Pearson.
8. Cotton, F. A. and Wilkinson, G., *Advanced Inorganic Chemistry,* Wiley Publications.
9. Puri, B. R., Sharma, L. R., Kalia, K. C.,*Principles of Inorganic Chemistry*, Vishal Publishing Co.
10. Housecroft, C. E. and Sharpe, A. G.,*Inorganic Chemistry*, Prentice Hall.

WEB REFERENCES:

1. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/magnetic-property
2. https://www.toppr.com/guides/chemistry/the-solid-state/imperfections-or-defects-in-a-solid/
3. https://www.quora.com/What-is-fajans-rule-in-chemistry
4. https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Supplemental_Modules_(Inorganic_Chemistry)/Crystal_Lattices/Thermodynamics_of_Lattices/Lattice_Energy%3A_The_Born-Haber_cycle
5. https://www.chem.fsu.edu/chemlab/chm1046course/solids.html

SEMESTER III

CORE COURSE

THEORY
Course Title: Comprehensive Chemistry – I (Theory) [with effect from June 2020].
Course Code: CHE- III. C-5
Maximum Marks: 75
Credits: 3
Duration: 45 hours

Course Objectives:

1. Will learn principles of Physical Chemistry and its applications in various processes.
2. Will obtain a comprehensive and detail understanding of the properties and compounds of the f-block elements i.e. the lanthanides and actinides.
3. Will gain a basic understanding of coordination compounds, their nomenclature and the types of coordination compounds.
4. Will be able to describe different crystal structures of ionic solids and the types of defects which can occur in a crystal.
5. Will be able to get a deeper understanding of the theory with practical knowledge.

Course Outcomes:

On successful completion of the course, the student will be able to:

CO1: Understand Second and Third law of Thermodynamics
CO2: Calculateequilibrium constant and formulate conditions for maximum yield in industrial processes
CO3: Explain theory of strong and weak electrolytes.
CO4: Explain trends in periodic properties of f-block elements with respect to its size of atoms or ions, reactivity, oxidation state, complex formation, colour, magnetic properties.
CO5: Name coordination compounds and to able to draw the structure based on its name.
CO6: Describe the shape and structures of coordination complexes based on different coordination numbers.
CO7: Explain merits and demerits of different theories of acids and bases and to explain the properties of a solvent that determines their utility.
CO8: Perform instrumental analysis
CO9: Perform synthesis and estimation of inorganic complexes

SECTION –I (PHYSICAL CHEMISTRY)

Unit I: Thermodynamics **10 hours**

Second law of thermodynamics: Different statements of the law; Carnot cycle and its efficiency, Carnot theorem; Thermodynamic scale of temperature; Concept of entropy: entropy as a state function, entropy as a function of V and T, entropy as a function of P and T, entropy change in physical processes, entropy as acriterion of spontaneity and equilibrium; Entropy change for ideal gases. Third law of thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data; Gibbs and Helmholtz functions; A and G as criteria for thermodynamic equilibrium and spontaneity, their advantages over entropy change; Variation of G and A with P, V and T.

Unit II: Chemical Equilibrium **05 hours**

Reversible reactions, equilibrium constant, Equilibrium constant and free energy; Thermodynamic derivation of law of mass action; Reaction isotherm and reaction isochore - Clapeyron equation and Clausius - Clapeyron equation; Le Chatelier's principle and its applications to some industrial processes.

Unit III: Electrochemistry **08 hours**

Electrical transport-conduction in metals and in electrolyte solutions, weak and strong electrolytes; conductance, specific conductance and equivalent conductance and measurements; variation of specificand equivalent conductance with dilution; Arrhenius theory of electrolyte dissociation and its limitations; Ostwald's dilution law, its uses and limitations; Migration of ions and Kohlrausch law; Debye-Huckel-

Onsager's equation for electrolytes; Transport number, determination of transport number by Hittorf's method, Applications of conductance measurements: degree of dissociation, dissociation constant of acids; Solubility and solubility product of a sparingly soluble salts; Conductometric titrations (e.g. Strong acid and strong base).

SECTION –II (INORGANIC CHEMISTRY)

Unit IV: Chemistry of f-block elements **09 hours**

Electronic structure, oxidation states and ionic radii; physical and chemical properties; occurrence and isolation of lanthanides from monazite ore; Lanthanide compounds; General properties and chemistry of actinides; Chemistry of extraction of Thorium and Uranium from its ore; Compounds of Th and U; comparison between lanthanides and actinides

Unit V: Introduction to Coordination Compounds **08 hours**

Werner's coordination theory; effective atomic number concept; nomenclature of coordination compounds; constitution and geometry; Isomerism and chirality in coordination compounds; chelates and macrocyclic effect

Unit VI: Acids, Bases and Non-aqueous solvents **05 hours**

Arrhenius concept and Bronsted theory; Lewis concept of acid and bases; Physical properties of a solvent; Solvents and their general characteristics; Reactions in non-aqueous solvent with respect to NH_3

PRACTICALS:
Course Title: Comprehensive Chemistry – I (Practicals) [with effect from June 2020].
Course Code: CHE- III. C-5
Maximum Marks: 25
Credit: 1
Duration: 30 hours

List of experiments:
PHYSICAL CHEMISTRY EXPERIMENTS

1. To verify Ostwald's dilution law by determining the equivalent conductance of a weak monobasic acid at different concentrations
2. To determine the equivalent conductance of a strong electrolyte at several concentrations and hence verify Onsager's equation.
3. To determine solubility product of sparingly soluble salt by conductometric method
4. To determine hydrolysis constant of sodium acetate by conductometric method
5. To determine G, Hand S of silver benzoate by solubility product method conductomtrically
6. To study the molecular condition of benzoic acid between toluene and water at room temperature by partition method
7. To study the solubility of benzoic acid in water at different temperatures and to calculate the heat of solution
8. To determine energy of activation for acid catalysed hydrolysis of methyl acetate

INORGANIC CHEMISTRY EXPERIMENTS

1. Preparation of Tetraamine copper (II) sulphate monohydrate
2. Estimation of Copper (II) from teraamine copper (II) sulphate by iodometry
3. Preparation of Hexamine nickel (II) chloride complex
4. Estimation of Nickel in hexamine nickel (II) chloride by EDTA method
5. Gravimetric estimation of Nickel as Ni-DMG
6. Volumetric Estimation of Calcium by EDTA method
7. Volumetric Estimation of dissolved oxygen in water sample

PHYSICAL CHEMISTRY
TEXT BOOK:

Raj G., *Advanced Physical Chemistry*, Goel Publishing House, Meerut, 27^{th} Edition

REFERENCE BOOK:

4. Puri B.R., Sharma L.R., Pathania M. S., *Principles of Physical Chemistry*, Vishal Publishing Co.

WEB REFERENCES:
1. https://www.livescience.com/50941-second-law-thermodynamics.html
2. https://www.chemguide.co.uk/physical/equilibria/lechatelier.html
3. https://sciencenotes.org/electrolytes-strong-weak-and-non-electrolytes/

INORGANIC CHEMISTRY
TEXT BOOK:
Shriver D.F. and Atkins P. W., Inorganic Chemistry, 5th Edition, Oxford University Press

REFERENCE BOOKS:
1. Cotton F. A. and Wilkinson G, *Advanced Inorganic Chemistry*, 5th Edition, John Wiley
2. Lee, J. D.,*Concise Inorganic Chemistry*, 5th Edition, Wiley Blackwell Science Publications

WEB REFERENCES:
1. https://www.britannica.com/science/coordination-compound
2. https://www.unf.edu/~michael.lufaso/chem4612/chapter9.pdf
3. https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Supplemental_Modules_(Inorganic_Chemistry)/Descriptive_Chemistry/Elements_Organized_by_Block/4_f-Block_Elements/The_Lanthanides/aLanthanides%3A_Properties_and_Reactions

SEMESTER III

ELECTIVE COURSES

THEORY
Course Title: Name reactions and Synthetic methodologies (Theory) [with effect from June 2020].
Course Code: CHE-III. E-1
Maximum Marks: 75
Credits: 3
Duration: 45 hours

Course Objectives:
1. Students will learn importance of name reactions in organic chemistry.
2. Students will learn different types of reactions in organic chemistry through name reactions.

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Describe condensation reactions involving nucleophilic addition to carbonyl compounds.
CO2: Define and describe various name reactions and rearrangements along with their mechanisms.
CO3: Predict the product for various reactions involving these name reactions/rearrangements.
CO4: Apply these mechanisms towards the formation of complex molecules.
CO5: Discuss and describe the steps involved in the mechanism involving electrophilic aromatic substitution reactions
CO6: List the different oxidising and reducing agents.
CO7: Apply the theoretical knowledge to identify the reagents used to bring about a particular chemical reaction.
CO8: Apply the theoretical knowledge during practical hours to prepare selected compounds,

UNIT I: Name reactions involving nucleophilic addition to carbonyl compounds 15 hours
Structure and reactivity of carbonyl group; General mechanism of nucleophilic addition to carbonyl group; Introduction to condensation reactions; Reactions and mechanisms of: Aldol condensation, Claisen-Schmidt condensation, Claisen condensation, Dieckmann condensation, Perkin condensation, Knoevenagel condensation, Doebner modification, Stobbe condensation, Benzoin condensation, Michael addition.

UNIT II: Name reactions involving electrophilic aromatic substitutions & rearrangement reactions 15 hours
Introduction to general mechanism involved, reactivity of arenes, product distribution, ipso-substitution and orientation in aromatic compounds with electron donating and electron withdrawing substituents.

Reactions and mechanisms of: Friedel-Crafts alkylation and acylation, Vilsmeier-Haack reaction, Gattermann-Koch reaction, Reimer-Tiemann reaction and Kolbe-Schmitt reaction.Reactions and mechanisms of: Beckmann rearrangement, Curtius rearrangement, Hofmann rearrangement, Pinacol-Pinacolone rearrangement, Wagner-Meerwin rearrangement, Claisen rearrangement.

UNIT III: Oxidation & reduction reactions **15 hours**

Oxidation reactions: Oppenauer oxidation (with mechanism), aromatisation and dehydrogenation; Chromium and manganese compounds as oxidising agents: Preparation and applications of PCC and PDC, oxidation of alcohols, aldehydes, C-C double bonds and C-H bonds in hydrocarbons.

Reduction reactions: Catalytic hydrogenation: Different catalysts, solvents and equipments; functional group reductions and homogeneous catalytic hydrogenation; Reductions by hydride transfer reagents and related reactions: $NaBH_4$ and LAH reduction (with mechanism); reductions with borane and dialkylboranes;Other methods of reductions: Clemmensen's reduction, Wolff-Kishner reduction (with mechanism).

PRACTICALS

Course Title: Name reactions and Synthetic methodologies (Practicals) [with effect from June 2020].

Course Code: CHE-I. E-1

Maximum Marks: 25

Credit: 1

Duration: 30 hours

List of experiments:

1. Preparation of chalcone using benzaldehyde and acetophenone.
2. Preparation of dibenzalacetone.
3. Preparation of nitrostyrene using nitromethane and benzaldehyde.
4. Preparation of benzoin using benzaldehyde and thiamine hydrochloride.
5. Oxidation of benzoin to benzil.
6. Preparation of 2,4-DNP hydrazone of acetophenone
7. Preparation of oxime of cyclohexanone
8. Preparation of PCC and PDC
9. Reduction of m-dinitrobenzene to m-nitroaniline
10. Nitration of nitrobenzene
11. Nitration of acetanilide
12. Preparation of Cinnamic acid
13. Preparation of Michael adduct between cyclohexanone and nitrostyrenes
14. Oxidation of alcohols using PCC
15. Oxidation of alcohol using PDC

TEXT BOOK:

Morrison, R. T., Boyd, R. N. and Bhattacharjee, S. K. *Organic Chemistry*, Pearson India.

REFERENCE BOOKS:

1. Bruice, P. Y.,*Organic Chemistry*, Pearson India.
2. Carey, F. C. and Giuliano, R. M.,*Organic Chemistry*, Tata McGraw-Hill India.
3. Finar, I. L.,*Organic Chemistry*, Pearson India.
4. March, J., *Advanced Organic Chemistry Reaction, Mechanism and Structure*, 4^{th} Edition, Wiley Publications.

PRACTICAL TEXT BOOK:

Furniss, B., Brian, S.,*Vogel's Textbook of Practical Organic Chemistry*, Pearson education

WEB REFERENCES:

1. https://www.khanacademy.org/science/organic-chemistry/substitution-elimination-reactions
2. https://www.khanacademy.org/science/organic-chemistry/aromatic-compounds
3. https://www.masterorganicchemistry.com/2017/07/11/electrophilic-aromatic-substitution-introduction/
4. https://www.toppr.com/guides/chemistry/aldehydes-ketones-carboxylic-acids/nucleophilic-addition-reaction/

5. https://nptel.ac.in/content/storage2/courses/104101005/downloads/LectureNotes/chapter%2011.pdf
6. https://nptel.ac.in/content/storage2/courses/104101005/downloads/LectureNotes/chapter%2013.pdf

ELECTIVE COURSES

THEORY
Course Title: Introduction to Industrial Chemistry (Theory) [with effect from June 2020].
Course Code: CHE-III.E-2
Maximum Marks: 75
Credits: 03
Duration: 45 hours

Course Objectives:
The main objective of this course is to study the selected key industrial processes, waste management, properties of selected solid materials and industrial safety.

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Describe the importance of catalysts in industrial processes.
CO2: Explain the composition of various materials such as alloys, glass, etc. and understand the process of corrosion and its prevention.
CO3: Discuss several common industrial processes such as halogenations, nitration and sulphonation.
CO4: Classify and discuss boilers, heat exchangers and paints.
CO5: Describe diverse effluent treatments for waste management and apply the knowledge of safety in industries.
CO6: Will understand the fundamentals of industrial processes.
CO7: Will learn to treat industrial effluents.
CO8: Will learn electroplating.

Unit I: Fundamentals of Industrial Chemistry and Electroplating 15 hours
Relevance of catalysis in modern industrial processes, Mechanical properties of materials and change with respect to temperature, Metals and alloys – important metals and alloys, Glass – types, composition, manufacture, physical and chemical properties applications, Corrosion – various types of corrosion relevant to chemical industry – Mechanism, Preventive methods.
Introduction: definition, fundamental principles- Faraday's laws, mechanism of deposition, surface preparation for electroplating of Zinc and Tin. Testing of electrodeposits: for thickness, adhesion, stress and corrosion. Use of Hull cell in plating.

Unit II: Industrial processes, Boilers, Heat exchangers and Paint chemistry 15 hours
Halogenation: Introduction, type of halogenation reactions, halogenating agents, kinetics and mechanism of halogenation, manufacturing of chloroethane, chlorobenzene, chloral. Nitration: Introduction, type of nitration reaction, nitrating agents, kinetics and mechanism of nitration, manufacturing of nitrobenzene and p-nitroacetanilide. Sulphonation: Introduction, type of sulphonation reaction, sulphonating agents, mechanism of sulphonation reaction, commercial sulphonation of benzene and alkyl benzene. Physico chemical principles involved in the manufacture of HNO_3 (Ostwald's method) and NH_3(Haber's method). Introduction, classification and applications of boilers and heat exchangers. Introduction, general classification, composition, characteristics and applications of paints.

Unit III:Industrial Safety, Conducts, Waste management and Effluent treatment 15 hours
Meaning of industrial safety, industrial accidents, industrial hazards, MSDS and safety programme. Process Safety: a) Chemical reaction hazards: Fundamental understanding, various instruments used to understand chemical reaction hazards. b) Fire and Explosion Hazards: Fundamental understanding, various instruments used to understand fire and explosion hazards.
Principles and equipments for aerobic, anaerobic treatment, adsorption, filtration, sedimentation, bag filters, electrostatic precipitators, mist eliminators, wet scrubbers, absorbers, solid waste management and reverse osmosis.Treatment of electronic waste

PRACTICALS
Course Title: Introduction to Industrial Chemistry (Practicals) [with effect from June 2020].
Course Code: CHE-III.E-2
Maximum Marks: 25
Credits: 1
Duration: 30 hours

List of experiments:
1. Preparation of 1-nitronaphthalene from naphthalene (Nitration)
2. Preparation of 2,4,6-tribromophenol from phenol (Bromination)
3. Preparation of 4-hydroxybenzenesulphonic acid from phenol (Sulphonation)
4. Electroplating of Ni or Cu
5. Electroless plating of Ni or Cu
6. Effect of pH and salinity on rate of corrosion of iron/steel
7. Formation of thin films of metals or alloys
8. Synthesis of common industrial compounds involving two step reactions: phthalic acid to phthalic anhydride
9. To prepare crystals of potash alum, $K_2SO_4.Al_2(SO_4)_3.24\ H_2O$, from Aluminium foil.
10. Ore analysis: calcium from limestone.
11. To estimate the amount of copper by spectrophotometric method

TEXT BOOK:
Sharma, B. K. *Industrial Chemistry* (06 Ed.). Goel Publishing House, Meerut.

REFERENCE BOOKS:

1. Bentley, J. et. al. **2011***Introduction to paint chemistry and principles of paint technology* (04 Ed.). Springer Nethetlands.
2. Cotton, F. A. et. al. *Basic Inorganic Chemistry* (02 Ed.). Wiley Eastern Ltd.
3. De, A. K. *Environmental Chemistry* Wiley Eastern Limited.
4. Foye, A. O. *Principles of Medicinal Chemistry* Publication Philadephia.
5. Frederick, A. L.**1974***Modern Electroplating* (03 Ed.). J. Wiley and sons Inc. New York.
6. Iqbal, S. A. et. al. *Chemistry of Air and Air Pollution* Discovery Publishing House, New Delhi.
7. Korolkovas, A. et. al. *Essentials of Medicinal Chemistry* Wiley - Interscience.
8. Lednicer, D. et. al. *Organic Chemistry of Drugs Synthesis* Wiley Interscience.
9. Lee, J. D. *Concise Inorganic Chemistry* (05 Ed.). Wiley Blackwell Science Publications.
10. Naseer, K. **2004***Electroplating- Basic Principles, Processes and Practice* (01 Ed.). Elsevier.
11. Singh, P. P. et. al. *An Introduction to Synthetic Drugs* Himalaya Publication, Bombay.
12. Terrance, H. I. **1970***The Chemical Analysis of Electroplating Solutions* Chemical Publishing Co. New York 1970.
13. Tyagi, O. D. et. al. *A Text Book of Environmental Chemistry* Anmol Publications, New Delhi.
14. Wilson, C. O. et. al. *Textbook of Organic Medicinal and Pharmaceutical Chemistry* Lippincott - Toppan.

Note: Wherever possible, latest edition of the prescribed books are to be used.

WEB REFERENCES

1. https://www.sciencedirect.com/science/article/pii/S0010938X19309163
2. https://www.intechopen.com/books/wastewater-treatment-engineering/biological-and-chemical-wastewater-treatment-processes
3. https://www.acs.org/content/acs/en/careers/college-to-career/chemistry-careers/paints-pigments-coatings.html
4. https://oshwiki.eu/wiki/Prevention_of_fires_and_explosions
5. https://www.safeopedia.com/definition/1052/industrial-safety

ELECTIVE COURSE

THEORY
Course Title: Surface Chemistry and Catalysis (Theory) [with effect from June 2020].
Course Code: CHE- III. E-3
Maximum Marks: 75
Credits: 3
Duration: 45 hours

Course Objectives:
1. Will have an understanding of chemistry of surfaces and be able to interpret various types of adsorption.
2. Will understand the mechanism and applications of catalytic processes.
3. Will have practical knowledge of synthesis and characterization of catalysts.

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Describe the behavior of solid surfaces.
CO2: Understand the concept of catalysts and catalysis.
CO3: Classify and interpret various types of adsorption isotherms.
CO4: Estimate surface area of a solid.
CO5: Predict the mechanistic behavior of catalytic reactions.
CO6: Evaluate conditions under which a catalysed reaction changes rate dependence.
CO7: Synthesize and characterize catalysts

Unit I: Surfaces of Solids and Introduction to Catalysis **15 hours**
Introduction, surface mobility of solids-sintering; effect of past history on condition of solid surfaces; Thermodynamics of crystals; Surface tension and surface free energy; equilibrium shape of a crystal; Kelvin equation; Theoretical estimates of surface energies and free energies in various types of crystals and metals; Factors affecting surface energies and surface tensions of actual crystals; experimental methods for determining surface structure, reactions of solid surfaces. Introduction to catalysis, Types of catalysis, Characteristics of catalysts, Classification of catalysis, Some important classes of catalysts.

Unit II: Adsorption **15 hours**
Introduction, Differences between adsorption, absorption and sorption, Characteristics of adsorption, sorption and occlusion, Adsorption of gases on solids; Physisorption and chemisorption; Adsorption isotherms, Types of adsorption isotherms: Freundlich adsorption isotherm, Langmuir adsorption isotherm, The BET equation (Derivation not needed); Determination of surface area: Harkin and Jura method, Benton and White method, The BET method, Point B method, From electrical potential of adsorbed layer, Using rate of dissolution, From heat of wetting; Importance of surface area; Heat of adsorption and its measurement; Adsorption isobars; Adsorption from solution, Gibbs adsorption equation(Derivation not needed), Adsorption by porous solids, Adsorption in mesopores and micropores

Unit III: Theories of Catalysis **15 hours**
Theory of Homogenous catalysis, Function of a catalyst in terms of Gibbs Free energy of activation; Theory of heterogeneous catalysis, Quantitative treatment of Adsorption theory, Kinetics of heterogeneous reactions, Effect of temperature on heterogeneous reactions, Absolute rate theory in heterogeneous gas reactions; Enzyme catalysis, Characteristics of enzyme catalysis; Factors governing rate of enzyme catalysed reactions; Mechanism and kinetics of enzyme catalysed reactions, Michaelis-Menten equation; Acid-base catalysis, Mechanism and kinetics of acid-base catalysis, catalytic coefficients, Hammett and Bronsted equation(Derivation not needed); Acidity function.

PRACTICALS
Course Title: Surface Chemistry and Catalysis (Practicals) [with effect from June 2020].
Course Code: CHE- III. E-3
Maximum Marks: 25
Credits: 1
Duration: 30 hours

List of experiments:

1. To study the adsorption of acetic acid on charcoal and to verify Freundlich adsorption isotherm.
2. To study the adsorption of oxalic acid on charcoal and to verify Langmuir adsorption isotherm.
3. To study acid catalysed inversion of cane sugar by polarimetry.
4. To determine the interfacial tension between two immiscible liquids (chloroform-water) at room temperature.
5. To determine the indicator constant of a given indicator by colourimetric measurements.
6. To synthesize ZnO by decomposition method and determine the amount of zinc in ZnO by titrimetry.
7. To synthesize CuO and determine the amount of copper in CuO using titrimetry.
8. To study the kinetics of iodination of acetone.
9. To study the hydrolysis of methyl acetate in presence of sulphuricacid and determine the energy of activation.
10. To study the kinetics of the autocatalytic reaction between potassium permanganate and oxalic acid.
11. To determine the Scherrer particle size of any three catalysts using their X-ray diffraction data.
12. To calculate band gap of any five catalysts using their UV-DRS data.
13. To determine the Hammett constant of a substituted benzoic acid by pH measurements.
14. To study the adsorption of iodine from alcoholic solution using charcoal.
15. To investigate the autocatalytic reaction between $KMnO_4$ and oxalic acid.

TEXT BOOK:

Raj G., Advanced Physical Chemistry, Goel Publishing House

REFERENCE BOOKS:

1. Adamson A. W., Physical Chemistry of Surfaces, Interscience Publishers
2. Bowker M., The Basis and Applications of Heterogeneous Catalysis (1998), Oxford University Press
3. Somorjai G.A., Introduction to Surface Chemistry and Catalysis (1994), Wiley, New York

PRACTICAL BOOK:

Rajbhog S.W. and Chondhekar T. K., Systematic Experimental Physical Chemistry

WEB REFERENCES:

1. https://www.britannica.com/science/catalysis/Classification-of-catalysts
2. http://www.chemistrylearning.com/adsorption/
3. https://www.scienceofhealthy.com/enzyme-catalysis/
4. https://www.slideshare.net/lovnishthakur75/what-is-catalysis-its-type-and-its-application
5. https://www.slideshare.net/e_gulfam/sintering-33538445

ELECTIVE COURSE

THEORY
Course Title: Bioinorganic Chemistry (Theory) [with effect from June 2020].
Course Code: CHE- III. E-4
Maximum Marks: 75
Credits: 3
Duration: 45 hours

Course Objectives:

1. To be proficient in the basic principles of bioinorganic chemistry and biochemistry.
2. Understand the role of metal ions that are involved in different processes like oxygen transport, electron-transfer reactions etc. in biological systems.
3. Summarize the role of metal centres in the metalloenzymes that are involved in the catalysis of various biological reactions.
4. Will develop practical skills to prepare model systems which mimic the role of metal ions in biological systems.

Course Outcomes:

On successful completion of the course, the student will be able to:

CO1: Elucidate the role of metal ions that are involved in different processes like oxygen transport, electron-transfer reactions etc. in biological systems.

CO2: Apply the concepts of coordination chemistry to metallobiomolecules which are based on iron and copper ions.
CO3: Evaluate the role of metal centres in the metalloenzymes that are involved in the catalysis of various biological reactions and thus predict the reaction mechanisms.
CO4: Develop skills to prepare model systems which mimic the role of metal ions in biological systems.
CO5: Discuss the importance ofessential and trace elements in biological processes and evaluate their role in biology.
CO6: Explain the biologically important compounds like proteins, carbohydrates etc. and to interpret their biological importance.
CO7: Compare different mechanisms of ion transport across cell membrane and classify different biomolecules which help in the transport of ions and to illustrate PS-I and PS-II approach of photosynthesis.
CO8: Analyze how metals are used as diagnostic agents and application of Au, Cu, Zn, Pt-complexes as anti-cancer drug and in medicine.
CO9: Synthesize and analyze complexes.

Unit I: Introduction to Bioinorganic Chemistry 15 hours
Essential and trace elements in biological processes; distribution of elements in biosphere; bio-availability and bio-stability; Biologically important compounds: sugars (carbohydrates), fatty acids (lipids), nucleotides (nucleic acids) and amino acids (proteins); Biological importance of water; Structure and functions of biological membranes; mechanism of ion transport across membranes; sodium pump; Ionophores: valinomycin; Crown ether complexes of Na^+ and K^+; Photosynthesis: chlorophyll a, PS I and PS II; Role of calcium in muscle contraction and blood clotting.

Unit II: Iron containing compounds in biology 15 hours
Heme proteins: hemoglobin, myoglobin and cytochrome c; Non-heme proteins: hemerythrin and hemocyanin; Iron transport and iron storage proteins: Siderophores, transferrin and ferritin; Electron transfer: Iron-Sulphur clusters, cytochromes.

Unit III: Metalloenzymes and chemistry of metals in medicine 15 hours
Copper enzymes: superoxide dismutase, cytochrome oxidase and ceruloplasmin; Zinc enzymes: carbonic anhydrase, carboxy peptidase and interchangeability of zinc and cobalt in enzymes; Iron and Molybdenum enzymes: xanthine oxidase, nitrogenase; Coenzymes: Vitamin B_{12} and B_{12} coenzymes.
Metals as diagnostic and therapeutic agents: chelation therapy, cancer treatment, anti-arthritis drugs; Platinum complexes as anticancer drugs; Pt-DNA binding; complexes of gold, copper, zinc, mercury, arsenic and antimony as drugs.

PRACTICALS
Course Title: Bioinorganic Chemistry (Practicals) [with effect from June 2020].
Course Code: CHE- III. E-4
Maximum Marks: 25
Credit: 1
Duration: 30 hours
List of experiments:
1. Preparation of acetylacetonato manganese (III) complex
2. Preparation of trisethylenediamine nickel (II) complex
3. Preparation of Tris(acetylacetonato) iron (III) Estimation of Fe from the complex Tris(acetylacetonato) iron(III)
4. Preparation of tris(thiourea)copper(I)sulphate
5. Preparation of optical isomers, cis and trans dichloro(ethylenediamine)cobalt(III)chloride
6. Preparation of hexamine cobalt (III) chloride
7. Estimation of cobalt (III) from hexamine cobalt (III) chloride
8. Preparation of bis(dimethylglyoxime)cobalt (I) a Vitamin B12 model system
9. Preparation of Potassium trioxalato ferrate(III)

TEXT BOOK:
Bertini I., Gray H. B., Lippard S. J. and Valentine J.S., Bioinorganic Chemistry, University Science Books

REFERENCE BOOKS:
1. Fausto da Silva J. J. R. and Williams R. J. P., *The Biological Chemistry of the Elements*, Oxford University Press
2. Fenton D. E., *Bio-coordination Chemistry*, Oxford Chemistry Printers, Oxford University Press
3. Shriver and Atkins, *Inorganic Chemistry*, 5th Edition, Oxford University Press
4. Cotton F.A and Wilkinson G, *Basic Inorganic Chemistry*,Wiley Eastern Ltd.

PRACTICAL BOOK:
Bassett J., Denney R. C., Jeffrey G. H., Mendham J., *Vogel's Text Book of Quantitative Inorganic Analysis*

WEB REFERENCES:
1. https://www.nature.com/subjects/bioinorganic-chemistry
2. .https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Book%3A_Inorganic_Chemistry_(Saito)/8%3A_Reaction_and_Physical_Properties/8.2%3A_Bioinorganic_chemistry
3. https://nptel.ac.in/courses/104104109/
4. https://www.internetchemistry.com/chemistry/bioinorganic-chemistry.php
5. https://www.sciencedirect.com/journal/bioinorganic-chemistry

SKILL ENHANCEMENT COURSE

Course Title: Skill Development in Chemistry (Theory and Practicals) [with effect from June 2020].
Course Code: CHE.SEC-1
Maximum Marks: 100
Credits: 4
Duration: 60 hours

Course Objectives:
1. To understand the chemistry of fats, oils and the process involved in preparing soaps, detergents and disinfecting agents and provide necessary skills for the preparation.
2. To study the composition and chemical parameters of commonly consumed beverages like soft drinks and packed fruit juices, the process involved in their preservation and their long term effects on human health.
3. To study the various food additives like food colours, taste enhancers, preservatives, etc. and their effects on food and health. Food adulteration of commonly used kitchen ingredients like wheat, rice, dal, milk, butter, etc. and the tests involved to detect the adulterants will be studied.

Course Outcomes:
On successful completion of the course the students will be able to:
CO1: Determine the saponification value, iodine value and acid values of oils and test the adulterants in food items.
CO2: Apply the skills for the preparation of white phenyl and liquid soap.
CO3: Apply the knowledge for the safe disposal of white phenyl.
CO4: Understand chemistry of soaps, synthetic detergents, alkyl and aryl sulphonates and floor cleaners.
CO5: Determine the pH of soft drinks and other beverages.
CO6: Understand chemistry of food additives and adulterants and apply the knowledge for detecting and testing foods items for adulterants.

Unit I: Fats and Oils, Soaps, Detergents and Disinfecting agents, Beverages, Food Additives and Adulterants **15 hours**
Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides. Hydrogenation of unsaturated oils. Saponification value, iodine value and acid value of oils. Soaps, synthetic detergents, alkyl and aryl sulphonates, floor cleaners- preparation, storage and disposal of white phenyl. Soft drinks, soda, fruit juices and alcoholic beverages (Types and content of alcohol). Composition of soft drinks, and its excessive use leading to urinary bladder stones. Preservation in tetra pack. Nitrogen preservation and packing of fruit juices.Food additives: Artificial sweeteners-saccharin, cyclomate, asparatame; food Flavours-esters, aldehydes and heterocyclic compounds. Food colours: Restricted use, spurious colours. Emulsifying agents, preservatives and leavening agents- Baking powder, Yeast. Taste enhancers-MSG, vinegar.Food Adulteration: Contamination of wheat, rice, dal, milk, butter, etc. with clay, sand, stone,

water and toxic chemicals. Food poisons: natural poisons (alkaloids, nephrotoxins), pesticides (DDT, BHC, Follidol), Heavy metal (Hg, Pb, Cd) contamination of sea food.

PRACTICALS **45 hours**

List of experiments

1. Preparation of household/floor cleaner. **12 hours**
2. Preparation of detergent powder/soap/liquid soap. **13 hours**
3. Determination of Iodine number and saponification value of oils. **06 hours**
4. To analyze the pH of different soft drinks using pH meter **06 hours**
5. Test for adulterants in food items (turmeric powder, chilli powder, vanaspati in ghee, starch in milk, etc.) **08 hours**

REFERENCES BOOKS:

1. Battershall, J. P. **(2017).***Food Adulteration and its detection*, ebook.
2. Belitz, H. D. etal. (2009). *Food Chemistry*. 4th edition, Springer.
3. Branen, A. L. etal. **(2002).***Food Additives*. 2nd edition, Marcel Dekker, Inc.,
4. Fennema, O. R. **(1996).***Food Chemistry*, Marcel Decker Inc., New York.
5. Madan, R. L. **(2011)**. *Chemistry for Degree Students: T.Y.BSc. Students*, 2nd edition.S. Chand Publications.

WEB REFERENCES:

1. https://www.wikihow.com/Formulate-White-Phenyle
2. https://www.youtube.com/watch?v=33NysscBs1k
3. https://www.wisegeek.com/what-are-the-most-common-hand-sanitizer-ingredients.htm
4. https://www.sciencedirect.com/topics/food-science/food-adulteration
5. https://fssai.gov.in/
6. https://www.who.int/news-room/fact-sheets/detail/food-additives

SEMESTER IV

CORE COURSE

THEORY
Course Title: Comprehensive Chemistry-II (Theory) [with effect from June 2020].
Course Code: CHE- IV. C-6
Maximum Marks: 75
Credits: 3
Theory: 45 hours

Course Objectives:
Students will learn about;
1. Important classes of organic compounds include CHO elements.
2. Preparations involved in different classes of organic compound having CHO elements.
3. Important reaction involved in each class of included compounds.
4. Steps involved in an analytical procedure.
5. Sampling of solids, liquids and gases.
6. Statistical treatment of analytical data.

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Identify and classify diverse organic compounds containing C, H and O elements.
CO2: Predict the chemical reactivity of several organic compounds containing CHO elements.
CO3: Outline the preparations of several compounds belonging to different classes of organic compounds having CHO elements.
CO4: Apply the important reactions involved in each class of organic compounds with CHO elements.
CO5: Design scheme for an analytical process.
CO6: Use proper techniques of sampling of solids, liquids & gases.
CO7: Apply statistical treatment to analytical data.
CO8: Perform analytical procedures.

SECTION I (ORGANIC CHEMISTRY)

UNIT I: Ethers **04 hours**
Ethers:Properties of ethers, Dimethyl ether, Symmetric and asymmetric ethers, crown ethers, Preparation of ethers: Williamson ether synthesis, alkoxymercuration-demercuration, Reaction of ethers with acids (HX), application of ethers.

UNIT II:Aldehydes and Ketones **08 hours**
Properties of aldehydes and ketones, Geometry and polarity of the carbonyl group, Preparation of aldehydes: Oxidation of alcohols, reduction of acid chlorides, Ozonolysis of alkene; Preparation of ketones: oxidation of alcohols, Friedel-Crafts acylation, Reaction of acid chloride with organocopper compounds; Reactions of aldehydes and ketones: General mechanism of nucleophilic addition at carbonyl group; Oxidation and reduction of aldehyde and ketones; Reaction with amine derivative (imine formation with mechanism); Cannizaro reaction and addition of Grignard reagents; Addition of carbanions (Aldol condensation).

UNIT III: Carboxylic Acids **06 hours**
Properties of carboxylic acids, Preparation of acids: Oxidation of primary alcohols and alkyl benzenes, hydrolysis of nitriles with mechanism; Reaction of acids: Salt formation, conversion to different functional groups (esters, amides, acid chlorides and anhydrides), reduction of acids. Acid anhydrides: Preparation and reactions.

UNIT IV: Esters **05 hours**
Properties of esters; Preparation of esters: from acids, acid chlorides and anhydrides; Reactions of esters: Conversion to acids (Hydrolysis along with mechanism), conversion to amides, Trans-esterification, reduction to aldehydes and alcohols.

SECTION II (ANALYTICAL CHEMISTRY)

UNIT V:The Scope and Nature and of Analytical Chemistry 05 hours

Introduction; quantitative and qualitative analysis; qualitative analysis by classical and instrumental methods; analytical chemistry and analytical process (steps involved in chemical analysis): defining the problem, sampling, separation of desired components, actual analysis, presentation and interpretation of results; factors affecting the choice of analytical method.

UNIT VI: Sampling Techniques 07 hours

Terms encountered in sampling: Sample, the population or the universe, sampling unit, increment, the gross sample, the sub sample, Analysis sample, bulk ratio, size to weight ratio, random sampling, systematic sampling, multistage sampling, sequential sampling; sampling of gases, liquids and solids; Preservation, storage and preparation of sample solution.

UNIT VII:Statistical Treatment of Analytical Data 10 hours

Limitations of analytical methods, classification of errors, accuracy and precision; Errors: determinate and indeterminate error, constant and proportionate errors, minimization of errors; Significant figures and rounding off; mean, median, mode, range; standard deviation; histogram and frequency polygon; measures of central tendency and dispersion; Gaussian distribution curve; Confidence limit; Test of significance: F test, Students T; Rejection of the results: Q test, 2.5 d and 4.0 d rule; linear least squares/ method of averages.

PRACTICALS
Course Title: Comprehensive Chemistry-II (Practicals) [with effect from June 2020].
Course Code: CHE- IV. C-6
Maximum Marks: 25
Credit: 1
Duration: 30 hours

List of experiments:
ORGANIC CHEMISTRY EXPERIMENTS

1. Qualitative analysis of organic compounds:
   Solids (examples: Benzoic acid, Nitro-benzaldehyde, Benzophenone)
   Liquids (Acetone, methylacetate, benzaldehyde)
2. Identification of type and separation of mixture of organic compounds:
   Solid-solid (Soluble-insoluble, insoluble-insoluble), solid-liquid (Solid and low boiling liquid), liquid-liquid) (High boiling and low boiling liquid)
3. Estimation of Ester.
4. Estimation of Amide.

ANALYTICAL CHEMISTRY EXPERIMENTS

1. To estimate the NO_2^- in the given solution by $KMnO_4$ method by back titration
2. To determine the amount of HCl in the given solution by pH metric titration
3. To determine the specific rotation of the given solution and to determine the percentage composition of unknown solution using polarimeter
4. To estimate the amount of benzoic acid in the given solution by back titration
5. To estimate the amount of vitamin C in the given solution
6. To estimate the amount of aspirin in the given tablet
7. To calibrate the burette and pipette using statistical treatment of data
8. To calibrate the volumetric flask of different volume capacity
9. To determine the hardness of water by EDTA method and to take at least five readings and apply the statistical data treatment to calculate mean, median, range, standard deviation and Q test.

ORGANIC CHEMISTRY
TEXT BOOK:

Morrison, R. T., Boyd, R. N. and Bhattacharjee, S. K., *Organic Chemistry*, Pearson India.

REFERENCE BOOKS:

1. Bruice,, P. Y.,*Organic Chemistry*, Pearson India
2. Carey, F. C. and Giuliano, R. M.,*Organic Chemistry*, Tata McGraw-Hill India
3. Finar, I. L.,*Organic Chemistry*, Pearson India

PRACTICAL TEXT BOOK:

Furniss, B. Brian, S., *Vogel's Textbook of Practical Organic Chemistry*, Pearson education

WEB REFERENCES:

1. https://www.khanacademy.org/science/organic-chemistry/alcohols-ethers-epoxides-sulfides
2. https://www.khanacademy.org/science/organic-chemistry/aldehydes-ketones
3. https://www.khanacademy.org/science/organic-chemistry/carboxylic-acids-derivatives

ANALYTICAL CHEMISTRY

TEXT BOOK:

Skoog, D. A., West, D. M., Holler F. J. and Crouch, S. R., *Fundamentals of Analytical Chemistry, 8th Edition*.Saunders College Publishing

REFERENCE BOOKS:

1. Willard, H. H., Merritt, L. L., Dean, J. A., Settle, F. A., Instrumental Methods of Analysis, CBS Publishing, New Delhi, 7th Edition
2. Bassett J., Denney R. C., Jeffrey G. H., Mendham J., *Vogel's Text Book of Quantitative Inorganic Analysis*
3. Christian, G. D., *Analytical Chemistry*, John Wiley

PRACTICAL TEXT BOOK:

Yadav, J. B. Advanced Practical Physical Chemistry, Goel Publishing House, 14th Edition

WEB REFERENCES:

1. https://www.slideshare.net/umar121/errors-in-chemical-analysis
2. https://www.britannica.com/science/sample-preparation/Sampling-solids-liquids-and-gases

ELECTIVE COURSE

THEORY

Course Title: Pharmaceutical Chemistry (Theory) [with effect from June 2020].
Course Code: CHE-IV.E-5
Maximum Marks: 75
Credits: 3
Duration: 45 hours

Course Objectives:

1. Students will learn about important aspects with respect to pharmaceutical Chemistry.
2. Students will develop understanding in structure-activity relationship.
3. Students will learn efficient chemical synthesis involved in important drug.

Course Outcomes:

On successful completion of the course, the student will be able to**:**

CO1: Outline the significance of terminologies and regulation in Pharmaceutical chemistry.
CO2: Classify pharmacological drugs.
CO3: Understand the medicinal chemistry in plants.
CO4: Define and apply different types of chromatographic techniques in pharmaceutical industry.
CO5: Understand the working of quality control and quality.
CO6: Discuss Safety in Pharmaceutical laboratories.
CO7: Apply practical knowledge for the synthesis of some pharmaceutical drugs.

Unit I: General Introduction, Regulation and Authorities and Pharmacological classification of Drugs **15 hours**

Importance of Chemistry in Pharmacy, Definition of terminologies: Pharmacology: Pharmacokinetics, Pharmacodynamics; Pharmacognosy, Dosage forms and Routes of administration, Advantages and disadvantages. Pharmacopoeia. Introduction to different regulatory bodies and their role: WHO, Therapeutic Goods Administration(TGA),Medicines and Health care products Regulatory Agency (MHRA), Central Drugs Standard Control Organisation (CDSCO),UNICEF, USFDA, Food and Drug act 1945, Good Automated Manufacturing Practices (GAMP), State Licensing Authority. Requirement of regulation: 21CFR part 11, Electronic Signature and Password control, ICH, (Different guideline and scope), CGMP & Schedule M. Anti-Infective agents, anti-diabetic agents, anti-cancer agents, anti-pyretic agents, antipsychotic agents, Antacids, Analgesics, CNS Depressants, CNS stimulants, Anti histaminic agents, Diuretics, anti-malarial, antibiotics, adrenergic agents, cholinergic agents, Cardiovascular drugs, Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) (Definition of each class, any two examples with structure)

Unit II: Quality Control and Quality Assurance **15 hours**

Introduction, Quest for Quality, Role of QC, Good Laboratory Practices (GLP), Standards: Reference Standard, Primary standard, Working standard. Raw Material Testing: Solubility, Acidity /Alkalinity, Chloride, Sulphate, LOD, Sulphated ash, Loss on ignition, Heavy metals, Karl-Fischer titration. Finished Product Testing: Dimension, Weight variation, Hardness, Dissolution, Identification, Assay, Uniformity of content, Stability Testing, Different conditions for stability testing, Dissolution, Related substances. Handling of “Out of Specifications”, “Out of Trend”, Laboratory Incidences, Root cause analysis, Corrective action and Preventive Action. Facing audits: Roles, Responsibilities and ensuring compliances. Data integrity and its challenges, Archiving of results – introduction. Introduction: Role of QA, Standard Operating procedure, Change control, Deviation, Market complaints, Master production record (Batch card), Audit, Drug Master File (DMF), Complaints & adverse reactions, Labels & printed materials, Documentation & records, Distribution records. Validation: Method Validation, Types of Analytical Procedures to be Validated; Accuracy, Precision (Repeatability, Intermediate Precision, Reproducibility), Specificity, Detection Limit, Quantitation Limit, Linearity, Range, Robustness. Process validation.

Unit III: An introduction to the Medicinal Chemistry of plants, Introduction to Chromatography and Safety in Pharmaceutical laboratories **15 hours**

Historical background; Type of plant, active ingredient structure and their medicinal properties: Capsicum, Garlic, turmeric. Column chromatography, Paper Chromatography, HPLC, Gas chromatography. Introduction, Risks in a pharmaceutical Laboratory, Personal Protective Equipment (PPE), General preparation for Emergencies, Laboratory Emergencies: Spills and Fires.

PRACTICALS
Course Title: Pharmaceutical Chemistry (Practicals) [with effect from June 2020].
Course Code: CHE-IV.E-5
Maximum Marks: 25
Credits: 1
Duration: 30 hours

List of experiments:

1. Complete Pharmacopoeial analysis of drugs: a) Paracetamol b) Ibuprofen c) Aspirin
2. Synthesis of Benzocaine
3. Synthesis of benzophenone oxime.
4. Synthesis of phenytoin
5. Estimation of acetyl salicylic acid in the given aspirin tablet potentiometrically.
6. UV Absorbance Standard Curve of Salicylic Acid
7. Assay of Nitrazepam potentiometrically
8. Estimation of Ascorbic acid in tablets
9. Calibration of UV-visible spectrophotometer
10. Estimation of Penicillin – G
11. Estimation of Chloramphenicol

TEXT BOOKS:

1. Skoog D. A., Leary J. J., *Principles of Instrumental Analysis,* Philadelphia: Saunders College Publishing.
2. Beale J. Jr., Block J., *Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry,* Baltimore: Lippincott Williams and Wilkins.

REFERENCES BOOKS:

1. Indian Pharmacopoeia Commission. (2007). Indian Pharmacopoeia 2007.
2. Prichard Elizabeth, B. V. (2007). *Quality Assurance in Analytical Chemistry.* John Wiley & Sons.
3. Beckett A.H., StenlakeJ.B., (2001). *Practical Pharmaceutical Chemistry,* London: The Athlone Press.
4. Christian, G. D. (2004). *Analytical Chemistry* (06 ed.). New Jersey: John-Wiley & Sons, Inc.
5. Prabhu D.V, Raghuraman K, (2014). *Basic Principles of Analytical Chemistry,* Mumbai: Sheth Publishers.
6. Lednicer D., Mitscher L. (2008). *The Organic Chemistry of Drug Synthesis,* New Jersey: John-Wiley & Sons, Inc.
7. Gennaro, A. R. (1995). *Remington: The Science and Practice of Pharmacy,* London: Mack Publishing Company.
8. Sharma, D. B. (2005). *Instrumental Methods of Chemical Analysis,* Meerut: Goel Publishing House.
9. Higuchi T., E. B.-H. (1961). *Pharmaceutical Analysis.* New York: Interscience Publishers.

WEB REFERENCES:

1. http://www.chemistryexplained.com/Ny-Pi/Pharmaceutical-Chemistry.html
2. https://www.pharmatutor.org/articles/significance-of-pharmaceutical-regulatory-bodies-a-review
3. https://www.pharmatutor.org/articles/pharmaceutical-regulatory-agencies-and-organizations-around-world-scope-challenges-in-drug-development
4. https://luxury.rehabs.com/drug-abuse/classifications/
5. https://www.europeanpharmaceuticalreview.com/article/868/pharmaceutical-analysis-in-quality-control/
6. https://www.nhp.gov.in/introduction-and-importance-of-medicinal-plants-and-herbs_mtl
7. https://www.pharmatutor.org/articles/chromatography-introduction
8. https://www.labmanager.com/lab-health-and-safety/2017/12/science-laboratory-safety-rules-guidelines#.XiUvXcgzaM8
9. http://www.lawplainandsimple.com/legal-guides/article/health-and-safety-in-the-pharmaceutical-industry

ELECTIVE COURSE

THEORY
Course Title: Polymer and Colloid Science (Theory) [with effect from June 2020].
Course Code: CHE- IV. E-6
Maximum Marks: 75
Credits: 3
Duration: 45 hours

Course Objectives:
1. Will be able to classify colloids.
2. Will be able to calculate molar mass of polymers.
3. Will learn to synthesis some polymers in the laboratory

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Understand the colloidal state of matter
CO2: Evaluate properties of colloids.
CO3: Explain properties of gels and emulsions.
CO4: Calculate the molecular mass of polymer.
CO5: Understand solid state properties of polymers.
CO6: Design the synthesis of a polymer.
CO7: Synthesize and characterize colloids and determine molecular weight of polymer.

CO8: Distinguish between different types of solutions in terms of solute dimensions.

UNIT I: Colloidal Science **15 hours**
Colloidal state; colloidal solution; classification of colloids; lyophobic and lyophilic colloids; true solution, colloidal solution and suspension; preparation of sols; purification of sols; stability of colloids; protective action; Hardy- Schulze Law; gold number; General properties; electrical properties; electrical double layers; kinetics of coagulation; inhibition; general applications of colloids on size of colloidal particles

UNIT II: Emulsions, Gels and Introduction to Polymer Science **15 hours**
Emulsions- definition, types, preparation; gels- definition; classification, preparation and properties; Classification of polymers: thermoplastics and thermosetting, classification based on polymerization scheme, polymer structure: copolymers, tacticity, geometric isomerism; molecular weight: molecular weight distribution, molecular weight averages; chemical structure and thermal transitions; calculation of molecular weight: osmometry, light scattering method, intrinsic viscosity method

UNIT III: Polymer Chemistry **15 hours**
Step growth polymerization- kinetics, molecular weight; chain growth polymerization- free radical polymerization and copolymerization, ionic polymerization and copolymerization; polymerization technique; bulk polymerization, solution polymerization, suspension polymerization, emulsion polymerization, solid state- gas phase and plasma polymerization; polymer conformation and chain dimensions; thermodynamics of polymer solution- Flory-Krigbaum and Flory-Huggins theory; equation of state theory; amorphous state- chain enlargements and reputation, the glass transition, secondary relaxation processes; the crystalline state- ordering of polymer chains, crystalline-melting temperature, crystallization kinetics; technique to determine crystallinity.

PRACTICALS
Course Title: Polymer and Colloid Science (Practicals) [with effect from June 2020].
Course Code: CHE- IV. E-6
Maximum Marks: 25
Credit: 1
Duration: 30 hours

List of experiments:
1. To prepare colloidal solutions of cadmium sulphide and ferric hydroxide
2. To determine the flocculation value of a univalent and a divalent electrolyte for ferric hydroxide sol
3. To study the coagulation value of As_2S_3 sol with $AlCl_3$
4. To study the mutual coagulation value of ferric hydroxide sol
5. To determine the molar mass of a polymer using Ostwald's viscometer
6. To study the variation of the viscosity of a given liquid with temperature using Ostwald's viscometer
7. To determine the composition of a binary liquid mixture using viscometer
8. To determine the viscosity of liquid mixture and test the validity of Kendall's equation
9. To determine the surface tension of a liquid by drop number method using stalagmometer
10. To determine the composition of a binary liquid mixture using stalagmometer
11. To determine critical micelle concentration of a soap by surface tension method using stalagmometer
12. To determine the molecular weight of a given polymer by turbidimetric method
13. To separate the amino acids from the mixture by electrophoresis method
14. To separate the inorganic cations by paper electrophoresis method
15. To determine the amount of chloride ion by adsorption indicator method

TEXT BOOK:
Raj G., *Advanced Physical Chemistry*; Goel Publishing House, Meerut.

REFERENCE BOOKS:
1. Puri B. R., Sharma L.R., Pathania M. S., *Principles of Physical Chemistry*,Vishal Publishing Co.
2. Fried J. R., *Polymer Science and Technology*; Prentice Hall of India private limited
3. Bhatnagar M. S., *A Text Book of Polymer Science*, Volume 1

WEB REFERENCES:
1. https://www.toppr.com/guides/chemistry/surface-chemistry/classification-of-colloids/

2. https://www.slideshare.net/azamushahiullahprottoy/applications-of-colloid
3. https://www.livescience.com/60682-polymers.html
4. https://www.sciencenewsforstudents.org/article/explainer-what-are-polymers
5. https://www.toppr.com/guides/chemistry/surface-chemistry/properties-of-colloidal-solutions/

ELECTIVE COURSE

THEORY
Course Title: Spectroscopic Techniques (Theory) [with effect from June 2020].
Course Code: CHE-IV. E-7
Maximum Marks: 75
Credits: 3
Duration: 45 hours

Course Objectives:
On successful completion of the course, the student will be able to:
1. Will be able to understand the basic components of instruments and the choice of solvents for spectrometry.
2. Will be able to perform qualitative and quantitative analysis using principles of spectrometry.
3. Will be able to operate an UV-visible spectrophotometer.

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Outline the Beer's Law, Lambert's law and interprets the deviation from Beer-Lambert's Law; to identify the validity and limitations of Beer-Lambert's Law.
CO2: Interpret the spectroscopic methods for qualitative and quantitative analysis; compare the colorimeter and spectrophotometer and employ the UV-Visible Spectrophotometer.
CO3: Outline the principle on which inductively coupled plasma spectroscopy works and illustrate the instrumentation involved in the technique.
CO4: Apply inductively coupled plasma spectroscopy technique and understand its limitations.
CO5: Perform qualitative and quantitative analysis based on absorbance measurements

UNIT I: General Introduction **15 hours**
Overview of spectroscopy; meaning of electromagnetic radiation; interaction of electromagnetic radiation with matter; wave properties of electromagnetic radiation; particle properties of electromagnetic radiation; the electromagnetic spectrum; regions of spectrum; atomic and molecular spectra; representation of spectra; photons as a signal source; basic components of spectroscopic instruments; sources of energy; sources of electromagnetic radiation; sources of thermal energy; chemical sources of energy; wavelength selection; wavelength selection using filters; wavelength selection using monochromators; interferometers; detectors; photon transducers; thermal transducers; signal processors; solvents for spectrometry; quantitative calculations; spectrometric errors in measurements

UNIT II: UV- Visible Spectroscopy **15 hours**
Beer's Law; Lambert's Law; Beer - Lambert's Law; validity and limitations of Beer - Lambert's law; Deviations from Beer-Lambert's Law; Instrumentation principles: Sources, monochromators, cells; types of instruments; photoelectric colorimeters- single and double beam; spectrophotometers- single and double beam; comparison between colorimeter and spectrophotometer; analytical applications of colorimeter and spectrophotometer: λ_{max}, quantitative analysis, identification of structural groups in a molecule, study of co-ordination compound; photometric titrations

UNIT III: Electronic and Atomic Spectroscopy **15 hours**
Electronic (UV) spectroscopy- Theory; electronic transitions in a molecule; Chromophores and auxochromes; Bathochromic, hypsochromic, hyperchromic and hypochromic shifts; solvent effect; effect of temperature; applications of UV and visible spectroscopy- identification of structural groups, cis-trans isomerism, chemical kinetics, qualitative and quantitative analysis; limitations of UV and visible spectroscopy; Atomic Spectroscopy- origins of atomic spectra, production of atoms and ions; Atomic Emission Spectrometry: Introduction, principle, instrumentation, applications, advantages and limitations of flame photometry and Inductively coupled plasma spectroscopy; Atomic Absorption Spectrometry:

Introduction, principle, instrumentation, applications, internal standard and standard addition calibration, limitations Atomic Fluorescence Spectrometry: Introduction, principles, instrumentation and applications.

PRACTICALS
Course Title: Spectroscopic Techniques (Practicals) [with effect from June 2020].
Course Code: CHE-IV. E-7
Maximum Marks: 25
Credit: 1
Duration: 30 hours

List of experiments:
1. To test the validity of Beer-Lambert Law using spectrophotometer and determine the unknown concentration of a solution
2. To calibrate the UV- Visible spectrophotometer for control of absorbance and limit of stray light
3. Determination of Mn^{2+} ion concentration by periodate method using spectrophotometer
4. Determination of Fe^{3+} ion concentration by salicylic acid method using spectrophotometer
5. To estimate the amount of nitrite in water sample by spectrophotometric method
6. To determine the amount of K_2CrO_4 present in given sample by using UV-Visible spectrophotometer
7. To estimate the amount of paracetamol in tablet by spectrophotometric method
8. To estimate the amount of aspirin in the given tablet by spectrophotometric method
9. To verify the law of additivity of absorbance ($KMnO_4$ and $K_2Cr_2O_7$) at λ_{max} of $K_2Cr_2O_7$ and determine molar absorptivity
10. To determine the phosphate concentration in a soft drink by spectrophotometric method
11. Spectrophotometric methods for determining the stoichiometry of a complex formed between iron and 1,10- phenanthroline by continuous variation method
12. Spectrophotometric methods for determining the stoichiometry of a complex formed between iron and 1,10- phenanthroline by mole ratio method
13. To determine the dissociation constant of methyl red indicator by spectrophotometric method
14. To determine the amount of Cr (VI) in the given solution as dichromate by least square method spectrophotometrically

TEXT BOOK:
Skoog, D. A., West, D. M., Holler F. J., Crouch, S. R., Fundamentals of Analytical Chemistry, 8th Edition

REFERENCE BOOKS:

1. Holler, F. J., Skoog, D. A., Crouch, S. R., Principles of Instrumental Analysis, 6th Edition, Thomson Books
2. Willard, H.H., Merritt, L.L., Dean, J. A., Settle, F. A., Instrumental Methods of Analysis, CBS Publishing New Delhi, 7th Edition
3. Christian, G. D., Analytical Chemistry, John Wiley, 5th Edition
4. Ewing, G.W., Instrumental Methods of Chemical Analysis, 5th Edition, Mc-Graw Hill International Edition.
5. Bassett J., Denney R. C., Jeffrey G. H., Mendham J., Vogel's Text Book of Quantitative Inorganic Analysis, 4th Edition, ELBS and Longman

PRACTICAL BOOK:
Yadav, J. B., Advanced Practical Physical Chemistry, 14th Edition, Goel Publishing House

WEB REFERENCES:

1. https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/Spectrpy/UV-Vis/spectrum.htm
2. https://chemdictionary.org/beer-lambert-law/
3. https://www.indiastudychannel.com/resources/146681-Principle-working-and-applications-of-UV-spectroscopy.aspx
4. https://www.slideshare.net/manishpharma/application-of-uv-spectroscopy
5. http://liskeard.cornwall.sch.uk/images/Liskeard-Sixth-Form/Atomic-Absorption-Spectrometry.pdf

ELECTIVE COURSE

THEORY
Course Title: Chemistry of Natural Products (Theory) [with effect from June 2020].
Course Code: CHE-IV. E-8
Maximum Marks: 75
Credits: 3
Duration: 45 hours

Course Objectives:
1. Students will learn about importance of natural product in day today life.
2. Students will learn different techniques used in isolation and characterisation of natural products.
3. Students will learn important chemical synthesis involved in natural product.

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Identify, name and classify different natural products.
CO2: Describe the occurrence, isolation, biogenesis, biosynthesis, chemical synthesis and structure elucidation of selected terpenes.
CO3: Describe methods for the isolation, purification and characterization techniques in natural products Chemistry.
CO4: Describe the occurrence, classification, isolation, chemical synthesis and structure elucidation of selected alkaloids.
CO5: Describe the occurrence, composition, classification, nomenclature, uses and some reactions of various biomolecules like fats, carbohydrates, amino acids and nucleic acids.
CO6: Apply practical knowledge for the isolation and synthesis of natural products.

UNIT I: Introduction to Natural Product Chemistry, Isolation, purification and characterization techniques in natural products Chemistry **15 hours**
Introduction to natural products and classifications of natural products, Occurrence, classification and isolation of terpenes. Extraction methods in isolation/purification of natural products; Distillation techniques, Column chromatography for separation of natural products; Chromatographic techniques in natural products characterization: TLC, Mass spectrometry, spectroscopic techniques: IR, UV-Visible (Introduction, basic principle, utilization of techniques in identification of organic compounds).

UNIT II: Alkaloids and Biomolecules of life **15 hours**
Occurrence, Classification and isolation of alkaloids; Chemical synthesis and structure elucidation of selected alkaloids: Nicotine, Atropine, Papaverine. Fats: Occurrence and composition; Hydrolysis of fats; Carbohydrates: Classification, nomenclature anduses; Amino acids: Classification, nomenclature and uses. Structures and classes of peptides and proteins;Nucleic acids: different types of nucleic acids, Nucleosides, nucleotides and structure of DNA.

UNIT III: Terpenes **15 hours**
Occurrence, Classification and isolation of Terpenes; Chemical synthesis and structure elucidation of selected Terpenes: Citral, α-terpeneol, Camphor, Zinziberene.

PRACTICALS
Course Title: Chemistry of Natural Products (Practicals) [with effect from June 2020].
Course Code: CHE-IV.E-8
Maximum Marks: 25
Credit: 1
Duration: 30 hours

List of experiments:
1. Synthesis of dilantin natural product from benzyl
2. Synthesis of 2-phenyl-3,1-benzoxazin-4-on from anthranilic acid
3. Identification of citric acid in lemon juice as calcium citrate

4. Conversion of calcium citrate to citric acid
5. Synthesis of Benzylideneacetophenone
6. Carotenoid extraction from tomato using a green solvent
7. Carotenoid extraction from carrot using a green solvent
8. To prepare isopentyl acetate from isopentyl alcohol and acetic acid by the Fischer esterification reaction
9. To prepare octyl acetate from octyl alcohol and acetic acid by the Fischer esterification reaction
10. To prepare ethyl butyrate from ethyl alcohol and butyric acid by the Fischer esterification reaction
11. To synthesize salicylic acid from methyl salicylate in wintergreen oil
12. To identify the natural products using Spectroscopic techniques such as Mass spectrometry, IR, UV spectroscopy
13. Synthesis of dihydropyrimidinone
14. Preparation of caffeic acid from 3, 4 dihydroxy benzaldehyde
15. Isolation of caffeine from tea leaves

TEXT BOOK:

Nakanishi K., Natural Product Chemistry, Academic Press

REFERENCE BOOKS:

1. Manitto P., Biosynthesis of Natural Products, Horwood Ltd
2. Finar I. L., Textbook of organic Chemistry, Volume II
3. Finar I. L., Organic Chemistry: Stereochemistry and the Chemistry of Natural Products, ELBS Edition

WEB REFERENCES:

1. https://wou.edu/chemistry/courses/online-chemistry-textbooks/ch105-consumer-chemistry/ch105-chapter-6-hydrocarbons/
2. https://www.jsps.go.jp/english/e-plaza/e-sdialogue/03_data/Dr_Lemin.pdf
3. https://www.ukessays.com/essays/chemistry/natural-product-chemistry.php
4. https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/lipids.htm#terpen
5. https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/proteins.htm#aacd1
6. https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/carbhyd.htm#carb1
7. https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/nucacids.htm#nacd1
8. https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Book%3A_Basic_Principles_of_Organic_Chemistry_(Roberts_and_Caserio)/30%3A_Natural_Products_and_Biosynthesis

SKILL ENHANCEMENT COURSE

Course Title: Plating and corrosion (Theory and Practicals) [with effect from June 2020].
Course Code: CHE. SEC-2
Maximum Marks: 100
Credits: 4
Duration: 60 hours

Course Objectives:
1. Will learn principles of electroplating and its applications in various processes.
2. Will obtain a comprehensive and detail understanding of the principles of electroless plating.
3. Will be able to distinguish between various types of corrosion and calculate rate of corrosion.

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Understand principles of electroplating.
CO2: Design bath for electroplating.
CO3: Formulate ideal conditions for electroless plating.
CO4: Perform electroless plating.
CO5: Identify types of corrosion.
CO6: Calculate rate of corrosion.

Electroplating, Electroless plating and Corrosion studies **15 hours**
Electroplating processes: Rack plating, mass plating, continuous plating, in-line plating. Applications of plating. Requirements of metal finishing: Quality test for plated materials and cost effectiveness, ecology and environment. Materials that can be electroplated. Electrolytes for deposition of metal coatings. Electrolytic metal deposition: Direct current electrodeposition, pulse plating processes, laser induced metal deposition. Electroless metal deposition: Deposition of metal layers, deposition of alloys, deposition of composite coatings, coating thickness distribution. Electroless plating of nickel, electroless plating of copper. Thermodynamics of corrosion, electrochemical cells and galvanic corrosion, Pourbaix diagrams, kinetics of corrosion, concentration polarization and diffusion, passivity, crevice corrosion and pitting, mechanically assisted corrosion, corrosion inhibitors.

PRACTICALS **45 hours**
List of experiments:
1. To study electroplating of copper. **06 hours**
2. To study electroplating of nickel. **06 hours**
3. To study electroplating of chromium. **06 hours**
4. To study electroless plating of copper. **06 hours**
5. To study electroless plating of nickel **06 hours**
6. To study corrosion of copper in acid solution. **04 hours**
7. To calculate rate of corrosion of copper in acid solution. **04 hours**
8. To study corrosion of iron in salt solution. **04 hours**
9. To study corrosion of aluminium and zinc. **03 hours**

TEXT BOOKS:
1. Kanani N., *Electroplating: Basic Principles*, Processes and Practice, Elsevier.
2. McCafferty E., *Introduction to Corrosion Science*, Springer-Verlag New York Inc.
3. Mallory G. D. and Hajdu J. B., *Electroless Plating: Fundamentals and applications,* Elsevier.

WEB REFERENCES:
1. https://sciencestruck.com/zinc-electroplating-process
2. http://www.iom3.org/sites/default/files/Development%20and%20Application%20of%20%20Corrosion%20Control%20Methods.pdf
3. https://www.twi-global.com/technical-knowledge/faqs/what-is-corrosion
4. https://nptel.ac.in/content/storage2/courses/113108051/module1/lecture1.pdf
5. https://inversesolutionsinc.com/different-types-of-plating-and-their-effect-on-the-end-product/

SKILL ENHANCEMENT COURSE

Course Title: Laboratory Techniques in Organic Chemistry (Theory and Practicals) [with effect from June 2020].
Course Code: CHE. SEC-3
Maximum Marks: 100
Credits: 4
Duration: 60 Hours

Course Objectives:
1. Develop skill that are required in a Research Laboratory setup.
2. To make the students aware of the hazards in Organic Chemistry Laboratory and precautions.
3. To learn how to write a Lab note book.
4. To learn how to use a handbook and other references.
5. To develop experimental skills required in Organic Chemistry Laboratory.

Course Outcomes:
On successful completion of the course the students will be able to:
CO1: Students will be able to work in Research and Development industry, Chemical Laboratories etc.
CO2: Take responsibility for their safety and the safety of their colleagues
CO3: Set up reaction and distillation assemblies.

Skill Enhancement Course in Laboratory Techniques in Organic Chemistry **15 hours**

General introduction: Synthesis, isolation, purification and characterization. Safety in the laboratory, Laboratory note book. Handbook: CRC handbook, Merck index, Aldrich catalogue. Glassware: Joints, adapters, round bottom flask, columns and condensers, greasing of joints, cleaning and drying of glassware. Drying agents: Drying agents and using a drying agent. Handling of solid and liquid products. Recrystallization: Theory and practice, practice of solvent extraction and washing. Distillation: Clamping and distillation setup, boiling chip, steam distillation. Heating and cooling methods: Steam bath, Bunsen burner, Heating mantel, oil bath, proportional heaters and stepless controllers. Assembling reaction apparatus for: Refluxing, anhydrous reactions, Inert reaction condition, addition of reagents during a reaction, removal of noxious vapor's. Preparation of TLC and staining techniques. Drying of solvents

PRACTICALS **45 hours**

List of experiments

1. Drying of Acetone. **07 hours**
2. Distillation of Ethyl acetate and Pet ether. **08 hours**
3. Cleaning glass ware and drying. **04 hours**
4. Separation of colourless compound by thin layer Chromatography (Anthracene, Acetophenone, Benzophenone). **04 hours**
5. Recrystallization of organic compounds having low and high solubility and melting point determination. **04 hours**
6. Reaction involving inert atmosphere/anhydrous condition: Grignard Reaction: Synthesis, reaction monitoring, purification and characterization of Product OR Preparation of Fremys Salt and oxidation of phenol to quinone and purification. **08 hours**
7. Preparation of PDC **02 hours**
8. Oxidation of cinnamyl alcohol using PDC: Synthesis, reaction monitoring, purification by column chromatography and characterization of product. **08 hours**

TEXT BOOKS:

Vogel, A. I.;Tatchell, A. R.; Furnis, B. S.; Hannaford, A. J. Smith, P. W. G., *Textbook of Practical Organic Chemistry*. 5th edition, Prentice Hall.

REFERENCES BOOKS:

1. MANN, F. G.; SAUNDERS, B. C.**,** *Practical Organic Chemistry*. 2nd edition, Longman Inc., New York.
2. GATTERMANN, L.,*The Practical Methods of Organic Chemistry*. 2nd edition, Macmillan & Co., Ltd.

WEB REFERENCES:

1. https://www.linfield.edu/assets/files/chem/Courses/CHEM%20321/2014-labtechniques-chem321-53f4eb52cbe42.pdf
2. https://open.umn.edu/opentextbooks/textbooks/organic-chemistry-laboratory-techniques
3. https://doi.org/10.1021/acs.jchemed.5b00528
4. http://do.chem.uni.wroc.pl/system/files/Organic%20chemistry%20-%20laboratory%20methods_201617_0.pdf

SEMESTER V

CORE COURSE

THEORY
Course Title: Advanced Chemistry I: Physical and Inorganic Chemistry (Theory) [with effect from June 2020].
Course Code: CHE-V. C-7
Marks: 75
Credits: 3
Duration: 45 hours

Course Objectives:
1. Will have a working knowledge of the main areas of Physical Chemistry, will develop critical thinking abilities and be able to work in chemical or related fields.
2. Will help to get better understanding about the basics of Physical and Inorganic Chemistry.
3. Will be able to carry out experiments with required skills.

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Understand the interactions of electromagnetic radiation and matter in IR and Raman spectroscopy and their applications.
CO2: Express applications and harmful effects of nuclear radioisotopes.
CO3: Demonstrate a sound knowledge of the photochemistry principles and their application.
CO4: Employ the theories that govern metal ligand bonding.
CO5: Interpret the types of crystal field splitting and calculate the crystal field stabilization energy.
CO6: Discuss the types of d-d transitions and its theory.
CO7: Perform instrumental methods of analysis
CO8: Synthesize and analyze complexes

SECTION I (PHYSICAL CHEMISTRY)

UNIT I: Molecular Spectroscopy **07 hours**
Definition of spectrum. Electromagnetic radiation, quantization of different forms of energies in molecules: translational, rotational and electronic, Born Oppenheimer approximation, factors affecting line width and intensity.
Infrared spectroscopy
Hook's law, energy levels and transitions: Simple harmonic oscillator, anharmonic oscillator (derivations expected), Calculation of force constant, Stretching and bending vibrations, modes of vibration of diatomic, linear triatomic (CO_2) and non-linear triatomic (H_2O) molecules, applications of IR spectroscopy.
Raman spectroscopy - Rayleigh and Raman scattering, Stokes and Antistokes lines. Mutual exclusion principle. Differences between Raman and IR spectroscopy. Numerical problems expected.

UNIT II: Photochemistry **04 hours**
Interaction of radiation with matter, difference between thermal and photochemical processes, Laws of photochemistry: Grothus–Drapper law, Stark–Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions. Numerical problems expected.

UNIT III: Electrochemistry **07 hours**
EMF of a cell and its measurements, concentration cells: electrode and electrolyte with and without transport, liquid junction potential and its measurement; applications of concentration cell: determination of ionic product of water, transport number of ions, solubility and solubility product.Numerical problems expected.

UNIT IV: Nuclear Chemistry **05 hours**

Natural Radioactivity: kinetics of radioactive decay, half-life and average life of radioelements (derivations expected),Measurement of radioactivity: GM counter, Scintillation counterArtificial radioactivity: Chain reaction and conditions for its control.Radioisotopes and their applications; radiolabelled reactions, radiocarbon dating, medicinal and agricultural field, hazards of radiation.Numerical problems expected.

SECTION II (INORGANIC CHEMISTRY)

UNIT V: Metal-Ligand Bonding in Transition Metal Complexes **11 hours**

Principles and limitations of Valence bond theory, Crystal field theory (CFT) splitting of d- orbitals inoctahedral, tetrahedral and square planar complexes. Crystal Field Stabilization Energy (CFSE), Measurement of 10 Dq for $[Ti(H_2O)_6]^{3+}$ complex, Factors affecting 10 Dq, Spectrochemical series, Effect of crystal field splitting on properties of Octahedral complexes: Magnetic, Spectral.

UNIT VI: Electronic spectra of Transition Metal Complexes: **11 hours**

Introduction, types of electronic transitions: The d-d transitions (d^1/d^9 and d^2/d^8), charge transfer transitions and ligand-ligand transitions, selection rules (Laporte orbital and spin), applications (ligand field strength, colour of complexes, *cis*-, *trans*- isomerism and geometry of complexes).

PRACTICALS
Course Title: Advanced Chemistry I: Physical and Inorganic Chemistry (Practicals) [with effect from June 2020].
Course Code: CHE- V. C-7
Marks: 25
Credits: 1
Duration: 30 hours

List of experiments:
PHYSICAL EXPERIMENTS:

1. To determine the percent composition of acid mixture (strong acid and weak acid) by titrating against strong base conductometrically.
2. To determine the strength of mixture containing weak acid (CH_3COOH) and salt of strong acid and weakbase (NH_4Cl) by titrating against strong base conductometrically.
3. To determine the formal redox potential of Fe^{2+}/Fe^{3+} system using standard 0.1N $K_2Cr_2O_7$ solution potentiometrically.
4. To determine the percent composition and amount of halide ions from their mixture (any two halides) using standard 0.1N $AgNO_3$ solution potentiometrically.
5. To determine the dissociation constant of weak monobasic acid (CH_3COOH) by titrating against standard 0.1N NaOH solution using pH meter.
6. To study the acid hydrolysis of ethyl acetate at two different temperatures and calculate the energy of activation.
7. To determine solubility product of silver halide potentiometrically.

INORGANIC CHEMISTRY

1. Preparation of the following complexes.
   a) $[Ni(NH_3)_6]Cl_2$
   b) $[Co(NH_3)_3(NO_2)_3\ Cl_3$
   c) $K_3[Al(C_2O_4)_3].H_2O$
   d) $K_3[Fe(C_2O_4)_3]$.
2. Estimation of Al from the $K_3[Al(C_2O_4)_3].H_2O$ complex.
3. Preparation of zinc oxalate and estimation of zinc from the complex.
4. To estimate the amount of barium as $BaSO_4$ in a solution of Barium chloride containing ferricchloride and free HCl.

PHYSICAL CHEMISTRY
TEXTBOOK:

BahlB.S., et.al, 2004, *Essentials of Physical Chemistry*, S. Chand & Co., New Delhi

ADDITIONAL READING:

1. Arnikar H. J., 1995,*Essentials of Nuclear Chemistry*, Wiley-Eastern Ltd., New Delhi.
2. Atkins P, et.al, 2006, *Physical Chemistry*, Oxford University Press, New Delhi.
3. Castellan G.W., 2002, *Physical Chemistry*, Narosa Publishing House, New Delhi.
4. Kundu K.,2003, et.al.,*Physical Chemistry*, S. Chand & Co., Ltd., New Delhi.
5. Puri B.R., et.al, 2008, *Principles of Physical Chemistry*,Vishal Publishing Company, Jalandhar.
6. Raj G., 2000, *Advanced Physical Chemistry*, Goel Publishing House, Meerut.

WEB REFERENCES:

1. https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/photchem.htm
2. https://www.nde-ed.org/EducationResources/HighSchool/Radiography/detectionmeasurement.htm
3. https://ocw.mit.edu/courses/chemistry/5-35-introduction-to-experimental-chemistry-fall-2012/labs/MIT5_35F12_Mod1_Background.pdf

INORGANIC CHEMISTRY

TEXTBOOK:

Atkins P, Overton T, Rourke J et.al, *Shriver and Atkins' Inorganic Chemistry*, 5th Edition, Oxford University Press.

ADDITIONAL READING:

1. Cotton F.A and Wilkinson G, *Basic Inorganic Chemistry*,Wiley Eastern Ltd.
2. Huheey J.E, Keiter E.A, Keiter R.L, Medhi O.K, *Inorganic Chemistry: Principles of Structureand Reactivity*, Pearson Edu.
3. Lee J.D, *Concise Inorganic Chemistry*, Wiley-India

WEB REFERENCES:

1. http://cdn.intechopen.com/pdfs/38537/InTech-Electronic_absorption_spectra_of_3d_transition_metal_complexes.pdf
2. https://employees.csbsju.edu/cschaller/Principles%20Chem/New_Folder/TMligands.htm
3. https://link.springer.com/chapter/10.1007/978-3-662-25191-1_8

SEMESTER V

ELECTIVE COURSE

THEORY

Course Title: Heterocyclic Chemistry (Theory) [with effect from June 2020].
Course Code: CHE-V. E-9
Maximum Marks: 75
Credits: 3
Duration: 45 hours

Course Objectives:

1. Students will learn about important aspects with respect to heterocyclic chemistry.
2. Students will develop understanding with regards to reactivity of heterocyclic chemistry.
3. Students will learn efficient chemical synthesis involved in heterocyclic compounds.

Course Outcomes:

On successful completion of the course, the student will be able to:

CO1: Identify, name and classify the various heterocyclic compounds.

CO2: Describe the structure, different reactions and preparations of selected nitrogen and oxygen containing aliphatic heterocycles such as oxiranes, aziridines, tetrahydrofuran and pyrrolidine.

CO3: Describe the structure, diverse reactions and syntheses of pyrrole, furan, thiophene and pyridine heterocycles.

CO4: Describe the structure, diverse reactions and synthetic routes with mechanisms of numerous condensed heterocycles such as benzofuran, indole, benzothiophene, quinoline and isoquinoline.

CO5: Predict the reactivity of complex heterocyclic compounds containing the structural motif of these simple heterocycles.

CO6: Apply the synthetic methodologies for the synthesis of complex heterocycles.

CO7: Apply practical knowledge for the synthesis of other heterocycles.

UNIT I: Introduction to heterocyclic compounds and Aliphatic heterocycles **15 hours**
Classification and Nomenclature of aliphatic and aromatic heterocycles. Structure and reactivity of nitrogen and oxygen containing aliphatic heterocycles. Any two methods of preparation and reactions of oxiranes, aziridines, tetrahydrofuran, pyrrolidine.

UNIT II: Five and six membered aromatic heterocycles **15 hours**
Structure and reactivity of five and six membered heterocycles: furan, pyrrole, thiophene and pyridine; comparison of basicity of pyrrole, pyridine and piperidine. Electrophilic substitution reactions of five and six membered heterocycles: General mechanism, mechanism of halogenation, nitration and reaction using acids (HCl, H_2SO_4 and HNO_3). Any two methods of preparation of furan, pyrrole, thiophene and pyridine. Nucleophilic substitution reactions of aromatic heterocycles.

UNIT III: Condensed heterocycles **15 hours**
Structure and reactivity of condensed heterocycles like benzofuran, indole, benzothiophene, quinoline and isoquinoline. Electrohilic and nucleophilic substitution reactions of condensed heterocycles: General mechanism and with examples. Oxidation and reduction of condensed heterocycles. Any two methods of preparation of benzofuran, Indole, benzothiophene, quinoline and isoquinoline.

PRACTICALS
Course Title: Heterocyclic Chemistry (Practicals) [with effect from June 2020].
Course Code: CHE-V. E-9
Marks: 25
Credits: 1
Duration: 30 hours

List of experiments:
1. Epoxidation of chalcones (2steps)
2. Synthesis of the Coumarins via Pechmann condensation
3. Synthesisof 3,4- dihydropyrimidin-2(1H)-ones by a one-pot three component cyclocondensation reaction of 1,3 dicarbonyl compound, aldehyde, and urea via Biginelli reaction
4. Synthesis of 1,3,5-trisubstituted pyrazoles (2steps)
5. Synthesis of benzimidazole from o-phenylenediammine and formic acid
6. Synthesis of 2-substituted benzoxazoles from 2-amino phenol and aromatic aldehydes.
7. Synthesis of quinoxaline derivatives
8. Synthesis of flavones via Baker-Venkataraman rearrangement (3steps)
9. Preparation of 2-phenyl indole via Fischer indole synthesis

TEXT BOOK:
Joule, J. A. and Mills, K.,*Heterocyclic Chemistry*", Wiley publications.

ADDITIONAL READING:
1. Carey, F. C. and Giuliano, R. M.,*Organic Chemistry*, Tata McGraw-Hill India.
2. Gilchrist, T., Heterocyclic *Chemistry,* Pearson Education India.
3. Smith, M. B. and March, J.**,** *March's Advanced Organic Chemistry*, Wiley publications.

WEB REFERENCES:
1. https://www.britannica.com/science/heterocyclic-compound
2. https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/heterocy.htm
3. http://www.3rd1000.com/chem301/chem302a.htm
4. http://www.chem.gla.ac.uk/staff/stephenc/teaching/HeterocycleLectures2011_2C12.pdf
5. .http://www.chtf.stuba.sk/~szolcsanyi/education/files/Chemia%20heterocyklickych%20zlucenin/Heterocyclic%20Reviews%20and%20Summaries/Short%20Course%20on%20Heterocyclic%20Chemistry_Katritzky.pdf
6. http://www.chem.gla.ac.uk/staff/stephenc/teaching/HeterocycleLectures2011_2C12.pdf
7. https://www.studocu.com/en/document/glasgow-caledonian-university/organic-chemistry-2/lecture-notes/heterocyclic-compounds-lecture-notes/2771041/view

ELECTIVE COURSE

THEORY
Course Title: Nanomaterials and Solid State Chemistry (Theory) [with effect from June 2020].
Course Code: CHE-V. E-10
Maximum Marks: 75
Credits: 3
Duration: 45 Hours

Course Objectives:
1. Will be able to have a basic and concise knowledge of nanomaterials.
2. Will develop skills in nanomaterial synthesis.
3. Will be able to understand characterization techniques in solid state chemistry.

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Recall the history, occurrence and technological development of nanomaterials and classify them.
CO2: Compare different synthesis techniques of nanoparticles like biological, chemical and physical and design various nanomaterials.
CO3: Evaluate XRD data, and calculate its parameters; carry out analysis of TG-DTA thermogram; assess morphology and particle size from SEM/TEM images.
CO4: Express the physical and chemical properties of solids like magnetic, electrical and dielectric which can be interpret the applications of materials in various field like catalysis, ferrofluids, etc.
CO5: Synthesize and characterize nanomaterials.

UNIT I: Introduction, synthesis, properties, characterization of nanomaterials 15 hours
Fundamentals: terminology and history, classification of nanomaterials, properties of nanomaterials-mechanical, optical, magnetic, electronic, catalytic and surface area; synthetic approach with at least one example of each- Chemical methods (sol-gel, hydrothermal, sonochemical, microwave, precursor); Top down and bottom up; physical methods (mechanical methods, methods based on evaporation, sputter deposition, chemical vapour deposition); biological methods (using microorganism and plant extract); characterization techniques- diffraction techniques, electron microscopic techniques (SEM/TEM), magnetic measurement, UV-Visible spectroscopic, BET surface area.

UNIT II: Applications of nanomaterials and Solid State Reactions 15 hours
Energy, automobiles, sports, textile, cosmetics, medicinal, space, defense, engineering and catalytic applications; toxicity of nanomaterials; reactions of solids- tarnish reactions, decomposition reaction, solid-solid reactions, addition reactions, double decomposition reaction, electron transfer reaction, solid-gas reactions; sintering; phase transformations in solids- structural change in phase transformation, Martensite transformation, temperature and pressure induced transformations, order-disorder transitions.

UNIT III: Electrical and magnetic properties of solids 15 hours
Electrical conductivity, insulators, semiconductor and conductors; Band theory of semiconductors, photo conductivity and ionic conductivity; Piezoelectric, ferroelectric materials and applications; Introduction to magnetism, behavior of substance in a magnetic field, magnetic moments, diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism, magnetizations of a ferromagnetic substance; experimental determinations of susceptibility; Superconductors: Theory of Superconductivity, discovery, critical temperature, Meissner effect, types of superconductors.

PRACTICALS
Course Title: Nanomaterials and Solid State Chemistry (Practicals) [with effect from June 2020].
Course Code: CHE-V. E-10
Maximum Marks: 25
Credits: 1
Duration: 30 hours

List of experiments:
1. Synthesis of silver nanoparticles by chemical method
2. Synthesis of ZnO nanoparticles by chemical method

3. Synthesis of CdS nanoparticles by chemical method
4. Synthesis of PbS nanoparticles by chemical method
5. Synthesis of nanoparticles using plant extract (metal/ metal oxides)
6. Synthesis of CdS nanoparticles using plant extract
7. To find out particle size using SEM/TEM data
8. To study the X-ray diffraction pattern of given sample (Phase and particle size)
9. Preparation of zinc oxalate dihydrate and analysis of its TG/DTA pattern
10. To prepare mixed metal oxide of Zn and Fe using co-precipitation technique
11. To prepare mixed metal oxide of Zn and Fe using precursor technique
12. Measurements of electrical and magnetic properties of pure and mixed metal oxides

TEXTBOOK:

Atkins P. W., Overton T. L., Rourke J. P., Weller M. T. and Armstrong F. A., *Shriver and AtkinsInorganic Chemistry,* Oxford University press.

ADDITONAL READING:

1. Keer H. V., *Principles of Solid State Chemistry*, New Age International Publishers,
2. Kulkarni S. K., *Nanochemistry, Principles and Practices*, Capital publishers.
3. Poole C. P. and Owens F. J., *Introduction to Nanotechnology*, John-Wiley and Sons.
4. Rao M. B. and Reddy K. K., *Introduction to Nanotechnology*, Campus books International.
5. West A. R., *Solid State Chemistry and its Applications*, John-Wiley and Sons.

WEB REFERENCES:

1. https://www.toppr.com/guides/physics/electric-charges-and-fields/conductors-and-insulators/
2. https://www.livescience.com/38059-magnetism.html
3. https://www.understandingnano.com/nanomaterials.html
4. https://www.sciencedirect.com/topics/chemistry/solid-state-chemistry
5. https://link.springer.com/article/10.1007/s11837-013-0826-6
6. https://www.slideshare.net/Krishanyadav28/synthesis-of-nanomaterials

ELECTIVE COURSE

THEORY
Course Title: Organometallic Chemistry (Theory) [with effect from June 2020].
Course Code: CHE-V. E-11
Maximum Marks: 75
Credits: 03
Duration: 45 hours

Course Objectives:

1. Understand the basic principles of chemistry and molecular orbital theory with respect to chemical bonding.
2. To predict the structure and stability of organometallic cluster compounds based on the electron count and explain the chemical behavior and reactivity of organometallic compounds.
3. Describe and explain catalytic processes using an organometallic compound as a catalyst and explain how organometallic compounds are used as catalysts in organic synthesis.
4. Develop practical skills in the preparation of organometallic compounds and their precursors.

Course Outcomes:

On successful completion of the course, the student will be able to:

CO1: Illustrate metal-ligand interaction in formation of different metal carbonyls based on valence bond theory.
CO2: Explain and rationalize the synthesis, structure, bonding, properties of organometallic compounds of main group elements.
CO3: Apply the EAN concept and Wade's rules to any organometallic system and predict its stability, structure and bonding.
CO4: Understand the chemical behavior and predict the reaction mechanism of organometallic compounds.

CO5: Illustrate the catalytic cycles using an organometallic compound as a catalyst for industrial synthesis of some organic compounds.

CO6: Carry out synthesis of organometallic compounds and Interpret IR spectra of metal carbonyls and predict their structure.

UNIT I: Introduction to organometallic chemistry and metal carbonyls **15 hours**

Definition,classification of organometallic compounds, Nomenclature, ligands, concept of hapticity of organic ligands, 18 electron rule, EAN concept, electron counting and oxidation states in complexes.

Classification of metalcarbonyls; Mononuclear metal carbonyls: Preparation, properties, structure and bonding of $Ni(CO)_4$, $Fe(CO)_5$, $Cr(CO)_6$ using VBT; Polynuclear metal carbonyls: Preparation, properties, structure and bonding of $Co_2(CO)_8$, $Mn_2(CO)_{10}$, $Fe_2(CO)_9$ and $Fe_3(CO)_{12}$. -acceptor behaviour of CO (MO diagram of CO), synergic effect and use of IR data to explain structure and bonding in metal carbonyls.

UNIT II: Metallocenes and Reactivity of organometallic compounds **15 hours**

Sandwich compounds, Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation etc.). Structure and aromaticity, comparison of aromaticity and reactivity with benzene. Synthesis and reactivity of cyclopentadienyl compounds, bonding in bis(cyclopentadienyl) complexes, Fluxional behaviour of metallocenes. Metal-metal bonding and metal clusters: structure of clusters, electron counting in clusters, synthesis of clusters.

Reactions of organometallic compounds: Ligand substitution, Oxidative addition and reductive elimination, σ-bond metathesis, 1,1-migratory insertion reactions, 1,2-insertions and β-hydride elimination. Catalysis by organometallic compounds: Alkene hydrogenation with Wilkinson's catalyst.

UNIT III: Organometallic compounds of Main group elements **15 hours**

Preparation,properties, reactions, uses and structure of alkyls and aryls of Group 1 elements (Li, Na); Group 2 elements (Be, Mg); Group 13 elements (B, Al) Group 14 (Sn, Pb). Alkyl and aryl compounds of Ti, Zn and Hg**.**

PRACTICALS
Course Title: Organometallic Chemistry (Practicals) [with effect from June 2020].
Course Code: CHE-V. E-11
Maximum Marks: 25
Credit: 1
Duration: 30 hours

List of experiments:

1. Synthesis of chloro cobaloximes $[Co(Dmg)_2LCl]$ {L= quinoline, indole, benzimidazole, NH_3, aquo}
   a) Synthesis of $[Co(dmg)_2(qui)Cl]$
   b) Synthesis of $[Co\ (dmg)_2(Im)Cl]$
2. Synthesis of (phenyl)(pyridine)cobaloxime
3. Preparation of alkyl (aquo)cobaloxime
4. Preparation of aquo bromobis(dimethylglyoximato) cobalt (III)
5. Preparation of chlorobis(dimethylglyoximato)triethanolamine cobalt(III)
6. Preparation of chlorobis(dimethylglyoximato)(1,10phenanthroline)cobalt(III)
7. Structure analysis of metal-carbonyls based on IR data
8. Synthesis of $Co(PPh_3)_2Cl_2.\ 2H_2O$
9. Synthesis of $Ni(PPh_3)_2Cl_2.2H_2O$
10. Synthesis of $Ni(NCS)_2(PPh_3)_2$

TEXTBOOK:

Atkins P, Overton T, Rourke J et.al, *Shriver and Atkins' Inorganic Chemistry*, 5th Edition, Oxford University Press.

ADDITIONAL READING:

1. Cotton F.A and Wilkinson G, *Basic Inorganic Chemistry*,Wiley Eastern Ltd.
2. Huheey J.E, Keiter E.A, Keiter R.L, Medhi O.K, *Inorganic Chemistry: Principles of Structureand Reactivity*, Pearson Edu.
3. Lee J.D, *Concise Inorganic Chemistry*, Wiley-India

WEB REFERENCES:
1. https://www.nature.com/subjects/organometallic-chemistry
2. https://nptel.ac.in/content/storage2/courses/104108062/module2.pdf
3. https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Book%3A_Introduction_to_Organometallic_Chemistry_(Ghosh_and_Balakrishna)/8%3A_Carbonyls_and_Phosphine_Complexes/8.1%3A_Metal_Carbonyls
4. https://www.intechopen.com/books/recent-progress-in-organometallic-chemistry/radical-mechanisms-in-the-metallocenes
5. https://www.uni-due.de/ak_schulz/roocind.php

SEMESTER VI

CORE COURSE

THEORY
Course Title: Advanced Chemistry II: Organic and Analytical Chemistry (Theory) [with effect from June 2020].
Course Code: CHE-VI. C-8
Marks: 75
Credits: 3
Theory: 45 hours

Course Objectives:
1. Will learn to write mechanisms with stereochemistry.
2. Will learn principles of separation and its applications.
3. Will have practical knowledge of chromatographic techniques.
4. Will be able to carry out experiments with required skills.

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Assess conditions for obtaining maximum efficiency of extraction.
CO2: Classify chromatographic methods.
CO3: Apply chromatographic method for separation, qualitative and quantitative estimation.
CO4: Predict the stereochemistry of products for various reactions using the mechanisms involved in the course.
CO5: Explain the reactivity of organic compounds containing nitro, amino and cyano functional groups.
CO6: Name, classify the carbohydrates and analyze their chemical reactivity.
CO7: Name, classify organosulfur and organophosphorous compounds and analyze their chemical reactivity.
CO8: Perform qualitative and quantitative analysis based on theory.

SECTION I (ORGANIC CHEMISTRY)

UNIT I: Mechanism and stereochemistry of addition, substitution and elimination reactions 07 hours
Mechanism and stereochemistry of (i) Addition of halogens acids (HX) and halogen (X_2) to open chain alkenes. Markownikoff's and anti-Markownikoff's addition. (ii) S_N1, S_N2, S_Ni, substitutions and (iii) E1, E2 and E1 cb elimination reactions.

UNIT II: Organic Compounds containing Nitrogen 06 hours
Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media. Picric acid: preparation and properties. Structure and nomenclature of amines, physical properties. Structural features affecting basicity of amines. Preparation of alkyl and aryl amines by reduction of nitro compounds and nitriles, reductive amination of carbonyl compounds, Gabriel phthalimide reaction and Hofmann rearrangement.

UNIT III: Carbohydrates 06 hours
Classification and nomenclature. Monosaccharides: General reactions. Configuration of monosaccharides with reference to glucose. d(+)/l(-) and D/L systems of nomenclature. Interconversion of glucose to fructose and glucose to mannose. Cyclic structure of D(+)glucose. Mechanism of mutarotation. Formation of glycosides, ethers and esters. Structure of sucrose and inversion of cane sugar.

UNIT IV: Chemistry of Organosulfur and organophosphorus compounds 04 hours
Nomenclature and classification of Organosulfur compounds. Methods of preparation and chemical reactions of thiols, disulfides and sulphonic acids. Nomenclature and classification of organophosphorus compounds. Preparation of phosphines. Phosphorous ylides and their general methods of preparation. Wittig reaction and its synthetic applications.

SECTION II (ANALYTICAL CHEMISTRY)

UNIT V: Solvent Extraction **05 hours**

Principle,efficiency of extraction, percentage extraction, complexing agents in solvent extraction, separation factor, types of extraction, applications of solvent extraction
(Numerical expected)

UNIT VI: Chromatographic techniques **17 hours**

Principle, classification of chromatographic techniques Theory of chromatographic separation
Thin layer chromatography: Principle, technique and applications
Paper chromatography: Principle, technique and applications
Column Chromatography: Principle, technique and applications
Ion exchange chromatography: Principle, classification of ion exchangers. Factors affecting the distribution of ions between the resin and the solution, ion exchange capacity, applications of ion exchange chromatography
Gas chromatography: Principle, instrumentation, and applications. Comparison of GSC and GLC
HPLC: Principle, instrumentation and applications
Hyphenated techniques: GC-MS and LC-MS
(Numerical expected)

PRACTICALS
Course Title: Advanced Chemistry II: Organic and Analytical Chemistry (Practicals) [with effect from June 2020].
Course Code: CHE-VI. C-8
Marks: 25
Credits: 1
Duration: 30 hours

List of experiments:
ORGANIC CHEMISTRY EXPERIMENTS:
1. Organic mixture separation, purification of individual compounds and qualitative analysis of separated compound.
   Solid-solid, Solid-liquid, Liquid-liquid
   Note: 0.5 gm of solid-solid mixture to be analyzed on small scale. 3-4 ml of liquid to be added in mixture.
2. Preparation of 2-bromostyrene
3. Reduction of nitrobenzene to aniline
4. Estimation of Glucose
5. Wittig reaction between acetophenone and methylenetriphenylphosphorane

ANALYTICAL CHEMISTRY EXPERIMENTS:
1. To separate metal ions by paper chromatography and determine retardation factor
2. To study separation of organic compounds by TLC
3. To estimate nickel from Zn^{2+}/Ni^{2+} mixture by ion exchange chromatography
4. To estimate zinc from Zn^{2+}/Ni^{2+} mixture byion exchange chromatography
5. To determine the equilibrium constant for the reaction $KI + I_2 = KI_3$
6. To separate a mixture of carboxylic acid and neutral compound by using solvent extraction technique
7. To estimate amount of potassiumions in the given solution by ion exchange chromatography
8. To determine partition co-efficient of succinic acid between ether and water

ORGANIC CHEMISTRY
TEXT BOOK:
Morrison R. T., et. al., **2010.***Organic Chemistry*, Pearson Publications, Noida India.

ADDITIONAL READING:
1. Bruice P. Y.,**2015.***Organic Chemistry*, Pearson Publications, Noida India.
2. Carey F. C., et. al.,**2012.***Organic Chemistry*, Tata McGraw-Hill India.
3. Finar I. L.,**2013.***Organic Chemistry*, Volume 1. Pearson Publications, Noida India.

WEB REFERENCES:

1. https://www.khanacademy.org/science/organic-chemistry/stereochemistry-topic
2. https://www.khanacademy.org/science/organic-chemistry/substitution-elimination-reactions
3. https://www.khanacademy.org/science/organic-chemistry/amines-topic
4. https://www.saddleback.edu/faculty/jzoval/mypptlectures/ch12_carbohydrates/lecture_notes_ch12_carbohydrates_current.pdf

ANALYTICAL CHEMISTRY

TEXT BOOK:

1. Christian, G. D., *Analytical Chemistry*, 5^{th} edition, John Wiley publications
2. Skoog D.A., West D. M., Holler F. J.,*Fundamentals of Analytical Chemistry*, 2^{nd} edition,Saunders College Publishing

PRACTICAL BOOK:

Khosla B.D., Garg V.C., Gulati A., *Senior Practical Physical Chemistry*, R Chand & Co., New Delhi

WEB REFERENCES:

1. http://www.ccamp.res.in/sites/default/files/Basics%20of%20Chromatography_KR_C-CAMP.pdf
2. https://www.biochemden.com/ion-exchange-chromatography/
3. http://gonuke.org/wp-content/acad/Solventextraction.pdf

SEMESTER VI

ELECTIVE COURSE
THEORY
Course Title: Spectroscopic Methods in Organic Chemistry (Theory) [with effect from June 2020].
Course Code: CHE-VI. E-13
Maximum Marks: 75
Credits: 3
Duration: 45 hours

Course Objectives:

1. Will be able to do spectral analysis of organic compounds.
2. Will learn theory of important spectroscopic techniques.
3. Will be able to elucidate structures of organic compounds based on spectral data.
4. Will be able to operate an UV-visible spectrometer.

Course Outcomes:

On successful completion of the course, the student will be able to:

CO1: Describe the principles of IR, UV and Mass spectrometry.
CO2: Calculate UV maxima of any given organic compound using Woodward-Fieser rules.
CO3: Predict the presence of various functional groups in a given organic compound using IR spectroscopy.
CO4: Interpret the mass spectra of various organic compounds.
CO5: Predict the structures of organic compounds based on the given ^{1}H NMR and ^{13}CMR data.
CO6: Interpret the ^{1}H NMR and ^{13}CMR spectra of organic compounds.

UNIT I: UV-Visible Spectroscopy and IR-Spectroscopy **15 hours**

Nature of electromagnetic radiation: wave length, frequency, energy, amplitude, wave number, and their relationship, different units of measurement of wavelength, frequency, different regions of electromagnetic radiations. Interaction of radiation with matter: absorption, emission, fluorescence and scattering, types and advantages of spectroscopic methods.

UV Spectroscopy: Ultraviolet(UV) absorption spectroscopy: Absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophores and auxochromes, bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated dienes and enones, Woodward-Fieser rules for calculation of UV maxima of the above two systems.Numerical problems expected.

IR Spectroscopy: Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, functional group region, finger print region and its use to establish identity, applications to determine purity, to study progress of chemical reactions and hydrogen bonding, characteristic absorption bands of various functional groups and interpretation of IR spectra of organic compounds.

UNIT II: Proton Magnetic Resonance (^{1}H NMR) and ^{13}C Nuclear Magnetic Resonance spectroscopy **15 hours**

^{1}H NMR: Introduction to NMR Spectroscopy, types of protons: equivalent, non-equivalent, homotopic, enantiotopic and diastereotopic protons, NMR Spectrometer (block diagram), nuclear shielding and deshielding,chemical shift and molecular structure, spin-spin splitting and coupling constants, intensity of peaks, interpretation of ^{1}H NMR spectra of simple organic molecules. Structure elucidation of organic compounds using ^{1}H NMR spectral data is expected.

^{13}C NMR Spectroscopy: Number ofsignals, splitting of signals, proton coupled and decoupled spectra, off resonance decoupled spectra. ^{13}C NMR chemical shifts, identification of hybridization of carbons and nature of functionalization. Structure elucidation of organic compounds using ^{13}C NMR spectral data is expected.

UNIT III: Mass Spectrometry and spectral problems **15 hours**

Mass Spectrometry: Instrumentation, definitions of parent or molecular ion peak and base peak. Isotope effect with respect to alkyl halides. Fragmentation of alkanes, alkenes, aromatic hydrocarbons, alkyl halides, alcohols, aldehydes, ketones: α -cleavage and Mc-Lafferty rearrangement.

Structure elucidation of organic compounds using Mass, UV, IR, ^{1}H NMR and ^{13}C NMR spectral data is expected.

PRACTICALS

Course Title: Spectroscopic Methods in Organic Chemistry (Practicals) [with effect from June 2020].

Course Code: CHE-VI. E-13

Maximum Marks: 25

Credits: 1

Duration: 30 hours

List of experiments:

1. Calculate UV maxima for given organic structure and match it with the given spectra of organic compounds.
2. Match the given set of organic compounds with the given set of spectra. List: Alkane, alkene, alcohol, ether, amine, carboxylic acid, ester and amides.
3. Verify Bathochromic, hypsochromic, hyperchromic and hypochromic shifts in phenol and aniline using UV-Vis spectrometer.
4. Identification of organic compounds based on given IR spectra of organic compounds.
5. Distinguish between given set of organic compoundson basis of their IR spectra (3 sets of 2 compounds).
6. Identify the compounds based on given Mass Spectra. List: Alkane, alkene, alcohol, ether, amine, carboxylic acid, ester and amides.
7. Give the fragmentation patterns for the given mass spectra of organic compounds.
8. Compare relative abundance of isotopes of halogen containing compound.
9. Determination of organic compound using given set of ^{1}H NMR data.
10. Determination of organic compound using given ^{1}H NMR spectrum.
11. Assigning the chemical shift values to the peaks of given ^{1}H NMR spectrum of organic compounds.
12. Determination of organic compound using given set of ^{13}C NMR data.
13. Assigning the chemical shift values to the peaks of given ^{13}C NMR spectrum of organic compounds.
14. Assigning the chemical shift values to the peaks of given ^{1}H NMR spectrum of organic compounds.
15. Identification of organic compounds based on given spectroscopic information.

TEXTBOOKS:

Silverstein, R. M., et. al., *Identification of Organic Compounds*, Wiley publications

REFERENCE BOOKS:

1. Kalsi, P. S., *Spectroscopy of Organic compounds*, New Age International (P) Ltd. New Delhi.
2. Morrison, R. T., et. al.,*Organic Chemistry* Pearson Publications, Noida India.
3. Pavia, D. L., et. al., *Introduction to Spectroscopy*, Cengage Learning.

WEB REFERENCES:

1. https://www.khanacademy.org/science/organic-chemistry/spectroscopy-jay
2. http://web.mit.edu/5.33/www/lec/spec1.pdf
3. http://www.uni-salzburg.at/fileadmin/oracle_file_imports/359201.PDF
4. https://nptel.ac.in/content/storage2/courses/104106075/Week6/MODULE%2025.pdf
5. https://nptel.ac.in/content/storage2/courses/104106075/Week4/MODULE%2017.pdf
6. https://www.brown.edu/academics/chemistry/sites/academics-chemistry/files/NMR_Introductory_Lecture.pdf

ELECTIVE COURSE

THEORY
Course Title: Environmental Chemistry (Theory) [with effect from June 2020].
Course Code: CHE-VI. E-14
Maximum Marks: 75
Credits: 3
Duration: 45 hours

Course Objectives:
The course provides understanding how:
1. Pollution affects our environment
2. Knowledge of chemistry can be used to solve problems.
3. Instrumental techniques can be used for chemical analysis of pollutants.

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Delineate how pollutants are transported and accumulated in the environment.
CO2: Recognize different types of toxic substances and analyze toxicology.
CO3: Describe water purification and waste treatment processes.
CO4: Apply knowledge of chemical and biochemical principles of fundamental environmental processes in air, water, and soil.
CO5: Apply basic chemical concepts to analyze chemical processes involved in different environmental problems.
CO6: Develop skills in procedures and few instrumental methods applied in analysis of soil and water pollution.

UNIT I: Introduction **15 hours**
Atmosphere: Composition, Structure, properties vertical temperature behavior, lapse rate and temperature inversion.Air pollution: Introduction, classification of pollutants, sources, control, effect with respect to oxides ofNitrogen, Carbon and Sulphur, Photochemical smog, acid rain and Green House effect. Water pollution: Chemical, physical and biological characteristics of water pollution, specific and Nonspecific characterization of water. DO, BOD, COD and chlorine demand, typical water treatment and waste water treatment. Importance of buffer and buffer index in waste water treatment.Ozone Chemistry: Major atmospheric species involved in ozone formation and destruction, some major chemical reactions in the troposphere associated with ozone.Stratospheric ozone: pollutants, destroying stratospheric ozone layer. Species destroying ozone layer: i) catalytic NO, ii) photo dissociation, of CFCs, iii) catalytic role ofchlorine, and iv) combined chain reaction. The ozone holes

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UNIT II: Chemistry of Atmosphere, Soil and Pollutants **15 hours**
Chemistry of Atmosphere and soil: Reactions in the atmosphere: i) formation in the atmosphere ii) reaction of hydroxyl radical with trace gases and as sources of hydroperoxy radical and hydrogen peroxide. The methane cycle.Macro- and micro-nutrients in soil (N, P,K), chemistry of minerals of soil forming rocks.Sampling of Pollutants: Sampling of air pollutants: Absorption in liquids, Adsorption on solids- cold trapping adsorption and collection of particulates.Sampling of water pollutants: sampling and sample preservation. Sampling of solids: sample size, equipment and methods of sampling, Auger

sampler, tube sampler. Adverse effects of specific pollutants: Effects of Hg, Pb and nitrites on humans and other living organisms, Oil Spill: Biological and physical effects, Acid, mine and drainage: Reactions of FeS_2 (pyrites), Cr, As and F. Toxic elements in soil including those are in trace quantities

UNIT III: Application of instrumental techniques in environmental analysis and Solid waste management **15 hours**

Air analysis: a) SO_2, b) H_2S, c) CO d) CO_2 and e)NOx. Water analysis: a) determination of organic loadings b) determination of toxic metal ions c) C.O.D d) B.O.D and e) D.O. Soil/Sediment analysis: a) Bulk density, b)Specific gravity, c) Moisture content d) Water holding capacity e) Conductivity f) Alkalinity, and g) detection of sulphate, calcium and iron. Optical and radiochemical techniques:Introduction, basic principle and applications of Turbidimetry, Nephelolmetry, Isotope dilution analysis and Neutron activation analysis. Techniques of water treatment: a) Treatment of water for municipal purpose: Important processes involved in purification of water. b) Treatment of water for Industries: Removal of hardness of water by Clark's method and use of ion exchange resins. Solid waste origin and management: a) Origin andClassification of solid waste types b) Solid waste management method: i) Utilisation, ii) Recovery, iii) Reuse iv) Recycling of wastes residues, v) Recycling avoidance of solid waste, Use of Remote Sensing in Environmental Management

PRACTICALS
Course Title: Environmental Chemistry (Practicals) [with effect from June 2020].
Course Code: CHE-VI. E-14
Maximum Marks: 25
Credits: 1
Duration: 30 hours

List of experiments:
1. Determination of sodium in water: ion exchange method
2. Determination of Total solids, Total dissolved solids and total suspended solids and its significance.
3. Determination of chloride content in tap water samples: Mohr's method
4. Determination of acidity and alkalinity in water samples.
5. Determination of total, permanent and temporary hardness of water sample
6. Determination of DO of water sample
7. Determination of polluting elements such as Pb, Hg and As in water.
8. Analysis of Mn in a water sample by spectrophotometry.
9. Analysis of different types of soil- pH, conductivity, alkalinity
10. Determination of nitrite in water by colorimetric method
11. Determination of COD of water samples
12. Determination of BOD of water samples
13. Determination of phosphate: Colorimetric method

REFERENCE BOOKS:

1. Christan G. D., 5th edition ,"Analytical Chemistry ", Wiley publication
2. De, A. K,1995 "Environmental Chemistry", Wiley eastern Ltd.
3. Iqbal,S.A.et.al,1995," Chemistry of Air and Air Pollution", Discovery Publishing House, New Delhi
4. Katyal Jimmy et.al, 1993,"Environmental Pollution", Anmol Publications, New Delhi
5. Manahan, S.E. 1994,"Environmental Chemistry" Lewis Publishers
6. Neil,P. O 2007,"Environmental Chemistry", Blackie Academic & Professional
7. Raghuraman, K.et al,4th edition," Basic Principles of Analytical Chemistry",sheth publishers
8. Schroede, E.D,1997, "Water & waste water treatment", Mc. Graw Hill
9. Skoog et.al, 4th International edition ,"Principles of Analytical Chemistry" Saunders college Publishers
10. Trivedi P.R. et.al, 1st edition"Environmental Water and Soil Analysis",Akashdeep Publishing house , New Delhi
11. Tyagi, O.D. et.al, 1992,"A Text Book Of Environmental Chemistry" Anmol Publications, New Delhi
12. Vanloon G.W. et.al, 2003,"Environmental Chemistry", Oxford University Press

WEB REFERENCES:

1. https://www.clearias.com/composition-structure-earth-atmosphere/
2. https://www.nrdc.org/stories/air-pollution-everything-you-need-know

3. https://www.nrdc.org/stories/water-pollution-everything-you-need-know
4. https://biologyreader.com/ozone-depletion.html
5. https://www.conserve-energy-future.com/sources-effects-methods-of-solid-waste-management.php

ELECTIVE COURSE

THEORY
Course Title: Selected Topics in Inorganic Chemistry (Theory) [with effect from June 2020].
Course Code: CHE- VI. E-15
Maximum Marks: 75
Credits: 3
Duration: 45 hours

Course Objectives:
1. Understand and integrate concepts relevant to graduate level Inorganic Chemistry.
2. Acquire knowledge about the bond formation of compounds with special reference to MOT and CFT.
3. Determine the stability and instability of complexes using spectrophotometry.
4. Develop practical skills to carry out separation of metal ions by ion exchange method and analyze them using titrimetry or gravimetry.

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Differentiate between thermodynamic stability and kinetic stability and apply it to transition metal complexes.
CO2: Apply the concepts to determine the reaction mechanism of transition metal complexes.
CO3: Determine the factors that govern the stability and lability of transition metal complexes.
CO4: Understand the chemistry and function of some of the technologically useful materials like liquid crystals, superconductors and fullerides.
CO5: Discuss what are polymers and their properties, to classify the polymers (based on coordination, addition and condensation reaction).
CO6: Illustrate the preparation, structure and bonding and applications of polymers comprising of B, P, Si and S.
CO7: Analyze the magnetic properties of the transition metal complexes as well as interpret the effect of temperature on magnetic properties.
CO8: Explain Guoy's balance for determining the magnetic susceptibility.
CO9: Identify and apply the symmetry elements in molecules and to evaluate the Point groups and symmetry elements in molecules with appropriate examples.
CO10: Carry out separation and estimation of ions from compounds.

UNIT I: Magnetic Properties of Metal Complexes and Molecular Symmetry 15 hours
Types ofmagneticbehaviour, magnetic susceptibility, effect of temperature on magnetic properties, Curie temperature, Neel temperature, Curie-Weiss law. Methods of determining magnetic susceptibility, Guoy's balance, spin only formula, calculation of magnetic moment of transition metal ions, application of magnetic moment data for 3d-metal complexes.
Symmetry elements and operations: Centre of symmetry, Rotation axis, Mirror plane, rotation-reflection axis, Identity element. Point groups, Identifying symmetry elements and point group in molecules. (examples to be solved).

UNIT II: Thermodynamic and Kinetic Aspects of Metal Complexes 15 hours
Thermodynamic and kinetic stability of metal complexes, equilibrium constants, formation constants, labile and inert complexes, factors affecting the stability, substitution reactions in tetrahedral and octahedral complexes, Factors affecting the rate of substitution reactions. Electron transfer reactions- inner sphere mechanism and outer sphere mechanism. Trans effect with respect to square planar complexes.

UNIT III: Inorganic Materials Chemistry 15 hours
Definition, properties, classification (condensation, addition and coordination), preparation, structure and bonding and applications of polymers containing Boron (borazine), phosphorous (phosphazenes), silicon (silicones), sulfur (S_4N_4, thiazyl halides).

Zeolites: Types, structure and applications.
Composite materials: Metal-organic frameworks (MOF's); structure, ligands, applications.
Molecular materials: Fullerides, liquid crystals, molecular magnets.
Corrosion: Response of material to chemical environments, galvanic corrosion and other forms of corrosion, Prevention methods.

PRACTICALS
Course Title: Selected Topics in Inorganic chemistry (Practicals) [with effect from June 2020].
Course Code: CHE- VI. E-15
Maximum Marks: 25
Credit: 1
Duration: 30 hours

List of experiments:
1. Separation and Determination of transition metal ions
    a) Separation of Mg^{2+} and Zn^{2+} by ion exchange and its estimation
    b) Separation of Cd^{2+} and Zn^{2+} by ion exchange and its estimation
2. Determination of stability constant of complex ions in solution
    a) Fe(III) – salicylic acid complex (Job's Method)
    b) Fe(II) – 1,10-phenanthroline
3. Determination of instability constant for the reaction between Cu^{+} and NH_3.
4. Determination of instability constant for the reaction between Cu^{2+} and en.
5. Estimation of Ca in compounds containing calcium volumetrically.
6. Estimation of Ni in compounds containing nickel volumetrically.
7. Estimation of Cu in compounds containing copper volumetrically.
8. Estimation of metal ions in mixed metal compound.

TEXTBOOKS:
Atkins P., et.al., *Shriver and Atkins Inorganic Chemistry*, Oxford University Press.

ADDITIONAL READING:
1. Lee J.D., *Concise Inorganic Chemistry*, Wiley-India.
2. Huheey J.E., Keiter E.A., Keiter R.L., Medhi O.K., *Inorganic Chemistry: Principles of structureand reactivity*, Pearson Edu., 1993
3. Cotton F.A. and Wilkinson G., *Basic Inorganic Chemistry*, Wiley Eastern Ltd., 1993
4. Puri B.R., Sharma L.R., Kalia K.C., *Principles of Inorganic Chemistry*, Vishal Publishing Co.

WEB REFERENCES:
1. http://asdn.net/asdn/chemistry/zeolites.php
2. https://www.nanowerk.com/mof-metal-organic-framework.php
3. https://www.materialstoday.com/carbon/news/alkali-fullerides-reveal-more-superconductivity-se/
4. https://galvanizeit.org/corrosion/corrosion-process/types-of-corrosion
5. https://saylordotorg.github.io/text_general-chemistry-principles-patterns-and-applications-v1.0/s15-08-liquid-crystals.html
6. http://mathworld.wolfram.com/SymmetryOperation.html

Parvatibai Chowgule College of Arts and Science

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ANNEXURE A

(Summary of changes incorporated in the syllabus)

Semester	Course Title	Existing (Indicate only the unit where the change is proposed)	Changes Proposed	Specify the reason for the change
Sem I	**CHE-I. C-1** General Physical and Inorganic Chemistry	Practicals	*Following four new experiments are introduced in Course:* To study the molecular condition of benzoic acid in toluene-water system To study distribution of acetic acid between water and cyclohexane Preparation of lead carbonate. Preparation of ferrous ammonium sulphate	Four more experiments added in the course since earlier there were only eight experiments
	CHE-I. C-2 General Organic and Inorganic Chemistry	Unit II	*Title of Unit II* Structural Theories and Reactivities of Organic Compounds **changed to** Structure and Reactivity of Organic Compounds	Structure determines reactivity
			Term Curved arrows in organic chemistry **changed to** Different arrows used in organic chemistry	New term is more general in nature and has more scope
		Practicals	*Following one new experiment is introduced in Course:* Volumetric estimation of Calcium	need to add one more experiment in the course
Sem II	**CHE-II. C-3 Concepts in Physical and Analytical Chemistry**	Practicals	*Following four new experiments are introduced in Course:* To determine the heat of neutralization of strong acid with strong base. To determine the heat of neutralization of weak acid with weak base.	Four more experiments added in the course since earlier there were only eight experiments

			To determine the amount of boric acid in the given solution using conductometry To determine the amount of lead ions in the given solution using conductometry	
Sem III	**CHE-III. E-1 Name reactions and Synthetic methodologies**	Unit II	*Subtopic* ipso-attack and orientation in benzene with more than one substituent **changed to** ipso-substitution and orientation in aromatic compounds with electron donating and electron withdrawing substituents	ipso-substitution is a better term
	CHE-III. E-2 Introduction to Industrial Chemistry	Unit I	*Title* Fundamentals ofIndustrial chemicals and need for greener processes, materials Science and Introduction to Electroplating **changed to** Fundamentals of Industrial Chemistry and Electroplating	New title is more specific
		Unit II	*Title* Selected key industrial processes, Boilers and heat exchangers and Paint chemistry **changed to** Industrial processes, Boilers, Heat exchangers and Paint chemistry	New title is more specific
		Unit III	*Title* Industrial Safety and Conducts, Effluent treatment and Waste management **changed to** Industrial Safety, Conducts, Waste management and Effluent treatment	New title is more specific
			Introduction of subtopic Treatment of electronic waste	Topic is of utmost importance in today's scenario
	CHE-III. E-4 Bioinorganic Chemistry	Unit II	*Title* Iron and Copper containing compounds in biology **changed to** Iron containing compounds in biology	New title is more specific
		Practicals	*Deletion* Determination of hardness of water by EDTA	The experiment is already performed in other Course
			Addition Preparation of Potassium trisoxalato ferrate(III)	Replacement for the experiment removed
Sem IV	**CHE-IV. C-6 Comprehensive Chemistry-II**	Unit I	*Unit I* Studies of organic compound containing C, H and O **changed to** Ethers	Other classes of compounds apart from ethers are covered in earlier courses

		Unit III	*Addition of subtopic* Acid anhydrides: Preparation and reactions	Acid anhydrides is an important subtopic for the course
		Practicals	*Following two new experiments are introduced in Course:* Estimation of Ester Estimation of Amide	Need to add experiments based on organic estimation
	CHE-IV. E-5 Pharmaceutical Chemistry	Practicals	*Experiment* Estimation of Ascorbic acid in tablets by iodometry **changed to** Estimation of Ascorbic acid in tablets	New title was more general and different methods can be used for estimation
	CHE-IV. E-6 Polymer and Colloid Science	Practicals	*Following one new experiment is introduced in Course:* To determine the amount of chloride ion by adsorption indicator method	The experiment is aligned with the theory syllabus
	CHE-IV. E-7 Spectroscopic Techniques	Unit III	*Title* Electronic (UV) Spectroscopy and Atomic Spectroscopy **changed to** Electronic and Atomic Spectroscopy	New title is more specific
	CHE-IV. E-8 Chemistry of Natural Products	Unit I Unit II Unit III	*The course syllabus is restructured Unit wise with the following changes* *Subtopics deleted* 1. Morphine 2. Biogenesis and biosynthesis 3. Carbohydrates: Classification, nomenclature and uses *Subtopics added* 1. Atropine and Papaverine	Syllabus lacked continuity and restructuring of syllabus was necessary. Subtopic 1 and 2 were deleted because of its difficulty level Subtopic 3 was deleted because of repetition in another course. Subtopic 1 was added since it is easy for students to understand
	CHE. SEC-2 Plating and corrosion	Four credit course	New Introduction	As required by structure of the programme
			Subtopic Quality and cost effectiveness **changed to** Quality test for plated materials and cost effectiveness	New subtopic is more specific to the course objective
		Practicals	To study electroless plating of copper (one experiment) **changed to**	The experiment is aligned with the theory

			To study electroless plating of nickel	syllabus
	CHE. SEC-3 Laboratory Techniques in Organic Chemistry	Four credit course	New Introduction	As required by structure of the programme
		Practicals	Practicals restructured by removing some experiments and adding some new experimentsto align the practicalswith the learning objectives of the course	Restructuring of practicals was necessary to align the practicals with the learning objectives of the course
Sem V	**CHE-V. C-7 Advanced Chemistry I: Physical and Inorganic Chemistry**	Practicals	*Following four experiments are deleted from the Course:* Preparation of $K_3[Al(C_2O_4)_3].H_2O$ Preparation and estimation of Ti in $[Ti(H_2O)_6]^{3+}$ complex Estimation of Ni in $[Ni(NH_3)_6]Cl_2$ gravimetrically Estimation of Co in a cobalt complex gravimetrically *Following five new experiments are introduced in Course:* To determine solubility product of silver halide potentiometrically Preparation of $K_3[Fe(C_2O_4)_3]$ Estimation of Al from the $K_3[Al(C_2O_4)_3].H_2O$ complex Preparation of zinc oxalate and estimation of zinc from the complex To estimate the amount of barium as $BaSO_4$ in the solution of Barium chloride containing ferric chloride and free HCl	Restructuring of practicals was necessary to align the practicals with theory course and accordingly gave suggestions for restructuring
	CHE-V. E-9 Heterocyclic Chemistry	Unit I Unit II Unit III	*Subtopics* Methods of preparation **changed to** Any two methods of preparation *(For all kinds of classes of heterocycles in all three Units)*	Recommendation for making the syllabus more specific
	CHE-V. E-10 Nanomaterials and Solid State Chemistry	Unit II	*Title* Applications of nanomaterials and Solid State Chemistry **changed to** Applications of nanomaterials and Solid	New title is more specific

			State Reactions	
		Unit III	*Introduction of new subtopic* Superconductors: Theory of Superconductivity, discovery, critical temperature, Meissner effect, types of superconductors	Subtopic is essential in this Course
		Practicals	*Following two new experiments are introduced in Course:* Synthesis of PbS nanoparticles by chemical method Synthesis of CdS nanoparticles using plant extract	Need to add more experiments in this course
	CHE-V. E-11 Organometallic Chemistry	Practicals	*Following two experiments are deleted from the Course:* Preparation of chloro(pyridine) *bis*(dimethylglyoximato) cobalt(III) Preparation of bromo (pyridine) bis (dimethylglyoximato) cobalt (III) *Following five new experiments are introduced in Course:* Preparation of alkyl (aquo)cobaloxime Preparation of aquobromobis(dimethylglyoximato) cobalt (III) Preparation of chlorobis(dimethylglyoximato)triethanolamine cobalt(III) Preparation of chlorobis(dimethylglyoximato)(1,10-phenanthroline)cobalt(III) Synthesis of $Ni(NCS)_2(PPh_3)_2$	Restructuring of practicals was necessary to avoid some harmful chemicals
Sem VI	**CHE-VI. C-8 Advanced Chemistry II: Organic and Analytical Chemistry**	Practicals	*Following two experiments are deleted from the Course:* To estimate magnesium from Zn^{2+}/Mg^{2+} mixture by using an anion exchanger resin To estimate zinc from Zn^{2+}/Mg^{2+} mixture by using an anion exchanger *Following eight new experiments are introduced in Course:* Preparation of 2-bromostyrene	Restructuring of practicals was necessary to align the practicals with theory course as well as to prevent repetition of practical in another course

			Reduction of nitrobenzene to aniline Estimation of Glucose Wittig reaction between acetophenone and methylenetriphenylphosphorane To estimate nickel from Zn^{2+}/Ni^{2+} mixture by ion exchange chromatography To estimate zinc from Zn^{2+}/Ni^{2+} mixture by ion exchange chromatography To estimate amount of potassium ions in the given solution by ion exchange chromatography To determine partition co-efficient of succinic acid between ether and water	
	CHE-VI. E-13 Spectroscopic Methods in Organic Chemistry	Unit I Unit II Unit III	The course syllabus is restructured Unit wise with the same subtopics	Syllabus lacked continuity and restructuring of syllabus with same subtopics was necessary
	CHE- VI. E-15 Selected Topics in Inorganic Chemistry	Unit III	*Title* Inorganic Polymers and Materials Chemistry **changed to** Inorganic Materials Chemistry	New title is more specific
			Deletion Superconductors: discovery, critical temperature, Meissner effect, types of superconductors	Subtopic is repeated in another course and hence is deleted
		Practicals	*Experiment* Determination of instability constant for the reaction between Ag^+ and NH_3 **changed to** Determination of instability constant for the reaction between Cu^{2+} and NH_3	The new experiment is better experiment than the old one

Naik

Dr. Mayuri M. Naik

Member Secretary

Board of Studies

SBKakodkar

Dr. Sachin B. Kakodkar

Chairman

Board of Studies

Date: 09/03/2020

COMPUTER SCIENCE

B.Sc. Computer Science – Syllabus
(from Academic Year 2015-16)
Semester I

Paper Title: Mathematical Foundation of Computer ScienceI
Paper Code:COM-I.C-1
Name of Faculty: Dr. Animesh Adhikari
Marks: 75
Credits: 3
Course Objectives:

- To build mathematical foundations that are essential requirement in understanding various concepts related to computer science.

Learning Outcome:

On completion of the course students will learn the concepts of the following:

- Combination and permutation.
- Numbers systems and conversions
- Boolean Algebra and Logic
- Set, Relations and Functions
- Finite Machines

1. **Combinatory:** **[8L]**
   Permutations; Combinations; Counting; Summation; generating functions; recurrence relations.

2**.Binary Number System:[7L]**
Decimal to binary conversion and vice versa, binary number representation (signed, 1's Complementand 2's complement) binary addition, subtraction, binary to octal, hexadecimalconversion and viceversa. Floating point representation.

3. **Boolean Algebra:[7L]**
Boolean functions, truth table, DeMorgan's theorem, logic gates, Realization of BooleanFunctionusing logic gates, Simplification using Karnaugh map.

4.**Set, Relations and Functions: [9L]**
Venn diagram, set operations, relations and properties, closures, equivalence relations, Partialordering,functions, function types, inverse of functions, composition of functions, recursivefunctions,growth of functions.

5.**Logic:[6L]**
Propositional logic, first order logic, mathematical induction, deduction, proof bycontradiction,program correctness.

6.**Grammars, Languages and Automation:[8L]**

Grammars and languages, finite automation of finite state machines, regular languages, regular expressions.

Text Book:

Rosen H. Kenneth, *Discrete Mathematics and its Applications*, Tata McGraw Hill, seventh edition, 2011.

Reference:

Sarkar KumarSwapan, *A Textbook of Discrete Mathematics*, S Chand& Company, 2005.

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Practical: Mathematical Foundation of Computer Science I
Credit: 1
Marks: 25

Programs using C Language: (Any one from the choices a), b), c) ….)

1) Generate all permutations of n symbols, where $2 \leq n \leq 5$ is user defined.

2) a) Read an integer. Convert it into binary number.
   b) Read a binary number. Convert it into decimal n umber.
   c) Read a number. Convert it into normalized form.
   d) Read a binary number. Convert it into octal number.

3) Read a string of decimal digits. Find the frequency distribution of digits.

4) Read binary string. Check the occurrence of the pattern 1001 in the string.

5) a)Read two binary numbers. Add them using 1's complement method.
   b) Read two binary numbers. Add them using 2's complement method.

6) Read two integer numbers. Find their GCD using recursion.

7)a) Read the value of p. Find the p-th Fibonacci number from the following recurrence relation.
$f(0) = 0$, $f(1) = 1$, $f(n) = f(n\text{-}1) + f(n\text{-}2)$, $n \geq 2$
   b) The Ackermann function is defined as follows:

$$A(m,n) = \begin{cases} n+1 & \text{if } m = 0 \\ A(m-1,1) & \text{if } m > 0 \text{ and } n = 0 \\ A(m-1, A(m,n-1)) & \text{if } m > 0 \text{ and } n > 0. \end{cases}$$

Find $A(m,n)$ for given m, n.

8) Given two functions $f(x) = x^3 + 2x + 3$, and $g(x) = 3x^2/4 + 10$, find $f \circ g\ (x)$.

9) Read an expression. Check whether it has equal number of '(' and ')' brackets, equal Numberof '{' and '}' brackets, and equal number of '[' and ']' brackets.

10) Consider a set consisting of n numbers, where n is user defined. Read a set. Check whether agiven number is a member of the set.

11)a) Read two sets. Find their union.

b) Read two sets. Find their intersection.

12) Read an expression containing on parentheses (and). Check whether it is properly parenthesized.

13) Applications of set theory, finite state machines, matrices, Boolean algebra, gates, …

14) Bit-wise operations using C

<u>************</u>**

Paper Title: Introduction to Programming

Paper Code: COM-I.C-2

Name of Faculty: Mr. D. Prabakaran

Marks: 75

Credits: 3

Course Objectives:

- To make the student understand the concept of basic computer algorithm and use the algorithm for various problem solving.
- To implement algorithms using high level programming language.
- To understand basic principles of structured programming – example C

Learning Outcomes:

On completion of the course students will learn the following:

- Designing algorithms for a given problem.
- Writing C Programs to implement the algorithms.

1. **Introduction to Computer ProblemSolving:** **[5L]**

Algorithm, Flowchart, The Problem Solving Aspect,General problem solving strategies, Top-Down Design, Implementation of Algorithms,Efficiency of Algorithms, Recursive algorithms.

2.**Basic Algorithms:** **[3L]**

Exchanging the values,Summation of a set of numbers, factorial computation, generation of the Fibonacci series, reversing the digits of an integer, base conversion.

3.**Factoring Methods:** **[2L]**

Finding divisors of an integer, finding the Greatest Common Divisor of two integers, generating prime numbers, computing prime factors of an integers.

4.**Sorting and Searching algorithms** **[2L]**

Bubble sort, Insertion Sort, Sequential Search and Binary Search.

5.**Introduction to 'C':** **[3L]**

History, Structure of a C program, Keywords, Identifiers, variables, constants, data types, Arithmetic Operators & Expressions, Logical operators and Relational Operators, Precedence and Associativity rules.

6.**Conditions and Iterations:** **[3L]**

Conditions and Actions, Condition statement, Simple control statement (*if*, *if-else*, *switch*), Iterative control statements (*for, while*, *do-while*).

7.**Functions:** **[5L]**

What is a function, Advantages of functions, Standard library functions; User defined functions – declaration, definition, function call, parameter passing, return keyword. Scope of variables, Storage classes, Recursion.

8.**Arrays:** **[4L]**

One and Two dimensional arrays: Array declaration, initialization, accessing the values, passing arrays to functions.

9.**Pointers:** **[4L]**

Pointer declaration, initialization, Pointer arithmetic, Pointer to Pointer, Arrays and Pointers, Functions and Pointers – passing pointers to functions, function returning pointer, dynamic memory allocation.

10.**Strings:** **[4L]**

Declaration and initialization, standard library string functions, strings and pointers, array of strings.

11. **Structure and Union:** **[4L]**

Creating structures, accessing structure members, array of structures, passing structure to functions, nested structure, pointers and structures, union, difference between structures and unions.

12. **File Handling:** **[4L]**

FILE variable, file access modes, operations on files, random access to files, command line arguments.

13. **Preprocessing:** **[2L]**

Format of Preprocessor directive, File Inclusion directive, Macro substitution, conditional compilation.

Text Books:

1. Dromey R.G., *How to solve it by computer*, Prentice Hall of India, 2nd Edition, 2004.
2. KanetkarYeshwant, *Let us C*, BPB Publications, 13th Edition, 2012.
3. BehrouzForouzan, Richard Gilberg, *Computer Science: A Structure Programming Approach using C*, Cengage Learning3rd Edition, 2013.

Reference books:

1. Horowith Ellis, SahniSatraj, SanguthevarRajasekaran, *Fundamentals of Computer algorithm*, Orient Longman, 2nd Edition, 2008.
2. Gottfried Byron, *Programming with C*, Tata McGraw Hill, 3rd Edition, 2010.
3. Brain W. Kernighan and Dennis M Ritchie, *The C Programming Language*, Prentice Hall India, 2nd Edition, 1988.

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Practical: Algorithm design and Introduction to Programming
Credit: 1
Marks: 25

Programs using C language that covers the following concepts:

1. Program to compute a given formula.
2. Conditions
    - if..else
    - nested if
3. Iterative Control Statements
    - for
    - while
    - do…while
4. Functions.
    - Standard Library functions
    - Call by Value
    - Call by reference
5. Recursive functions.
6. Arrays.
    - One Dimensional Arrays
    - Two Dimensional Arrays
7. Sorting
    - Bubble sort
    - Insertion sort
8. Searching.
    - Sequential search
    - Binary search
9. Pointers.
    - Arrays and Pointers
    - Function returning pointers
    - Dynamic memory allocation
10. Strings.
    - Standard Library string functions
    - Strings and Pointers
11. Array of Strings.
12. Structure.
    - Array of structures
    - Passing Structure to functions
    - Nested structure
    - Structure and Pointer
13. Union.

14. File Handling.
    - Text file
    - Binary file
    - Random Access to a file
    - Command Line arguments
15. C Preprocessing.
    - Macro expansion
    - Conditional compilation

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Semester II

Paper Title: Object Oriented Programming
Paper Code: COM-II.C-3
Name of faculty: Mr. Ian Barreto
Credits: 3
Course Objectives:

- To teach the basic concepts and techniques which form the object oriented programming paradigm
- To introduce object oriented programming (OOP) using Java.

Learning Outcome:

- Understand the concept and underlying principles of Object-Oriented Programming.
- Understand how object-oriented concepts are incorporated into the Java programming language.
- Develop problem-solving and programming skills using the OOP concept.

1. **Principles of OOP: [4L]**

Programming Paradigms,Basic concepts, OOP:major principles - encapsulation, abstraction, inheritance, polymorphism. Benefits of OOP, Applications of OOP.

2. **Introduction to Java: [6L]**
   Basics of Java programming, Data types, Variables, Operators, Control structures including selection, Looping, Java methods, Overloading, java.Math class, Arrays in java.
3. **Objects and Classes: [7L]**
   Basics of objects and classes in java, Constructors, Finalizer, Visibility modifiers, Methods and objects, Inbuilt classes like String, Character, StringBuffer, File, this reference.

4. **Inheritance and Polymorphism: [7L]**
   Inheritance in java, Super and sub class, Overriding, java.lang.Object class, Polymorphism, Dynamic binding, Generic programming, Casting objects, Instance of operator, Abstract class, Interface in java, Package in java, java.util package.
5. **Event and GUI programming [6L]**
   Design patterns – what and why? It's classification. Introduce the Observer design pattern. Event handling in java, Event types, Mouse and key events, GUI Basics, Panels, Frames, Layout Managers: Flow Layout, Border Layout, Grid Layout, GUI components like Buttons, Check Boxes, Radio Buttons, Labels, Text Fields, Text Areas, Combo Boxes, Lists, Scroll Bars, Sliders, Windows, Menus, Dialog Box, Applet and its life cycle, Introduction to swing.
6. **I/O programming: [4L]**
   Text and Binary I/O, Binary I/O classes, Object I/O, Random Access Files.
7. **Multithreading in java: [4L]**

Multithreading in java, Thread life cycle and methods, Runnable interface, Thread synchronization.

8.Exception Handling: **[3L]**

Exception handling – what and why? Try and catch block. Multiple catch blocks. Nested try, finally block, throw keyword, throws keyword. Custom Exception.

9.Introduction to the Collections Framework. **[2L]**

10. Introduction to JavaBeans and Network Programming. **[2L]**

Text Book:

Deitel&Deitel, *Java - How to Program*, Prentice Hall Publications

Reference Books:

1) Patrick Naughton, Herbert Schildt,*Java 2 – The Complete Reference*, McGraw HillEducation (India) Pvt. Ltd., 2002.
2) Patrick Naughton,*The Java Handbook*, McGraw HillEducation (India) Pvt. Ltd., 1996.
3) Balaguruswamy E,*Programming with Java – A Primer*, McGraw HillEducation (India) Pvt. Ltd., 2009.
4) Flanagan David, *Java Examples in a Nutshell*, Spd/O'Reilly Reprint, 2nd Edition.
5) Gosling J, Arnold K, & Holmes D, *The Java Programming Language*, Addison-Wesley Professional, 3rd Edition, 2008.

Practical: Object Oriented Programming

Credit: 1

Marks: 25

Programs using Java language that covers the following concepts:

1) Classes and instances
2) Working with the java.Math class
3) Inheritance
4) Composition v/s inheritance
5) Polymorphism, abstract classes and interfaces
6) Algorithm and Data Structures
7) Utilising the java.util package
8) Event handling and GUI
9) Applets
10) I/O programming
11) Exception handling
12) Multithreading
13) Collections framework

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Paper Title: Data Structures
Paper Code:COM-II.C-4
Name of Faculty: Ms. Suchitra R. Bhat
Marks: 75
Credits: 3
Prerequisites: Knowledge of Programming Language

Course Objectives:

To understand different methods of organizing data and efficiently implement different data structures.

Learning outcome:

On completion of the course student will learn:

- Different data structures like Stack, Queues, Linked Lists, Graphs and their applications.
- Implementation of data structures.

1. **Introduction to data structures:** **[3L]**
Concept, Data type, Data object, ADT, Need of Data Structure, Types of Data Structure
2. **Algorithm analysis:** **[3L]**
Algorithm – definition, characteristics, Space complexity, time complexity, Asymptotic notation (Big O)
3. **Linked List:** **[8L]**
Introduction to List, Implementation of List – static & dynamic representation,Types of Linked List, Operations on List, Applications of Linked List,polynomial manipulation, Generalized linked list – concept & representation.
4. **Stacks:** **[8L]**
Introduction, Representation-static & dynamic, Operations, Application - infix to postfix& prefix, postfix evaluation, Simulating recursion using stack.
5. **Queues:** **[5L]**
Introduction, Representation -static & dynamic, Operations, Circular queue, priority queue (with implementation), Concept of doubly ended queue.
6. **Trees:** **[10L]**
Concept & Terminologies, Binary tree, binary search tree, Representation – static & dynamic, Operations on BST – create, Insert, delete, traversals (preorder, inorder, postorder), counting leaf, non-leaf & total nodes, non recursiveinorder traversal, Expression Tree.

7. **Graph:** **[8L]**
Concept & terminologies, Graph Representation – Adjacency matrix, adjacency list,

Traversals – BFS & DFS, Application of BFS, DFS – Shortest path, Backtracking.

Text Book:
Horowitz Ellis, SahniSartaj, *Fundamentals of Data Structures in C,* University Press, 2nd Edition, 2008.

Reference:

1. LangsamYedidyah, Augenstein J. Moshe, Tenenbaum M. Aaron , *Data Structures using C,* Pearson Education, Second Edition ,2009
2. Gilbeg Richard, ForouzanBehrouz, Data Structures: A PseudocodeApproch with C, Cengage Learning, Second Edition
3. Goodrich Michael, Tamassia Roberto, *Algorithm Design Foundations, Analysis and Internet Examples.* John Wiley and sons

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Practical: Data Structures
Credit: 1
Marks: 25
Programs using C language that covers the following concepts:
1. Stack: Static/Dynamic stack implementation.
2. Stack: infix to postfix.
3.Stack: Evaluation of Postfix expression.
4.Queues: Static and Dynamic Queue Implementation
5.Queues: Circular queue
6. List: Singly Linked List,
7. List: Doubly Linked List
8. List: Circular Linked List
9. Linked List: Polynomial addition
10. Trees: Binary Search Tree: create, add, delete, display nodes.
11. Trees: BST traversal.
12. Graph: Representation of Graphs, Graph Traversals.
13. Graph: DFS, BFS.

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Annexure I

Parvatibai Chowgule College of Arts and Science

(Autonomous)

DEPARTMENT OF COMPUTER SCIENCE

COURSE STRUCTURE

THREE YEAR B.Sc. / B.A. DEGREE COURSE IN COMPUTER SCIENCE

COMPONENT A:

SEMESTER	**CORE COMPULSORY**		**CORE ELECTIVE**			
I	**COM-I.C-1** Mathematical foundation of Computer Science – I	**COM-I.C-2 *** Introduction to Programming	---	---	---	---
	COM-II.C-3 **	**COM-II.C-4 ***				

II	Object Oriented Programming	Data Structures	---	---	---	---
III	**COM-III. C-5 *** Data Base Management Systems	---	**COM-III. E-1** Software Engineering	**COM-III. E-2** Digital Logic Design	**COM-III. E-3** Mathematical Foundation of Computer Science - II	**COM-III. E-4** Web Designing
IV	**COM-IV. C-6** Computer Architecture and Organization	---	**COM-IV. E-5** Design & Analysis of Algorithms	**COM-IV. E-6** Data Base Application Development	**COM-IV. E-7** Server Side Programming	**COM-IV. E-8** HCI
V	**COM-V. C-7 *** Operating Systems	---	**COM-V. E-9** Embedded Systems	**COM-V. E-10** Mobile Apps Development	**COM-V. E-11** Data Analytics	**COM- V. E-12** Software Testing and Quality Assurance

VI	**COM-VI. C-8 *** Computer Networks	---	**COM-VI. E-13** System Security	**COM-VI. E-14** Cloud Computing	**COM-VI. E-15** Project Management	**COM-VI. E-16** Business Intelligence

Note: * Core Compulsory papers also offered for minor subject combination.

** Core Compulsory papers also offered for minor subject combination in 4th Semester.

COMPONENT B:

1. **GENERAL COMPULSORY (GC-B) -** a. Cyber Security

2. **INTERDISCIPLINARY (GC-E) –** a. Multimedia

   b. Python Programming

Annexure II

Parvatibai Chowgule College of Arts and Science (Autonomous)
Margao, Goa

Syllabus for

Semester III

for the undergraduate course in

Computer Science

(2016-2017)

Paper Title: Data Base Management Systems
Paper Code: COM-III.C-5
Names of Faculty: Dr. Animesh Adhikari , Ms. Suchitra R. Bhat
Marks: 75
Credits: 3

Prerequisites: -

--Nil--

Course Objectives:

It provides basic knowledge of a database management system. It helps to understand importance of ER diagram. It introduces SQL to query a database.

Learning outcome:

- On completion of the course students will learn Database concepts and structures. They will be able to explain terms related to database design and management. Students will understand data modeling and database development process.
- Students will be able to construct and normalize data models and implement the same using any Relational Database Management System.
- Students will become proficient in using database query language, i.e. SQL.

Syllabus

1**. Overview of database management** [7L]

Data, information, database, database management system; Managing data; File systems versus a DBMS, advantages of a DBMS; Data abstraction, instances and schemas, data models; Data manipulation language, data definition language; Architecture of a DBMS; Users of a DBMS, database administrator

2**. Database design and the ER model** [10L]

Design phases – conceptual design, logical design, physical design; ER model – entities, attributes, and relationships, mapping cardinalities, keys; ER diagrams – strong entities, weak entities, generalization, specialization, aggregation; Converting ER diagram to relational schemas

3. **Relational model** [9L]

Relation, properties of relational model; Entities, integrity constraints, referential integrity constraints; Relational algebra – select, project, cross product, set operations, rename operation; Other relational operations – natural join, outer join

4. **SQL** [10L]

Basic structure of SQL query – Create, select, where, from, rename operation; Set operations; Aggregate functions; Group by, having clauses; Nested queries; Views; Insert, delete, update.

5**. Functional dependency and normalization** [6L]

Atomic domain, nested relation; Key, super key, primary key, candidate key; Functional dependency, axioms, closure of a set of attributes, closure of a set of functional dependencies; Purpose of normalization; 1NF; 2NF; 3NF; BCNF

6. Introduction to Transactions [3L]

Transaction concept, Transaction state, ACID properties, Concurrent Transactions, Serializability.

Text Book:

1. A Silberschatz, H F Korth, S Sudarshan, *Database system concepts*, McGraw-Hill ,sixth Edition

Reference Books:

Ramakrishan, J Gehrke, "*Database management systems"*, McGraw-Hill , 3rd edition

R Elmasri, S B Navathe, "*Fundamentals of database Systems"*, Pearson Education , 5th Edition

Lab : Database Management Systems
Credit : 1
Marks : 25

List of Practicals

1. ER diagram
2. ER diagram with specialization/generalization and aggregation.
3. Converting ER diagram to Schemas
4. Converting ER diagram with generalization/specialization, aggregation into schema
5. Studying RDBMS
    a. Understanding Client server architecture
    b. Creating tables
6. SQL
7. SQL
8. Introduction of .NET Framework, Advantages of .Net Framework,

Components of .NET Framework, Data type & Operators with examples.
8. Loops, Control Statements, Operators, Data Types
9. Controls : Label, Button, Textbox, Picture Box
10. Controls : Radio button, Checkbox, Timer Control, Scroll Bars
11. Controls : List box, Combo Box, Main Menu Dropdown list etc.
12. Working on Database
13. Working on Database
14. Normalization
15. Report Writing

****

Paper Title: Software Enginnering

Paper Code: COM-III.E-I

Names of Faculty: Dr. Sameena Falleiro & Ms.Judith Barreto

Marks: 75

Credits: 3

Prerequisites: Nil

Course Objectives:

On completion of the course the students will develop specific skills and competencies to use various software engineering tools and methods to develop software for medical, industrial, military, communications, aerospace, business, scientific, and general computing applications.

Learning Outcomes:

- Gain knowledge of concepts & principles, methods and tools used in software engineering .
- Appreciate the role of software engineering in the software development industry.
- Be enabled to use various software engineering methods and tools employed during analysis, design, programming, testing and project management

Syllabus

SOFTWARE PROCESS: **[9L]**

Introduction- What is software, Software myths from managers, 'users and developers' perspective, Software characteristics, Why engineering approach, definition(s) of software engineering.
Characteristics of software process.
Software Development Processes and Methodologies: waterfall, prototyping, iterative, spiral, unified process.
Benefits of iterative and incremental approach with emphasis on Unified process, CASE Tools, Agile methodologies.

PROJECT MANAGEMENT: **[8L]**

Planning a Software Project – Cost estimation, Project Scheduling, Software configuration management plans, Quality Assurance plans, Project Monitoring plans and Risk Management. Techniques such as Interviewing, Requirement Workshop, brainstorming, prototyping. Characteristics of SRS

Design: **[9L]**
Design Principles.
Design Concepts: Abstraction, Refinement, Modularity, Software architecture, Control Hierarchy, Structural Partitioning, Data Structure, Software procedure, Information hiding.
Effective modular design: Functional Independence, Cohesion, Coupling.
Design heuristics for effective modularity.
Design Specification outline.
Design methods: Data design – Principles, Architectural design using transform flow, transaction flow.
Interface Design- Internal and External Interface design, User Interface Design.
Interface design guidelines.
Procedural design.

CODING: **[5L]**
Coding styles, standards, peer reviews, checklist, Halstead Metrics

TESTING: **[5L]**
Testing Fundamental, Functional Testing, Structural Testing, Testing Process and Metrics.

DOCUMENTATION and MAINTENANCE: **[4L]**
Need for Software Documentation. Types of documentation
Need for Maintenance; Types of Maintenance

REENGINEERING: **[5L]**
Business Process Reengineering, Software Reengineering, Reverse Engineering, Restructuring, Forward Engineering, The Economics of Reengineering

Text Book:

- Roger Pressman, Software Engineering: A Practitioners Approach, (6th Edition), McGraw Hill, 1997.

Reference Books :

1. An Integrated Approach to Software Engineering by Pankaj Jalote. Narosa Publishing House, 2nd Edition

2. Glenford J.Myers, " The Art of Software Testing ", John Wiley & Sons, 1979.

3. Sommerville, Software Engineering, 7 th edition, Adison Wesley, 1996.

4. Thomas T. Barker, "Writing s/w documentation - a task oriented approach", Allyn & Bacon Series of Technical Communication , 1998.

5. Code Complete by Steve Mc Connell, published by Microsoft Press, ISBN 978-0-7356-1967-8 Second Edition (June 2004)

Laboratory: Software Engineering

Credit: 01

Marks: 25

List of suggested **PRACTICALS** (the numbers in brackets indicate number of practicals) :

1) Requirements Gathering Techniques**[2]**
2) SRS using IEEE format**[2]**
3) Cost and Effort Estimation **[4]**
4) I/O design **[2]**
5) Test Case Design **[2]**
6) Draw a Gantt Chart for a project**[2]**
7) Develop a mini project/ Case Study**[1]**

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Paper Title: Digital Logic Design
Paper Code: COM-III. E-2
Names of Faculty: Mrs. Shaila Ghanti & Mr. Kumaresh V.C.
Marks: 75
Credits: 3

Course objectives:

To understand the basics of Boolean algebra and the operation of logic components, combinational, sequential circuits and design of digital systems.

Learning Outcome:

- Apply the principles of Boolean algebra to manipulate and minimize logic expressions.
- Use K-maps to minimize and optimize two-level logic functions.
- Understand the operation of latches, flip-flops, counters, registers, and register transfers.
- Analyze the operation of sequential circuits built with various flip-flops.
- Apply the above concepts to develop digital systems.

Syllabus

1. **Introduction to Number Systems and codes:** [3L]
Decimal, Binary, Hexadecimal, and Octal number systems; BCD Code, Gray Code, Excess-3 Code, ASCII code, Unicode.

2. **Boolean Algebra:** [8L]
Basic Boolean functions, Postulates and theorems of Boolean Algebra, logic gates, Sum-of-Products and Product-of-Sums forms of Boolean functions; Canonical and Standard forms. Simplification of Boolean Functions, Plotting of K-Maps, POS and SOP Simplification, NAND and NOR implementation.

3. **Combinational Logic:** [8L]
Design procedure for combinational logic circuits; design and analysis of Half Adder, Full Adder; their use in designing other combinational logic circuits; Analysis & Design of Encoders and Decoders; Multiplexer and demultiplexers; their use in designing combinational circuits.

4. **Sequential Circuits:** [9L]
SR, JK, T, D Flip-flops and Latches, their schematic symbols, Truth tables. Shift Registers - SISO, SIPO, PISO, PIPO, Bi-directional Shift Registers, Loading methods for Shift Registers.

5. **Sequential Circuit Design:** [8L]

Design procedure for sequential circuits using state diagrams, State Tables; State assignments and State minimization methods; Circuit implementation. Design and analysis of Counters, Synchronous Counters; Modulo Counters, Asynchronous, Ripple and Ring Counters; Application of Counters.

6. D/A & A/D Converters: [4L]

Digital to Analog converter – Introduction, Weighted-Resistor & R-2R Ladder,
Analog to Digital Converter – Introduction, Successive Approximation method.

7. **Semiconductor memories:** [5L]

Memory organization and operation, expanding memory size, Classification and characteristics of memories, RAM, ROM, Synchronous DRAM (SDRAM), Double Data Rate SDRAM, Synchronous SRAM, DDR and QDR SRAM, Content Addressable Memory.

Text Book:

1. R.P. Jain , "Modern digital electronics" , 3rd edition , 12th reprint TMH Publication, 2007.

Reference Books:

1. D.P. Leach, A.P. Malvino, G.Saha, Digital Principles and Applications, 7th Edition, Mc. Graw Hill (SiE)
2. M. Morris Mano, Digital Logic and Computer Design.
3. Herbert Taub and Donald Schilling, Digital Integrated Electronics, McGraw-Hill.

Lab : Digital Logic Design
Credits : 1
Marks : 25

1. Introduction to digital ICs, specifications, verification of the truth tables of logic gates1.
2. Introduction to digital ICs, specifications, verification of the truth tables of logic gates2.
3. Implementation of the given Boolean function using logic gates in SOP form.
4. Implementation and verification of Decoder using logic gates.
5. Implementation of Multiplexer using logic gates.
6. Implementation and verification of De-multiplexer and Encoder using logic gates.
7. Implementation of Binary Adders.
8. Implementation of 4-bit parallel adder.
9. Verification of state tables of RS, JK, T and D flip-flops.

10. Implementation of Shift Registers using flip-flops.
11. Design and verification of the 4-bit synchronous counter1.
12. Design and verification of the 4-bit synchronous counter2.
13. Design and verification of the 4-bit asynchronous counter1.
14. Design and verification of the 4-bit asynchronous counter2.
15. Design and implementation of combinational logic using MUX and DEMUX ICs.

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Paper Title: Mathematical Foundation of Computer Science - II

Paper Code: COM-III.E-3

Name of Faculty: Dr. Animesh Adhikari

Credits: 3

Marks: 75

Course Objectives:

The objectives of this paper are to build mathematical foundations in the areas namely graph theory and numerical analysis being closely related to topics of computer science.

Learning Outcomes:

On completion of the course, students will learn the following concepts: graph theory and numerical analysis

Syllabus

Graph Theory

1. Graphs, Subgraphs and Components **[3L]**

Graphs, subgraphs, and some special graphs; Graph properties; Paths, cycles, and components

2. Trees and Cycles **[4L]**

Trees; Spanning trees; Algorithms to find MST; Cycles; Generation of Trees and Cycles

3. Connectivity **[3L]**

Cut vertices, Cut edges and Blocks; Eccentricity sequences and Sets; Connectivity parameters

4. Planarity **[4L]**

Planar embeddings; Bridges; two characterization theorems

5. Eulerian graphs **[3L]**

Introduction; Eulearian and traversable graphs; Non-Eulearian graphs

6. Digraphs **[4L]**

Basic definitions; types of connectedness; Covers and bases; Connectivity; Acyclic digraphs

Numerical Analysis

1. Interpolation with Equal Intervals **[6L]**

Introduction; Various methods of interpolation; Various methods of curve fitting; Newton's method of forward interpolation formula; Newton's method of backward interpolation formula

2. Interpolation with Unequal Intervals **[2L]**

Introduction; Lagrange's formula

3. Numerical Integration **[5L]**

Introduction; General quadrature formula; Trapezoidal rule; Simpson's one-third rule; Simpson's three-eighth rule; Weddle's rule

4. Solutions to algebraic and transcendental equations **[5L]**

Introductions; Graphical method; Bisection method; Method of false position; Secant method; Newton-Raphson method

Linear Algebra **[6L]**

Adjoint, inverse of a matrix; Rank; Linear equations; Characteristics roots and vectors

Text Books:

1. K R Parthasarathy, Basic Graph Theory, Tata McGraw-Hill Publishing, 1994

2. B S Goel, S K Mittal, Numerical Analysis, Pragati Prakashan, 13th Edition, 1998

3. S.N. Iyengar, Matrices, Anmol Publications, 2010

Reference Books:

1. J Clark, D A Holton, A First Look at Graph Theory, World Scientific, 1991

2. P N Chatterjee, Numerical Analysis, Rajhans Prakashan Mandir, 3rd Edition, 1996

3. V. Krishnamurthy, Introduction to Linear Algenra, Affiliated East-West Press, First Edition, New Delhi, 1976

Lab : Mathematical Foundation of Computer Science - II

Credit: 1

Marks: 25

List of Experiments

Graph Theory

1) Read a graph, and check if it is connected.

2) Find the components of a graph.

3) Check the existence of cycle in a graph.

4) Read a weighted graph. Find the minimum spanning tree

5) Identify cut vertices and cut edges in a graph

6) Find maximum distance between two vertices in a graph

7) Read a digraph, and check if it is connected.

8) Find the strongly connected components of a digraph.

Numerical Analysis

9) Find the value of dependent variable using Newton's forward formula for a given value of independent variable.

10) Use Newton’s backward formula to estimate a value

11) Estimate a value using Lagrange’s formula

12) Integrate a function using Simpson’s one-third rule

13) Apply Simpson’s three-eighth rule to find the value of integration

14) Find the value of a root using method of false position

15) Estimate root of an equation by secant method

16) Apply Newton-Raphson method to estimate the root of a equation

Linear Algebra

17) Find the rank of a matrix

18) Find solutions of a system of equations

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Paper Title: Web Designing

Paper Code: COM-III.E-4

Name of Faculty: Ian Barreto

Marks: 75

Credits : 3

Course objectives:

How to design good user interfaces covering importatant design principles such as learnability, visibility, error prevention, efficiency and graphic design

Learning Outcomes:

Implementation of user interfaces following design principles and using technologies such as HTML, CSS, JavaScript and Jquery.

Syllabus

Unit I : User Interface – Introduction, its importance, design principles – learnability, visibility, error prevention, efficiency, graphic design. Design Patterns for GUI – View tree, Listener, Widget, Model-View-Controller. Approaches to GUI programming – Procedural, Declarative, Direct Manipulation. Web UI – HTML, Javascript, Jquery.

[6L]

Unit II : Structure and Style with HTML and CSS

HTML [6L]

Introduction. The development process, basic HTML, formatting and fonts, commenting code, color, hyperlink, lists, tables, images, simple HTML forms, web site structure, Meta tags, Character entities, frames and frame sets.

HTML5 [6L]

Introduction, New Elements, Canvas, SVG, Drag/Drop, Geolocation, Video, Audio, Input types, form elements, form attributes, semantic, web storage, app cache, web workers, SSE

CSS [5L]

Introduction – Syntax, Id & Class, Backgrounds, Text, Fonts, Links, Lists, Tables. CSS Box Model – Border, Outline, Margin, Padding. Advanced - Grouping/Nesting, Dimension, Display, Positioning, Floating, Align, Pseudo-class, Pseudo-element, Navigation Bar, Image Gallery, Image Opacity, Image Sprites, Media Types, Attribute Selectors.

CSS3 [5L]

Introduction, Borders, Backgrounds, Gradients, Text Effects, Fonts, 2D Transforms, 3D Transforms, Transitions, Animations, Multiple Columns.

Unit 3 : Javascript [10L]

Introduction - What is JavaScript, Understanding Events, JavaScript Example, External JavaScript. Basic Elements – Comment, Variable, Global Variable, Data Types, Operators, If Statement, Switch, Loop: for and while, Function. JavaScript Objects – objects, Array. Browser Object Model - Browser Objects, Window Object, Document Object – getElementById, getElementsByName, getElementsByTagName, innerHTML property, inner Text property. Validation- form validation, email validation.

Unit 4 : Introducing jQuery [7L]

JQuery : Introduction - Syntax, Selectors, Events. Effects- Hide/Show, Fade, Slide, Animate, stop(), Callback, Chaining. HTML/CSS- Add, Remove, CSS Classes, css(), Dimensions, slider. Traversing – ancestors, descendants, siblings, filtering.

Reference books:

Elisabeth Robson, Eric Freeman, “Head First HTML and CSS”, O'Reilly

Ivan Bayross, “HTML 5 and CSS 3 Made Simple”, BPB publication

Kogent Learning Solutions Inc., “HTML5 Black Book: Covers CSS3, Javascript, XML, XHTML, Ajax, PHP and Jquery”, Pearson Education.

Steven M. Jacobs, Ben Shneiderman, “Designing the User Interface : Strategies for effective human-computer interaction”, 5^{th} Edition, Pearson Education

Lab : Web Designing

Marks: 25

Credits: 1

List of Assignments: (the numbers in brackets indicate number of practicals) :

1) Case studies to review UI designs [2 P]

2) Create a HTML page with the following : [3 P]

   a) title heading paragraph emphasis strong and image elements

   b)complex HTML table

   c)simple HTML Form covering major form elements

   d)Embed Video in an HTML page

3) Using CSS do the following : [3 P]

   a)Create a Navigation bar (with dropdown) with CSS

   b)Create a CSS Grid

   c)Create a CSS3 based button

   d)make an image rounded shape

   e)Create a CSS based sticky footer

   f)Create CSS3 Corner Ribbon

   g)Create CSS3 blurry text effect

   h)Create CSS3 speech bubble shape

   i)Create image cross fade with CSS3 transition

   j)Set style for link hover active and visited states of hyperlink

4)Write JavaScript functions to : [4 P]

   a) accept a string as a parameter and converts the first letter of each word of the string in upper case

   b) check whether a given credit card number is valid or not.

c) check whether a given value is an valid url or not.

d) check whether a given email address is valid or not.

e) print an integer with commas as thousands separators

f) remove items from a dropdown list.

5)Use JQuery to : [3 P]

a) Disable buttons

b) Make textbox read only

c) Uncheck check boxes

d) Confirm again

e) Sort

f) Switch rows and columns

A mini project combining all the technologies learnt using a front-end development framework such as bootstrap is recommended.

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Annexure III

Parvatibai Chowgule College of Arts and Science (Autonomous)
Margao, Goa

Syllabus for

Semester IV

for the undergraduate course in

Computer Science

(2016-2017)

Paper Title: Computer Architecture and Organization

Paper Code: Com-IV. C-6

Names of Faculty: Mr. Kumaresh V.C. & Mrs. Shaila Ghanti

Marks: 75

Credits: 3

Objectives:

To have a thorough understanding of the basic structure and operation of a digital computer.

Learning Outcome:

- Understand the CPU organization and the instruction set of 8086 processor.
- Study the hierarchical memory system including cache memories.
- Study the different ways of communicating with I/O devices and standard I/O interfaces.
- Briefly study the different types of parallel processing.
- Design, execute and debug assembly language programs for 8086 processor.

Syllabus

1. **Computer System:** [3L]
   Function and structure of a computer, Interconnection of components, Performance of a computer. Computer Architecture – Princeton (Von Neumann) and Harvard architecture.

2. **Processing Unit:** [6L]
   Architecture of 8086 processor - Registers, ALU and Control unit, Data path in a CPU. Instruction cycle, Organization of a control unit – Block Diagram of Hardwired and Microprogrammed control unit.

3. **Representation of Instructions:** [10L]
   Machine instructions characteristics, Types of operations-data transfer, arithmetic, logical, conversion, I/O, system control, transfer of control; 8086 Instruction Set

and Assembly language: Addressing modes-immediate, direct, indirect, register, register indirect, displacement, stack. Instruction formats - instruction length, allocation of bits, variable length instructions, Instruction set architectures - CISC and RISC architectures.

4. Memory Subsystem: [10L]

Characteristics of memory system, the memory hierarchy, Semiconductor memories, Types of ROM & RAM, Cache memory unit - Concept of cache memory, Organization of a cache memory unit, Mapping methods, replacement algorithms, write policy, block size.

5. Input/Output Subsystem: [8L]

General block diagram of External device & I/O module, Programmed I/O,

Interrupt driven I/O, DMA, I/O channels and I/O processors. I/O interfaces –

Serial port, Parallel port, PCI bus, SCSI bus, USB bus, Firewire and Infiniband.

6. Parallel Processing: [8L]

Classifications, Introduction to pipeline processing: Instruction pipeline & Arithmetic pipeline, Introduction to Array & Vector processors, Introduction to Multiprocessors.

Text Book:

1. William Stallings, "Computer Organization and Architecture - Designing for performance", EEE, PHI, 9th Edition.

Reference Books:

1. M. Morris Mano, "Computer System Architecture", Pearson Education, 3rd Edition, 2008

2. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design – The Hardware/Software Interface", Morgan Kaufmann, 4th Edition.

3. Douglas V. Hall, "Microprocessors and its Interfacing**"**, McGraw Hill Education (India) Private Limited, 3rd Edition.

Lab **:** Computer Architecture and Organization

Credits : 1

Marks : 25

1. Study of Motherboard, Peripherals and the Computer System.
   O.S. Installation (Dual Boot):

   BIOS; Manage disk partitions: understand MBR-style partitions, (primary, extended, logical); list/create/delete partitions;

   Manage logical volumes: create/remove physical volumes, create/delete logical volumes, Boot loader

   Installation of drivers; updating software packages

2. DOS Commands, Tools for Computer Management (Disk Management, Disk Cleanup, Defragmentation, Performance Monitor, System Restore etc).

Assembly language programs for 8086 using MASM / compatible assembler or Simulator, either in Windows or Linux.

3. Study of addressing modes.
4. Programs for arithmetic operations1
5. Programs for arithmetic operations2
6. Programs for arithmetic operations3
7. Programs for data transfer operations
8. Programs for logical operations1
9. Programs for logical operations2
10. Programs code conversion1
11. Programs code conversion2
12. Programs on sorting
13. Programs on searching
14. DOS/BIOS – Programming1
15. DOS/BIOS – Programming2

****

Paper Title : Design and Analysis of Algorithms

Paper Code : COM-IV.E-5

Names of Faculty : Ian Barreto & D.Prabakaran

Marks : 75

Credits : 3

Course Objectives:

- To study paradigms and approaches used to analyze and design algorithms and to appreciate the impact of algorithm design in practice.
- To ensure that students understand how the worst-case time complexity of an algorithm is defined, how asymptotic notation is used to provide a rough classification of algorithms and compare with one another, and how there are still some problems for which it is unknown whether there exist an efficient algorithm, and how to design efficient algorithms.

Learning Outcomes:

On completion of the course students will learn the following:

- To explain basic concepts related to the design and analysis of algorithms
- To describe classical algorithms and their complexity.
- To design and analyse selected algorithms.

Syllabus

1. Introduction [8L]

What is an Algorithm?, Rules for writing Algorithms, Properties of Algorithms, Framework for design and analysis of algorithms(RAM model of computation),Recursive Algorithms, Space and Time Complexity by Tabular method(Performance Analysis).

2. Divide and Conquer [7L]

Elements of Divide and Conquer Algorithms, QuickSort algorithm, Merge sort analysis, Strassen's algorithm for matrix multiplication, Analysis of Binary Search,The Maximum subarray Problem.

3. Dynamic programming [8L]

General Method, caching v/s computation, Fibonacci numbers by recursion, Fibonacci numbers by cashing, Fibonacci numbers by dynamic programming,Optimal Binary Search Tree,Rod Cutting Problem.

4. Greedy algorithms [5L]

Elements of greedy strategy, Activity-selection problem, Job sequencing with deadlines.

Knapsack problem.

5. Basic Traversal and Search Technique [7L]

Techniques for Binary Trees, Techniques for Graphs(Breadth First search and Traversal, Depth First Search and Traversal)

6. Graph Algorithms [6L]

Elementary graph algorithms- Minimum spanning tree, growing a spanning tree, Kruskal and Prim algorithms.

7. Complexity Classes [2L]

Introduction to polynomial time algorithms, NP, NP Complete, NP Hard

8. Introduction to Randomisation and approximation. [2L]

Text books

Thomas H. Cormen, charles E. Leiserson, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", EEE, PHI, Third Edition

Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", Galgotia, 2nd Edition

Reference Books

A. Aho, J. Hopcroft, J. Ullman, "The Design and Analysis of Computer Algorithms", Pearson Education, Eighth Edition

<u>Lab : Design and Analysis of Algorithms</u>

Credit : 1

Marks : 25

Lab Assignments are to be done using a Programming Language for the following :

1. Program to find GCD of 2 numbers using Iterative approach and Recursive approach
2. Program for quickSort
3. Program to perform Binary Search using Recursive approach
4. Program to generate Fibonacci numbers using Dynamic Programming approach.
5. Program to implement Activity Selection Problem.
6. Program to implement job sequencing with Deadlines.
7. Program to implement Knapsack Problem
8. Program to implement Rod Cutting Problem.
9. Program to implement Binary Tree.
10. Program to implement Optimal Binary Search Tree.
11. Program to represent graph using matrix.
12. Program to represent graph using Linked List.
13. Program to implement BFS/DFS Traversal on graph.
14. Program to implement Kruskal’s Algorithm
15. Program to implement Prim’s Algorithm

****

Paper Title: Data Base Application Development
Paper Code: COM-IV.E-6
Names of Faculty: Dr. Animesh Adhikari **,** Ms. Suchitra R. Bhat
Marks: 75
Credits: 3

Prerequisites: - Data Base Management Systems

Course Objectives:
To provide advance database solutions.

Learning outcome:
On completion of the course student will learn:

- Advance SQL
- Concept of Big data.
- Developing a database application.

Syllabus

1**. Advanced SQL** [15L]

SQL data types and schemas, Integrity constraints, Authorization, Embedded SQL, Dynamic SQL, Triggers, Stored Procedures, views

2**. Indexing and Hashing** [7L]

Basic concepts**,** Ordered Indices, Dense and Sparse Indices. B and B+ trees Hashing – Static hashing, Dynamic Hashing, Extendable hashing, Comparison of Ordered Indexing and Hashing.

3. Transaction, Concurrency Control, Recovery System. [10L]

Transaction: Transaction concept, Transaction state, Implementation of Atomicity and Durability, concurrency. Serializability, conflict serializability.

Concurrency Control : Lock-Based Protocol

Recovery System: Failure Classification, Storage structure, Stable storage implementation, Recovery and Atomicity: Log-Based Recovery.

4. Introduction to Big data and NoSQL [13L]

Introduction to the Big Data problem. Current challenges, trends, and applications

Comparison between SQL and NOSQL Databases

Types and examples of NoSQL databases- Column, Document, Key-value, Gtraph, Multi-model

Introduction to Document type NoSQL database such as MongoDb. - Introduce concepts of collection and documents, Advantages, Data types, Projections, indexing, Sharding .

Text Book:

A Silberschatz, H F Korth, S Sudarshan, *Database system concepts*, McGraw-Hill ,sixth Edition

Reference Books :

Ramakrishan, J Gehrke, "*Database management systems"*, McGraw-Hill , 3rd edition

R Elmasri, S B Navathe, "*Fundamentals of database Systems"*, Pearson Education , 5th Edition

Kristina Chodorow *MongoDB : The Definitive Guide (English)* O'Reilly 2nd Edition

Lab : Database Application Development

Credits : 1

Marks : 25

Practical should cover following concepts

1. SQL Revision
2. Advance SQL- Dynamic SQL, Triggers
3. Advance SQL- Stored Procedures
4. Using ODBC API for insertion of record into database.
5. Using ODBC API for deletion of record.
6. Using ODBC API for modification of data.
7. Using ODBC API for data retrieval.
8. Installing and Creating a document using MongoDb concept
9. Performing Indexing using MongoDb
10. Performing aggregation functions on MongoDb
11. Implementation of Master-Slave approach.
12. Connection of MongoDb using Java

13. Insertion, modification, deletion using MongoDb
14. Data retrieval using MongoDb
15. Shrading using Java and MongoDb.

****

Paper Title: Server Side Programming

Paper Code: COM-IV.E-7

Name of Faculty: Ian Barreto

Marks: 75

Credits : 3

Course Prerequisite:

- **Object Oriented Programming**
- **Software Engineering**

Course Objectives:

- Provide an in depth understanding of object oriented approaches to software development, in particular to the analysis and design phases of the software life cycle.
- Design and implement basic server-side scripts
- Create data documents using XML
- Create and manipulate databases using SQL and server side technologies Understand how rich internet applications are implemented using AJAX and XML/JSON.

Learning Outcomes:

- Understand the basic underlying concepts in World Wide Web: web server, 3-tier web applications, server side scripting and programming languages, rich internet applications, AJAX and web services
- Understand and apply supporting and emerging web technologies: access to databases, AJAX, rich client user interfaces.

Syllabus

OOAD and UML: **[12L]**

OOAD: Definition; object oriented analysis; object oriented design and modelling; Assigning responsibilities.

UML: Main UML diagrams – Class diagram, sequence diagram, activity diagram, use case diagram. Use case model – use case diagram, use case descriptions, use case realization using sequence and activity diagrams. Supplementary requirements. Advanced use case model features.

Requirements: Functional and non-functional

System Design: Class diagram, sequence diagram, activity diagram, state chart diagram, deployment diagram. Brief introduction to other UML diagrams.

Server-side technologies: [11 L]

Static vs. Dynamic web pages, Need for Server Side technologies, Multitier Web Architecture. Common Gateway Interface standard, server-side includes, server APIs, server-side scripting – working principles, and implicit objects. Database and file access. Comparison of Web servers.

Ajax-Enabled Rich Internet Applications with XML and JSON [13 L]

AJAX – introduction, purpose, advantages and disadvantages. Key elements of AJAX – introduction to XML. XML processing with server sidescript. XSL, transforms and templates. The XMLHttpRequest object – methods and properties. Creating and using XMLHttpRequest objects. Using XSLT with AJAX.

JSON – Syntax, mixing literals, Array, object, encoding/decoding, JSON versus XML, server-side JSON tools.

Web Services: [9 L]

Introduction, its role. Basics – Creating, Publishing, Testing and Describing a Web services (WSDL)-Consuming a web service. SOAP - introduction, requests and responses. Role of UDDI – accessing registries. REST based web services – building, deploying and consuming

Reference Books:

1. Martin Fowler, UML Distilled, 3rd Edition, Addison Wesley

2. Booch, Rumbaugh, Jacobson, The Unified Modelling Language User Guide, 2nd edition, Addison Wesley,

3. James Rumbaugh, Object Oriented Modelling and Design, Prentice Hall

4. Dana Moore, Edward Benson, Professional Rich Internet Applications: Ajax And Beyond (English), Wiley India.

5. Schmelzer, XML and Web Services Unleashed, Pearson India.

Lab : Server Side programming

Credit : 1

Marks : 25

List of suggested **PRACTICALS** (the numbers in brackets indicate number of practicals)

1) Perform OOAD of a given system using the following diagrams: [3 P]

   a) use case

   b) class

   c) sequence

   d) activity

2) Using server side programming and following OOAD principles develop a dynamic web application. [6 P]

3) Add AJAX and Web service(s) to the application. [3 P]

****

Paper Title: Human Computer Interface

Paper Code: COM-IV.E-8

Names of Faculty: D.Prabakaran & Neeta Dhopeshwarkar

Marks: 75

Credits: 3

Prerequisites: Nil

Course Objectives:

To study the different aspects of human computer interaction and the computer interface design concepts.

Learning Outcomes

- To understand the intricacies of human interaction with a computer System
- To understand the concept of a graphical user interface, and its design characteristics
- To recognize the human element its strengths and weakness for computer interaction
- To know the principles of good screen design and layouts
- To know the different navigation schemes on windows based interface; learn the different types of selection devices and components of a window based interface
- To know the different types of interaction devices and media

Syllabus

1. Introduction: Human-Computer Interaction, Evaluating Designs, The Birth of HCI. Importance of user Interface, Importance of good design, Benefits of good design, principles & heuristics of good design (4L)
2. Human interaction with computers, Importance of : Human characteristics, Human consideration, Human interaction speeds, Understanding business functions. User centred design- Need-finding: Participant Observation, Interviewing, Additional Need finding, contextual inquiry & persona. (6L)
3. Rapid Prototyping: story boarding. Paper Prototyping and Mockup, Video Prototyping, Creating and Comparing Alternatives (5L)

4. Direct Manipulation and Representations: various user interaction models-command, menu, Direct Manipulation. Mental Models. Heuristics (guidelines) for design. (7L)
5. Graphical Interface Design: Graphical user interface, standards such as Microsoft windows HCI guidelines, Windows: Navigation schemes selection of window; Selection of devices based and screen based controls, Components, Text and messages, Icons, Multimedia, Colors., controls, Help & error messages design. (8L)
6. Web user interface design – jessy James Garette five layers of user experience. (4L)
7. Heuristic Evaluation: Heuristic Evaluation — Why and How? (4L)
8. visualization, Amount of information, Focus and emphasis, Presentation information simply and meaningfully, Information retrieval on web, Statistical graphics (7L)

<u>Text books:</u>

1. Alan Cooper & Robert Reimann, About Face 2.0: The Essentials of Interaction Design, Wiley

2. Alan Dix, Janet Finlay, Gregory D. Abowd, and Russell Beale, Human-Computer Interaction (3rd Edition), Pearson, 2004.

3. Ben Shneiderman and Catherine Plaisant, Designing the User Interface: Strategies for Effective Human-Computer Interaction (5th Edition), 5th ed., Pearson Addison-Wesley, 2009

4. Donald A. Norman, The Design of Everyday Things, Basic Books, 2002

Lab : Human Computer Interface

Credit : 1

Marks : 25

Suggested list of practical (Numbers in brackets indicate number of practicals)

1. Paper Prototyping using templates (1)

2. Conducting survey interview and summarizing the result(1)
3. Persona- conducting contextual interview and developing persona(1)
4. GUI design- form design, menu design, help, error messages(2)
5. Web UI design- pages, navigation, controls, (Ajax) (2)
6. Report designs (2)
7. Visualization and info graphics (1)
8. Heuristic evaluation(2)
9. Story boarding (1)

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Annexure IV

Parvatibai Chowgule College of Arts and Science (Autonomous)
Margao, Goa

Syllabus for

Interdisciplinary Papers

(2016-2017)

Semester : III

Paper Title: Multimedia

Names of Faculty: Dr. Sameena Falleiro & Ms.Judith Barreto

Marks: 75

Credits: 3

Prerequisites: Nil

Course Objectives:

On completion of the course the students will develop specific skills and competencies by making them proficient in Designing Graphical Images, Audio and Video Capture and Editing using Software tools

Learning Outcomes:

- To study Multimedia Concepts
- To develop their Creativity and publish a self-contained multimedia Application using multimedia authoring tools in various application areas.

Syllabus

INTRODUCTION TO MULTIMEDIA: [6 L]

Commonly used terms associated with multimedia like CDROM, Storyboard, Script and Authoring tools.

Stages of a Multimedia Project: Planning and Costing, Designing and Producing, Testing and Delivering.

The Multimedia team and their roles: Project Manager, Writer, Video specialist, Audio specialist and Multimedia programmer.

Multimedia Software. Multimedia Hardware

MULTIMEDIA AUTHORING TOOLS: [3 L]

Types of Authoring tools - card or page based tools, icon-based, event-driven tools, time-based and presentation tools and object-oriented tools.

MULTIMEDIA BUILDING BLOCKS:

TEXT [4 L]

Designing with Text, menus and buttons for navigation

Animating text

Hypermedia and Hypertext

SOUND [6 L]

Basic Sound Concepts

Music

Speech

MIDI and Digital Audio

IMAGES [8 L]

Making still images, Bitmaps, Clipart,

Capturing and Editing Images

Scanning Images

Vector Drawing

3D Drawing and Rendering

Image File formats

ANIMATION [8 L]

Principles of Animation- persistence of vision, animation file formats

Computer animation-kinematics and morphing

Making animations that work- a rolling ball, a bouncing ball and creating an animated scene

VIDEO [8 L]

Video Broadcast Standards- NTSC, PAL, SECAM, HDTV

Integrating Computers and Television like Video Overlay Systems, Digitized Video Playback, Differences between Computer and Television Video

Recording Formats like S-VHA Video, Component (YUV), Component Digital, Composite Digital, Video Hardware Resolutions

Video Tips like Shooting platforms, Lighting, Chroma Key or Blue Screen

Video Compression methods like MPEG and DVI

ASSEMBLING AND DELIVERING A PROJECT [2 L]

The four primary navigational structures used in multimedia like linear, hierarchical, non-linear and composite

Text Book:

Vaughan, Tay , "Multimedia: Making it Work", 3rd edition, Tata McGraw-Hill

Reference Books:

1. Jeffcoate, Judith, "Multimedia in Practice, Technology and Applications", Prentice Hall India.

2. Buford, J.F. K , "Multimedia Systems", Pearson Education

3. Elson-Cook, "Principles of Interactive Multimedia", McGraw Hill Higher Education. ISBN- 13: 978-0077096106

Laboratory: Multimedia

Credit: 01

Marks: 25

List of suggested **PRACTICALS** using any Multimedia Software (the numbers in brackets indicate number of practicals) :

1.Image Handling: Cropping an image, adjusting image size, increasing the size of the work canvas, saving an image **[2]**

2. Layers: Adding layers, dragging and pasting selections on to layers, dragging layers between files, viewing and hiding layers, Editing layers, rotating selections, scaling an object, preserving layers transparency, moving and copying layers, duplicating layers, deleting layers, merging layers, using adjustment layers **[2]**

3. Channels and Masks: Channel palette, showing and hiding channels, splitting channels in to separate image, merging channels, creating a quick mask, editing masks using quick mask mode **[1]**

4. Painting and Editing: Brushes palette, brush shape, creating and deleting brushes, creating custom brushes, setting brush options, saving, loading and appending brushes, Options palette **[2]**

5. Opacity, pressure, or exposure , paint fade-out rate, making selections, using selection tools, adjusting selections, softening the edges of a selection, hiding a selection border, moving and copying selections, extending and reducing selections, pasting and deleting selections **[2]**

6. Sound : Recording Sound using Sound Recorder (Capture), Sound capture through sound editing software , Sound editing, Noise correction, Effect enhancement ; Voice Recognition; Importing audio and saving audio from Audio CD. Sound Quality types: CD Quality, Radio Quality, Telephone Quality**[2]**

7. Video: Record video from video capture devices, webcams, screen capture or even streaming video and Video Editing **[2]**

8. Mini Project/Problem Statement/Case Study (integrating the above experiments) **[2]**

****

Semester : IV

Paper Title: Python Programming

Names of Faculty: Ian Barreto, Animesh Adhikari

Marks : 75

Credits : 3

Prerequisite: nil

Course Objectives : To provide skills of data analysis using Python programming language

Learning Outcome:

Students will learn Python programming, and apply it in data analysis & visualization.

Syllabus

Introduction to Computer Problem Solving [3L]

Algorithm, Flowchart, The Problem Solving Aspect, General problem solving strategies, Top-Down Design, Implementation of Algorithms

Basic Algorithms [3L]

Exchanging the values, Summation of a set of numbers, factorial computation, generation of the Fibonacci series, reversing the digits of an integer, base conversion.

Introduction to Python [3L]

Motivation, programming paradigms, What Python can do, Python's technical strength, Python interpreter, Program execution, Execution model variations, How to run programs

Basic Syntax [5L]

Variable and Data Types, Operator, Conditional Statements - if, if- else, Nested if-else. Looping – For, While, Nested loops. Control Statements – Break, Continue, Pass.

String Manipulation [4L]

Accessing Strings, Basic Operations, String slices, Function and Methods.

Lists [3L]

Introduction, Accessing list, Operations, Working with lists, Function and Methods

Tuple [4L]

Introduction, Accessing tuples, Operations, Working, Functions and Methods

Dictionaries [4L]

Introduction, Accessing values in dictionaries, Working with dictionaries, Properties, Functions

Functions [5L]

Defining a function, Calling a function, Types of functions, Function Arguments, Anonymous functions, Global and local variables

Modules [4L]

Importing module. Math module. Random module. Packages. Composition

Input-Output [4L]

Printing on screen, Reading data from keyboard, Opening and closing file, Reading and writing files, Functions

Exception Handling [3L]

Exception. Exception Handling - Except clause, Try ? finally clause. User Defined Exceptions

Text Book:

1. Mark Lutz, Learning Python, Third Edition, O'Reilly Media, 2008

Reference Books:

1. Alex Martelli, Python – A Nutshell, Second Edition, O'Reilly Media, 2006

2. Wes McKinney, Python for Data Analysis, O'Reilly Media, 2012

Laboratory: Python Programming

Credit: 01

Marks: 25

List of Experiments using Python Language

1) Program to compute a given formula

2) if else

3) nested if else

4) loop

5) loop

6) string manipulation

7) string manipulation

8) list

9) tuple

10) dictionary

11) function

12) module

13) Input-Output

14) Input-Output

15) exception handling

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Annexure V

Dept. of Computer Science

Parvatibai Chowgule College of Arts & Science

(Autonomous)

Margao - Goa

Continuous assessment (CA)

- The CA (Continuous Assessment) shall be conducted in a given Semester using alternate modes of evaluation such as assignment, seminar presentation, orals, demonstration, written etc.
- Generally, CA for a given course shall be conducted by the teacher/s teaching that course.
- CA shall not be conducted for the Practical component of a paper.
- The schedule for the CAs shall be notified to all students at the beginning of the semester.
- The marks of CA shall be communicated to the students within one week.
- The teachers are expected to submit the average of CAs to the examination committee two weeks before the commencement of SEE (Semester End Examination).
- The CA tests shall carry 40% of maximum marks allotted for the course.
- Students who fail to appear for the CA due to a genuine reason shall be given another

opportunity by the end of semester on a date pre-determined by the department.

- A student who does not appear for a minimum of three CA of a course shall not be eligible to answer SEE of that course.
- A theory paper carrying 100 marks shall have CA component of 40 marks and a SEE component of 60 marks. For a 75 marks theory course, the CA component shall be 30 marks and the SEE component shall be 45 marks.
- No separate examination(s) in Laboratory exercises shall be conducted for courses having practical(s) component.
- Each experiment/laboratory work carried out by the student shall be assessed by the teacher/s during the regular practicals.
- In practical paper/component a student shall be required to score a minimum of 40% marks to pass in all the Semesters.
- Minimum number of Practicals to be completed for a Course is 10.
- The practical assessment shall be treated as an independent head of passing.

Framework of Question paper(Semester End Examination)

Q1	Q2	Q3	Q4	Max marks	Total marks
Any 3 OF 4 (3 marks each)	**Any 2 OF 3 (6 marks each)**	**Any 2 OF 3 (6 marks each)**	**Any 1 OF 2 (12 marks each)**	**45**	**72**

Note: Teachers are requested to take a note that Q4 in their respective question paper should preferably be set involving a higher order thinking. They are requested to submit answer key to the respective question paper.

- Unit wise marks distribution to be submitted along with the question paper.
- No question to be assigned less than 3marks.
- Question 2, 3,4 could further be split into a maximum of 2 sub questions only.
- There shall be no sections in the question paper.
- No questions shall be of objective type.
- Faculty members to submit two sets of manuscripts, along with answer keys.
- Answer key of the question paper appearing at the examination to be uploaded on the college website.

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Annexure I

Parvatibai Chowgule College of Arts and Science

(Autonomous)

DEPARTMENT OF COMPUTER SCIENCE

COURSE STRUCTURE

THREE YEAR B.Sc. DEGREE COURSE IN COMPUTER SCIENCE

COMPONENT A:

SEMESTER	**CORE COMPULSORY**		**CORE ELECTIVE**			
I	**COM- I.** **C-1** Mathematical foundation of Computer Science – I	**COM- I.** **C-2 *** Introduction to Programming	---	---	---	---
II	**COM-II.** **C-3 **** Object Oriented Programming	**COM-II.** **C-4 *** Data Structures	---	---	---	---

III	**COM-III.** **C-5 *** Data Base Management Systems	---	**COM-III.** **E-1** Software Engineering	**COM-III.** **E-2** Digital Logic Design	**COM-III.** **E-3** Mathematical Foundation of Computer Science - II	**COM-III.** **E-4** Web Designing
IV	**COM-IV.** **C-6** Computer Architecture and Organization	---	**COM-IV.** **E-5** Design & Analysis of Algorithms	**COM-IV.** **E-6** Data Base Application Developme nt	**COM-IV.** **E-7** Server Side Programming	**COM-IV.** **E-8** HCI
V	**COM-V.** **C-7 *** Operating Systems	---	**COM-V.** **E-9** Embedded Systems	**COM-V.** **E-10** Mobile Application Developme	**COM-V.** **E-11** Introduction to Data Science	**COM- V.** **E-12** Software Testing

				nt		
VI	**COM-VI.** **C-8 *** Computer Networks	---	**COM-VI.** **E-13** Network Security	**COM-VI.** **E-14** Cloud Computing	**COM-VI.** **E-15** Multimedia Techniques	**COM-VI.** **E-16** Digital Marketing

Note: * Core Compulsory papers also offered for minor subject combination.

** Core Compulsory papers also offered for minor subject combination in 4^{th} Semester.

COMPONENT B:

1. **GENERAL COMPULSORY (GC-B) -** a. Cyber Security

2. **INTERDISCIPLINARY (GC-E) –** a. Multimedia

   b. Python Programming

Parvatibai Chowgule College of Arts and Science (Autonomous)
Margao, Goa

Syllabus for

Semester V

for the undergraduate course in

Computer Science

(2017-2018)

Paper Title: Operating Systems
Paper Code: COM-V.C-7
Marks: 75
Credits: 3

Prerequisite Courses :

- Introduction to Programming(COM-I.C-2)
- Data structures(COM-II.C-4)

Course Objectives:

This course aims at understanding functions of operating system. As part of the course students will study different aspects of operating system such as Memory management, CPU scheduling, Concurrency, Storage management etc.

Learning Outcomes:

On completion of the course

- Students will understand Memory Management
- Students will become familiar with different CPU scheduling algorithms
- They will learn about how concurrent transactions are handled by operating system.
- Students will be able to implement algorithms for CPU scheduling, memory management, Deadlocks etc.

Syllabus :

1. **Introduction to Operating System: [4L]**

   Basic elements of a computer system: Processor, Main Memory, I/O Modules, System Bus, Instruction Execution; Operating Systems: Definition, Operating system Structure, operating system operations, Relationship between Kernel, OS, and Hardware, Operating system services, System calls, Types of system calls, System programs.

2. Process Management: **[8L]**

Process Definition, Process Control Block, Process States, Operations on Process; Interprocess communication, Threads and Microkernels: Definition, Multi-threading Model Process Scheduling, Scheduling Criteria, Scheduling Algorithms, Multi-Processor Scheduling;

3. **Process Coordination** **[8L]**

Process Synchronization, Principles, Mutual Exclusion, The Critical-Section Problem, Petersons Solution, Semaphores, Monitors, Readers/Writers Problem; Classic Problems of Synchronization, Dining Philosopher’s problem

Deadlocks- system models, Deadlock characterization , Deadlock Handling Methods, Prevention, Avoidance, Detection, Recovery From Deadlock

4. **Memory Management:** **[12L]**

Introduction, Swapping, Contiguous Memory Allocation, Paging, Page Table, Segmentation

Virtual Memory: Introduction, Demand Paging, Page Replacement, Allocation of Frames, Thrashing

5. Storage Management **[5L]**

File System, Concepts, File Organization and Access Methods, Directory and Disk Structure.

Secondary Storage Structure - Overview, disk structure, Disk attachment, Disk scheduling

6. **Protection and Security** **[3L]**

System Protection :Goals of protection, Principles, domain of protection, Access Matrix, Implementation of Access Matrix.

7. **Advanced Concepts:** **[5L]**

   Distributed Operating System, Motivation, types of network based operating systems, Network structure, Network topology, Communication structure,

   Mobile Operating System, Multimedia Systems – What is multimedia, compression, Requirements of multimedia kernels.

<u>Text Book:</u>

1. A. Silberchatz, Galvin, Gagne, 2008, Operating System Concepts, Wiley publication 8th Edition.

<u>Reference Book:</u>

William Stallings, Operating Systems: Internals and Design Principles,Prentice Hall, 6th Edition

Lab : Operating Systems
Credit : 1
Marks : 25

Suggested list of Practical

1. Demo/Review of Installing Linux / Windows Operating System, Partitioning and formatting disk, Installing applications device drivers, working with files, mounting file systems, checking system space, creating, modifying and deleting user accounts (1P)
2. Study of Basic commands of Linux. (1P)
3. Shell Programming in Unix/Linux, arithmetic operations, loops (1P)
4. Shell Programming – advanced (1P)
5. Menu Driven Shell scripting (1P)
6. Filters and Pipes in LINUX (1P)
7. Implementation of Inbuilt Linux/UNIX commands like cp, rename etc. (1P)
8. Implementation of CPU scheduling policies (3P)

9. Implementation of Memory allocation techniques: (2P)

10. Implementation of Banker's algorithm. (Resource Allocation Graph) (1P)

****

Paper Title: Embedded Systems
Paper Code: COM-V.E-9
Marks: 75
Credits: 3

Prerequisite Courses:

- Digital Logic Design(COM-III.E-2)
- Knowledge of Programming

Course Objectives:

- To have a thorough understanding of Embedded Systems and their applications.

Learning Outcome:

After completion of the course students will be able to:

- Gain knowledge about the world of Embedded Systems, their characteristics and applications.
- Understand the function and use of Embedded System hardware and Interfacing I/O devices.
- Identify various sensors, actuators and their use.
- Understand the need for Real Time Operating Systems
- Develop Embedded Applications.

Syllabus :

1. **Introduction:** **[6L]**

   Introduction to Embedded Systems, Microprocessors and Micro-controllers. Components of Embedded System & its Classification, Characteristic of embedded system.

   Introduction to embedded processor, Digital Signal Processor, Application Specific System Processor, Design Process in Embedded System, Design metrics, Steps in design process. Challenges in Embedded System design, Design Examples. Advances in Embedded Systems.

2. **System hardware:** **[10L]**

System hardware, Interrupt structure and Applications, ARM Processor - Architecture, Programmer's model, Modes of operation, Interrupt**,** Handling Interrupts, Comparison of ARM7 & ARM9.
Components of Embedded Systems**-**Management of Power Supply, Clocking Unit, Real Time Clock and Timers, Reset Circuitry and Watchdog Timer. Processor and Memory Selection, Memory Map of Embedded System, Interfacing Processors, Memories and I/O – Analog vs Digital. Overview of Arduino, Intel Edison and Raspberry Pi boards.

3. Sensors and Actuators (Overview): [12L]

Sensors / Transducers: Principles – Classification – Parameters – Characteristics – Environmental Parameters (EP) – Characterization.

Thermal Sensors: Introduction – Gas thermometric Sensors – Thermal Expansion Type Thermometric Sensors.

Magnetic sensors: Introduction – Sensors and the Principles Behind – Magneto-resistive Sensors, Semiconductor Magnetoresistors.

Smart Sensors: Introduction – Primary Sensors – Excitation – Amplification – Filters – Converters – Compensation – Information Coding/Processing - Data Communication – Standards for Smart Sensor Interface – The Automation.

Sensors Applications: Introduction – On-board Automobile Sensors (Automotive Sensors) – Home Appliance Sensors – Aerospace Sensors –– Sensors for Manufacturing – Sensors for environmental Monitoring.

Actuators: Overview of Pneumatic and Hydraulic Actuation Systems, Mechanical Actuation Systems, Electrical Actuation Systems

4. I/O Interfacing and Communication: [10L]

I/O interfacing and Communication Buses, Serial vs Parallel Communication, Serial Data Communication RS-232/UART.
I/O devices, ADC / DAC, Optical Devices such as LED / LCD Display devices, Opto-Isolator, Relays, DC motor, Stepper motor, Timers/Counters, Parallel ports - Device interfacing.
Serial communication Protocols - UART Protocols, I^2C, CAN, USB & ZigBee – Protocol Architecture, Topology, Packets, Communication Cycle, Arbitration, Applications and comparison.

5. Internet of Things (IoT): [3L]

Introduction to IoT, **M2M to IoT**-The Vision-Introduction, M2M towards IoT- the global context, IoT **Architectural Overview, Potential and Challenges.**

6. Real Time Operating System: [4L]

Introduction to RTOS, architecture of kernel, task and task scheduler, interrupt service routines in RTOS Environment.

Text Books

1. Rajkamal, “Embedded Systems – Architecture, Programming and Design”, Tata McGraw Hill, Second Edition, 2008.
2. D. Patranabis, “Sensors and Actuators”, 2nd Ed., PHI, 2013.

Reference Book:

1. Dr. K. V. K. K. Prasad, “Embedded / Real Time System : Concepts, Design, & Programming – Black Book‖”, Dreamtech Press Publication.
2. David E Simon, “An Embedded Software Primer”, Pearson India, 1st Edition.
3. Tammy Noergaard, “Embedded Systems Architecture”, Elsevier
4. D. Patranabis, “Sensors and Transducers”, PHI Learning Private Limited.
5. Dr. K. V. K. K. Prasad, Gupta Dass, Verma, “Programming for Embedded system”, Wiley – Dreamtech India Pvt. Ltd.
6. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.

Lab : Embedded Systems

Credit: 1

Marks: 25

Programs to be executed on some of the embedded boards like Arduino, Intel Edison, Raspberry Pi, Bolt, etc., that covers the following tasks:

1) Interfacing sensors (3P)
2) Interfacing output devices (1P)
3) Interfacing input devices (1P)
4) Interfacing actuators (1P)
5) Building obstacle avoiding Robot (1P)
6) Line Following Robot (1P)
7) Programming with Raspberry Pi (2P)
8) Monitoring Data over Cloud (1P)

9) Building Web app to control devices. (1P)
10) Mini Project

****

Paper Title: Mobile Application Development
Paper Code: COM-V.E-10
Marks: 75
Credits: 3

Prerequisite Courses :

- Object Oriented Programming(COM-II.C-3)
- Web Designing(COM-III.E-4)

Course Objective:

Students learn how to develop applications for mobile devices, including smart phones and tablets. Students are also introduced to the current mobile platforms, mobile application development environments and mobile device input methods. Students will design and build a variety of apps on a popular platform throughout the course to reinforce learning and to develop real competency.

Learning Outcome :

Upon successful completion of the course, the student will demonstrate the ability to:

1) Explain mobile devices, including their capabilities and limitations.
2) Review current mobile platforms and their architectures.
3) Develop mobile applications on a popular mobile platform.
4) Evaluate development with another mobile platform.

<u>Syllabus :</u>

Introduction to mobile devices (3 L)

Mobile devices vs. desktop devices, Why we Need Mobile App, Different Kinds of Mobile Apps, ARM and intel architectures, Power Management, Screen resolution, Touch interfaces, Application deployment - App

Store, Google Play, Windows Store, Development environments – Android Studio, PhoneGAP, Native vs. web applications.

Review of HTML5/JS/CSS3 **(2 L)**

Quick recap of technologies, Mobile-specific enhancements, Browser-detection, Touch interfaces, Geolocation, Screen orientation, Mobile browser "interpretations" (Chrome/IE).

Mobile OS Architectures **(3 L)**

Comparing and Contrasting architectures of Android, iOS and Windows, Underlying OS(Darwin vs. Linux vs. Windows), Kernel structure and native level programming, Runtime (Objective-C vs. Dalvik vs. WinRT), Approaches to power management, Security.

Android overview **(2 L)**

Introduction to Android.Overview of android stack, Introduction to OS layers, Android features.

Linux Kernel, Libraries, Android Runtime, Application Framework, Dalvik VM

Android Components – Introduction **(3 L)**

Activities, Services, Broadcast Receivers, Content Providers.

Building UI with Activities **(4 L)**

Activities, Views, layouts and Common UI components, Creating UI through code and XML,

Activity life cycle, Intents, Communicating data among Activities.

Advanced UI **(5 L)**

Selection components (GridView, ListView, Spinner), Adapters, Custom Adapters, Menus, Toast, Custom Toast,Dialogs, Status bar Notifications.

Multithreading **(4 L)**

Using Java Mutithreading classes, AsyncTask, Handler, Post.

Intent, Intent Filters and Broadcast Receivers **(4 L)**

Role of filters, Intent-matching rules, Filters in your manifest, Filters in dynamic Broadcast Receivers, Creating Broadcast receiver, Receiving System Broadcast, Understanding Broadcast action, category and data, Sending Broadcast.

Data Storage **(5 L)**

Shared Preferences, Android File System, Internal storage, External storage. SQLite Introducing SQLite, SQLiteOpenHelper and creating a database, Opening and closing a database, Working with cursors, inserts, updates, and deletes.

Content Providers **(5 L)**

Accessing built in content providers, Content provider MIME types, Searching for content, Adding, changing, and removing content, Creating content provider, Working with content files.

Services **(5 L)**

Overview of services in Android, Implementing a Service, Service lifecycle, Inter Process Communication (AIDL Services).

Web Services and WebView - Consuming web services, Receiving HTTP Response (XML, JSON), Parsing JSON and XML, Using WebView.

<u>Reference books:</u>

1. Beginning Android 4 Development, Wei-Ming Lee(John Wiley & Sons)
2. Pro Android 4 ; Satya Komateneni, Dave MacLean (Apress)
3. Hello Android - Introducing Google's Mobile Development platform - Ed Brunette (The Pragmetic Bookshelf)
4. Android Apps with Eclipse 1st Edition, Onur Cinar(Apress)
5. Android- A Programmer'S Guide, Dimarzio, J.F.(Tata McGraw Hill)

Web References:

1. http://developer.android.com/index.html
2. http://www.appinventor.org/

Lab : Mobile Application Development

Credit: 1

Marks: 25

List of practicals

1. Getting Started with Android – Installing the Development Environment, Configuring Android Stack (1P)
2. Creating the First Android Application - Creating a Simple Android Project, Debugging Application through DDMS. setting up environment. AVD Creation, Executing Project on Android Screen. (1P)
3. Android application development - Use of GUI components to implement a simple application such as a Calculator. (1P)
4. Review the earlier application making use of the advanced UI components. (1P)
5. Implementing Data storage application - an application to make Insert , update , Delete and retrieve operation on the database. (2P)

6. Understanding content providers and permissions: Read phonebook contacts using content providers and display them suitably. (1P)

7. Optimizing your app performance with Services/Multithreading/Multiprocessing

   (2P)

8. Course Project (3P)

****

Paper Title: Introduction to Data Science
Paper Code: COM-V.E-11
Marks: 75
Credits: 3

Prerequisite courses:

Students are expected to have basic knowledge of algorithms and reasonable programming experience, and some familiarity with basic linear algebra and basic probability and statistics.

Course Objectives:

Become familiar with methods of data science and their practical usefulness.

Learning outcomes:

At the conclusion of the course, students should be able to:
• Describe what Data Science is and the skill sets needed to be a data scientist.
• Explain in basic terms what Statistical Inference means. Identify probability distributions commonly used as foundations for statistical modeling. Fit a model to data.
• Use R to carry out basic statistical modeling and analysis.

<u>Syllabus :</u>

Introduction **[4L]**

What is Data Science?,Big Data and Data Science hype -and getting past the hype,
Why now? –Datafication,Current landscape of perspectives,Skill sets needed

Statistical Inference **[6L]**

Populations and samples,Statistical modeling, probability distributions, fitting a model,
Intro to R

Exploratory Data Analysis and the Data Science Process **[6L]**

Basic tools (plots, graphs and summary statistics) of EDA,Philosophy of EDA,
The Data Science Process, Case Study: RealDirect (online real estate firm)

Three Basic Machine Learning Algorithms **[6L]**

Linear Regression,k-Nearest Neighbors (k-NN),k-means

Feature Generation and Feature Selection (Extracting Meaning From Data) **[6L]**

Motivating application: user (customer) retention,Feature Generation (brainstorming, role of domain expertise, and place for imagination) , Feature Selection algorithms ,Filters; Wrappers; Decision Trees; Random Forests

Mining Social-Network Graphs **[6L]**

Social networks as graphs,Clustering of graphs,Direct discovery of communities in graphs,
Partitioning of graphs, Neighborhood properties in graphs

Data Visualization **[6L]**

Basic principles, ideas and tools for data visualization,Examples of inspiring (industry) projects,
Exercise: create your own visualization of a complex dataset

Data Science and Ethical Issues **[5L]**

Discussions on privacy, security, ethics, A look back at Data Science,Next-generation data scientists

Text Book:

Cathy O’Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline, O’Reilly, 2014.

References Books :

• Jure Leskovek, Anand Rajaraman and Jeffrey Ullman, Mining of Massive Datasets v2.1,

Cambridge University Press, 2014 (free online)
• Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, ISBN 0262018020, 2013.
• Foster Provost and Tom Fawcett, Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking, ISBN 1449361323, 2013.
• Trevor Hastie, Robert Tibshirani and Jerome Friedman. Elements of Statistical Learning, Second Edition, ISBN 0387952845, 2009 (free online)
• Avrim Blum, John Hopcroft and Ravindran Kannan. Foundations of Data Science. (Note: this is a book currently being written by the three authors. The authors have made the first draft of their notes for the book available online. The material is intended for a modern theoretical course in computer science.)
• Mohammed J. Zaki and Wagner Miera Jr, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, 2014.
• Jiawei Han, Micheline Kamber and Jian Pei, Data Mining: Concepts and Techniques, Third Edition, ISBN 0123814790, 2011.

Lab : Introduction to Data Science

Credit: 1

Marks: 25

List of practicals

1: Implementation of probabilty distribution	[1P]
2: Sampling and re-sampling.	[1P]
3: Linear Models	[1P]
4: K-Nearest neighbour	[2P]
5: K-Means	[1P]
6: Feature Selection Algorithm	[2P]
7: Filters and Wrappers	[1P]
8: Decision Trees	[1P]

All the experiments will be implemented using Excel /R-Tool/ or equivalent.

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Paper Title: Software Testing
Paper Code: COM-V.E-12
Marks: 75
Credits: 3

Prerequisite courses: Introduction to Programming (COM-I.C-2)

Course Objectives:

- To study fundamental concepts in software testing, including software testing objectives, process, criteria, strategies, and methods.
- To discuss various software testing issues and solutions in software unit test; integration, regression, and system testing.
- To learn how to plan a test project, design test cases and data, conduct testing operations, manage software problems and defects, generate a testing report.

Learning Outcomes:

On Completion of this course the student will:

- Have an ability to understand and identify various software testing problems, and solve these problems by designing and selecting software test models, criteria, strategies, and methods.
- Have an ability to use software testing methods and modern software testing tools for their testing projects.

Syllabus :

Software testing principles - Software Testing- Need for testing, Psychology of testing**,**Testing economics**,** SDLC and Testing**,**Verification & Validation**.**Quality Assurance, Quality Control

(3L)

Testing strategies and types - White box testing techniques - Statement coverage, Branch Coverage , Condition coverage, Decision/Condition coverage , Multiple condition coverage, Dataflow coverage, Automated code coverage analysis, Inspections, Walkthroughs Code Review

(5L)

Black box testing techniques - Boundary value analysis**,**Robustness testing **,**Equivalence partitioning**,**Syntax testing**,**Finite state testing**,**Levels of testing**,**Unit, Integration and System Testing**,**Compatibility Testing**,**Domain Testing**,**Adhoc Testing **,**Use of Requirement,Traceability Matrix **(6L)**

Integration Testing Waterfall - Top-down ,Bottom up ,Big bang,Sandwich **(3L)**

System and Performance Testing - Types of system testing ,Functional and non-functional testing Acceptance Testing ,Setting entry and exit criteria for phases and typical product release scenarios ,Basic factors governing performance testing, Methodology for performance testing ,Tools for performance testing **(4L)**

Regression Testing - Purpose **,**Timing, Choice of tests **,**Smoke tests **,**Best practices **(3L)**

Internationalization and Localization testing - Preliminary concepts,Adhoc testing,Pair testing, Extreme testing, Agile testing, Exploratory testing,Defect seeding **(3L)**

Usability Testing - Factors in usability testing ,Aesthetics testing ,Accessibility testing ,Tools for usability testing **(3L)**

Testing object oriented software - Definitions and Challenge differences from testing non-OO Software,Class testing strategies Class Modality,State-based Testing,Message SequenceSpecification **(4L)**

People and organizational issues in testing - Common people issues and myths in testing, Providing career paths in testing,Organizational structures for testing teams,Geographically distributed testing teams and success factors **(6L)**

Test Management and Automation- Test Planning,Test Management,Test Process,Test Reporting,Test Automation,Factors to consider in automation,Challenges in test automation,Test Metrics,Product Metrics,Process Metrics,Progress Metrics
Use of metrics in ascertaining product release **(5L)**

References:

1. 1.Software Testing- Principles and Practices ,Srinivasan Desikan and Gopalaswamy Ramesh , Pearson Publication
2. Integrated Approach to Software Engineering , Pankaj Jalote, Narosa Publishing House
3. Software Engineering – A Practitioners Approach, Roger Pressman, McGraw Hill Publication

Lab: Software Testing
Credit: 01
Marks: 25

List of suggested **PRACTICALS** using any testing tool such as Selenium or equivalent :

1. Planning Test Cases (1P)
2. Generating Test Cases/Test Suite (2P)
3. Enhancing Tests (3P)
4. Debugging Tests (2P)
5. Running Tests (2P)
6. Analyzing Results (1P)
7. Reporting Defects (1P)

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Parvatibai Chowgule College of Arts and Science (Autonomous)
Margao, Goa

Syllabus for

Semester VI

for the undergraduate course in

Computer Science

(2017-2018)

Paper Title: Computer Networks
Paper Code: COM-VI. C-8
Marks: 75
Credits: 3

Prerequisite Courses :

- Introduction to Programming (COM-I.C-2)
- Object Oriented Programming (COM-II.C-3)

Course Objectives:

- To understand the basic concepts of Computer Networking
- Be familiar with the components required to build and design different types of networks.

Learning outcome:

- Gain Knowledge of the Reference models
- Understand basic concepts of data transmission over wired medium Compare various routing, transport protocols and Identify suitable protocol for a given network.
- Able to design the basic Computer network and maintain the networks
- Develop client server programs for different applications

Syllabus :

1. Introduction **[8L]**

Basics of Computer Networks, Classification: transmission technology, scale; Applications; Data Communications: data, signal, bandwidth, bit interval and bit rate, Modes of Communication. Layered network architecture, Networks models: OSI model, TCP / IP protocol suite; Guided and Unguided Transmission media, Multiplexing: FDM, TDM. Switching: Circuit switching, message switching, Packet Switching.

2. Data link layer **[12L]**

Data link control: Framing:Character Count, Character Stuffing, Bit Stuffing; , Error Detection and correction, Flow and error control, HDLC; Multiple access: Random access – Controlled access , ALHOA, CSMA, CSMA/CD and CSMA/CA; Ethernet : IEEE standards, standard Ethernet, Fast Ethernet, Gigabit Ethernet; Connecting devices: repeater/hub, bridge, router and gateway, Backbone networks - Virtual LANS

3. Network layer **[14L]**

Functions of Network layer; Network Service types: Virtual Circuits, Datagrams; Logical addressing: IPv4, private and public IP addressing, special IP addresses, subnetting, IPV6 addressing Internet Protocol: Internetworking:IPv4, Fragmentation and reassembly , Address mapping : ARP, RARP, BOOTP, DHCP, ICMP . Routing: classification of routing, Shortest path routing, Distance Vector routing, Link State routing;

4. Transport layer and Application layer **[9L]**

Process-to-Process delivery: User Datagram Protocol (UDP), Transmission ControlProtocol (TCP), Quality of services (QoS); Application Layer: Domain Name System (DNS) , E-mail, FTP, HTTP.

5. Wireless Networks **[2L]**

Basics of wireless networking.

TEXT BOOK:

1. Andrew S. Tanenbaum, David J. Wetherall “Computer Networks”, Prentice-Hall, 5th Edition.

REFERENCES:

1. Behrouz A. Forouzan, “Data communication and Networking”, Tata McGraw – Hill, 2011, 4th Edition.
2. James F. Kurose, Keith W. Ross, “Computer Networking – A Top-Down Approach Featuring the Internet”, Pearson Education, 2009, 5th Edition,
3. Nader. F. Mir, “Computer and Communication Networks”, Pearson Prentice Hall Publishers, 2010.
4. Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, “Computer Networks: An Open Source Approach”, Mc Graw Hill Publisher, 2011.
5. Larry L. Peterson, Bruce S. Davie, “Computer Networks: A Systems Approach”, Morgan Kaufmann Publishers, 2011, 5th Edition

Lab : Computer Networks
Credits : 1
Marks : 25

List of Practicals

1. Installing virtual machines, Ethernet cabling
2. Study of network commands ping, ipconfig, netstat, traceroute
3. Setting up of LAN Network
4. IP address manipulation -Extract network id and Host id given netmask
5. Mini Project / Packet capture tool/ packet generator tool
6. UDP Socket programming (c/c++/Java/ perl)

7. TCP Socket programming -I
8. Configuring VLAN (DLink Switch)/ TCP Socket programming –II
9. Configuring routing tables
10. Configuring DHCP server/client
11. Mini Project / Simulation of IP fragmentation
12. Mini Project/Configuring E-Mail/DNS

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Paper Title: Network Security

Paper Code: COM-VI. E-13

Marks: 75

Credits: 3

Prerequisite Courses:

Introduction to Programming(COM-I.C-2)/Object Oriented Programming(COM-II.C-3)

Course Objectives:

- To understand the theory and concepts of Network Security

Learning outcome:

- Gain Knowledge of the threats, vulnerabilities and system risks
- Understand cryptography, ciphers and encryption algorithms

- Know about viruses, Trojan horses, worms, program flaws and the defenses against them

Syllabus :

1. Concepts of Security & Classical Encryption Techniques [8L]

Introduction, The need for security, Security Approaches, Security Attacks, Security Services, Security Mechanisms, A Model for Network Security. Symmetric Cipher Models – Substitution techniques, Transposition techniques, Steganography, Block Cipher Operation, Electronic Code Book, Cipher Block Chaining, Block Cipher Principles, The Data Encryption Standard

2. Public Key Cryptography and Cryptographic Hash Functions [8L]

Introduction To Number Theory, Modular Arithmetic, Prime Numbers, Euler's Totient Function, Principles of Public Key Cryptosystems, The RSA Algorithm, Other Public key cryptosystems, Diffie Hellman Key Exchange.

Applications of Cryptographic Hash Functions, Two Simple Hash Functions, Hash Functions Based on Cipher Block Chaining, MD5 Message Digest Algorithm, Secure Hash Algorithm SHA 512.

3. Message Authentication Codes and Digital Signatures [8L]

Message Authentication Requirements – Message Authentication Functions –Requirements for Security of MACs, MACs Based on Hash Functions, HMAC, MACs Based on Block Ciphers, Data Authentication Algorithm. Digital Signatures, Digital Signature Standard.

4. Key Management & Distribution And User Authentication [8L]

Introduction, Digital Certrificate,Private key Management, The PKIX Model,Public key cryptographic standards,XML,PKI and security

5. Program Security [7L]

Flaws, Malicious code: viruses, Trojan horses, worms, Program flaws: buffer overflows, time-of-check to time-of-use flaws, incomplete mediation. Defenses: Software development controls, Testing techniques.

6. Firewall and Virtual Private Network **[6L]**

Introductionto network security techniques: IP Security, firewalls, virtual private networks.

TEXT BOOKS:

1. William Stallings, ―Cryptography and Network Security – Principles and Practices‖,

Prentice Hall of India, Fifth Edition

2. Kahate Atul, "Cryptography and Network Security" Tata McGraw-Hill.

3. Charles P. Pfleeger and Shari L. Fleeger, ―Security in Computing‖. Prentice-Hall.2003, (3rd edition)

4. Menezes A. J., P.C. Van Oorschot and S.A. Vanstone, "Handbook of Applied Cryptrography"

Lab : Network Security

Credits : 1

Marks : 25

List of Practicals

1. Implementation of Caesar Cipher
2. Implementation of One-Time Pad
3. Implementation of Playfair Cipher
4. Implementation of Hill Cipher
5. Implementation of Data Encryption Standard Algorithm
6. Implementation of Image Steganography
7. Implementation of RSA Algorithm

8. Implementation of Digital Signatures using RSA Algorithm

9. Design Network protocol analyzer tool to analyse network traffic.

10. Mini Project/ Case Study

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Paper Title: Cloud Computing
Paper Code: COM-VI. E-14
Marks: 75
Credits: 3

Prerequisite Courses:

Operating Systems(COM-V.C-7)

Course Objectives:

- To make students understand the key elements of cloud computing.
- To understand the difference between deploying applications on the cloud and the local infrastructure.
- To understand various cloud service models.

Learning Outcomes:

On completion of the course students will be able to:

- Explain the core concepts of the cloud computing paradigm.
- Characterize the different cloud services ie. Infrastructure, Platform and Software as a Service (IaaS, PaaS, SaaS).

Syllabus :

1. **Overview of Computing Paradigm** **[7L]**
   Recent trends in Computing: Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing.

2. **Introduction to cloud computing:** **[7L]**

Cloud Computing definition, History of Cloud Computing, How Cloud Computing Works, Benefits and challenges of cloud computing, Issues for Cloud Computing.

3. **Cloud Computing Architecture** **[10L]**
Comparison with traditional computing architecture (client/server), Cloud Computing Service Models, Deployment Models- Public cloud, Private cloud, Hybrid cloud and Community cloud, Key drivers to adopting cloud, Impact of cloud on users, Governance in the cloud.

4. **Infrastructure as a Service(IaaS)** [**7L**]
Introduction to IaaS: IaaS definition, Introduction to virtualization, Different approaches to virtualization, Hypervisors, Machine Image, Virtual Machine(VM). Resource Virtualization: Server, Storage, Network. Examples: Amazon EC2.

5. **Platform as a Service(PaaS)** **[7L]**
Introduction to PaaS: What is PaaS, Service Oriented Architecture (SOA).Cloud Platform and Management: Computation, Storage, Examples: Google App Engine, Microsoft Azure, SalesForce.com.

6. **Software as a Service(PaaS)** **[7L]**
Introduction to SaaS, Web services,Web 2.0, Web OS, Introduction to MapReduce, Case Study on SaaS.

Text Books:

1. Tim mather, subrakumarswamryandsharhedLatif, “Cloud Computing Security and Privacy”, O’Reilly publication.
2. Richard Hill, Laurie Hirsch, Peter Lake, SiavashMoshiri, “Guide to Cloud Computing Principles and Practices”, Springer, 2013.
3. RajkumarBuyya, James Broberg, Andrzej M. Goscinski, “Cloud Computing: Principles and Paradigms”, Wile,2011.
4. Nikos Antonopoulos, Lee Gillam“Cloud Computing: Principles, Systems and Applications”, Springer, 2012.
5. Ronald L. Krutz, Russell Dean Vines,“Cloud Security: A Comprehensive Guide to Secure Cloud Computing”, Wiley-India, 2010

Lab : Cloud Computing

Credit : 1

Marks : 25

1. Create virtual machines that access different programs on same platform. [1P]

2. Create virtual machines that access different programs on different platforms. [1P]
3. Install a C compiler in the virtual machine and execute a sample program. [1P]
4. Working on tools used in cloud computing online- [2P]

a) Storage

b) Sharing of data

c) Manage your calendar, to-do lists,

d) A document editing tool

5. Working with any cloud service to make spreadsheet and notes and collaborate online in real time and chat with other collaborators. [1P]
6. Exploring Public Cloud. [1P]
7. Exploring Cloud IDE's. [1P]
8. Installation and Working of Google App Engine [1P]
9. Web Service deployment and usage over cloud. [2P]

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Paper Title: Multimedia Techniques
Paper Code: COM-VI. E-15
Marks: 75
Credits: 3

Prerequisite Courses: Nil

Course Objectives:

On completion of the course the students will develop specific skills and competencies by making them proficient in Designing Graphical Images, Audio and Video Capture and Editing using Software tools

Learning Outcomes:

On Completion of this course the student will:

- Study Multimedia Concepts
- Develop their Creativity and publish a self-contained multimedia Application using multimedia authoring tool in various application areas.

Syllabus :

1. Introduction to Multimedia: [8L]

Commonly used terms associated with multimedia like CDROM, Storyboard, Script and Authoring tools.

Stages of a Multimedia Project-Planning and Costing, Designing and Producing, Testing and Delivering.

The Multimedia team and their roles- Project Manager, Writer, Video specialist, Audio specialist and Multimedia programmer.

Multimedia Software. Multimedia Hardware.

Social & Ethical considerations, Digital Representations & Standards.

2. Introduction to Computer Graphics: **[8L]**

Vector graphics fundamentals, shapes, transforms and filters,

Bitmapped graphics: resolution, image compression, manipulation, Geometrical transformations

3. Text and Layout: **[5L]**

Text in graphics, character set, fonts, layout

4. Sound: **[8L]**

Basic Sound Concepts, Digitising and processing sound, Music, Speech, Compression, formats, MIDI and Digital Audio

5. Color Science and Color Models: **[8L]**

Human vision, Camera systems, Gamma correction, Color matching, different Color models – RGB, CYMK, Transformations among color model

6. Video: **[8L]**

Digitising video, streamed video, video standards, compression: mpeg, dv, codec comparison, introduction to Animation: captured, sprite, key frame, web, 3-D. Virtual reality: VRML

Text Book:

1. Nigel Chapman, Jenny Chapman; Digital Multimedia; Wiley India Edition, 2nd Edition
2. Ze-Nian Li & Mark S Drew; Fundamentals of Multimedia; Pearson Education International Edition
3. Vaughan, Tay; Multimedia: Making it Work; Tata McGraw-Hill, 3rd edition

4. Jeffcoate, Judith; Multimedia in Practice, Technology and Applications, PHI

Lab: MULTIMEDIA TECHNIQUES

Credit: 01

Marks: 25

List of suggested **PRACTICALS** (the numbers in brackets indicate number of practicals):

Practical can be done using Proprietary or FOSS for Text, Image, Audio and Video Editing. For example Scribus, GIMP, Audacity, Movie maker, Openshot, etc.

1. Design a Brochure for a given product, give details. Learn about different Image file Formats (2P)
2. Design a Poster with given information and learn about Image compression (2P)
3. Learn to prepare Images for Print, Web and Video. (1P)
4. Edit the Sound file and Learn about Effects and Filters of sound (3P)
5. Record Your voice and learn about Audio Compression. (1P)
6. Record an Audio Program and Learn about streaming an audio content. (1P)
7. Learn about Video editing – Prepare video with rough cut (2P)
8. Prepare Video content with title and special effects. (1P)
9. Record Video content and learn about video compressions. (1P)
10. Prepare Video content for streaming. (1P)

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Paper Title: Digital Marketing

Paper Code : COM-VI.E-16

Marks: 75

Credits: 3

Prerequisite Courses: Web Designing(COM-III.E-4)

Course Objectives:

- To study various online Marketing Strategies.
- Analyze and research Internet to improve the quality and marketability of the Websites.

Learning Outcomes:

On completion of the course students will learn the following:

- Optimize the website for various search engines.
- Market the company/product using Search Engine and Social Media.
- Analyze the Web for improving the marketing strategy.

Syllabus :

I. Search Engine Optimisation (SEO): [10L]

Introduction to Online Search; Function of Search Engines Google Page Rank; Introduction to Search Engine Optimisation; Building Accessible Site; Keyword Research and Optimisation; Link Building Strategies; Useful Tools for SEO; The Past, Present and Future of SEO.

II. Search Engine Marketing (SEM): [9L]

Introduction to Internet and Search Engine Marketing; Google Adwords; Adwords Account Structure; Navigating in Google Adwords; Working with Keywords; Creating Ads in Google Adwords; Creating and Managing your First Ad Campaign; Adwords Reporting and Account Performance Reports.

III. Social Media Marketing (SMM): [9L]

Introduction to the World of SMM; Why Social Media?; Getting Started with Social Media; Building Relationships via Facebook, Twitter, LinkedIn, YouTube; Handling Positive and Negative Comments; Social Media Content Base Creation.

IV. Email Marketing: [5L]

Importance of Email marketing; Email Marketing Software's; Subscriber List; Email Marketing Campaign; Newsletters; Measuring the results.

V. WEB Analytics: [9L]

Web Analytics and Intelligence Tools; Basic Metrics Demystified; Introduction to Google Analytics; Goals and Actionable Insights; Data Management; Social Media Analytics; Social Media Goals and KPI's; Tools for Social Media Analytics.

VI. Marketing Automation: [3L]

Introduction to Marketing Automation; Advantages of using Marketing Automation Software; Issues with Marketing Automation.

Text Books:

- Damian Ryan, 2014 *"Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation"*, Kogan Page Publisher, 3rd Edition.

Reference Books:

- Calvin Jones and Damian Ryan, 2012 "The Best Digital Marketing Campaigns in the World**:**
- Nick Smith, 2013 , *"Successful SEO and Search Marketing in a Week"*, Teach Yourself Publisher,.
- Lee Odden,2012,*"Optimize: How to Attract and Engage More Customers by Integrating SEO, Social Media, and Content Marketing"*, Wiley Publishing, 1st Edition.
- Avinash Kaushik, 2013, *"Web Analytics 2.0: The Art of Online Accountability & Science of Customer Centricity (Sybex)"*, Wiley Publishing, 2nd edition .

Practical: Digital Marketing

Credit: 1

Marks: 25

1. Using Search Engine Optimization tools (like google & bing search console, hubspot, webceo, google page speed) **(3P)**

2. Using Search Engine Marketing tools (like google adwords, google adwords certifications, search, display, remarketing formats, facebook marketing, linkedin advertising) **(3P)**

3. Using Social Media Marketing tools (like hootsuite, buffer, sproutsocial, klear, twitonomy, socialmention, google alerts, mention) **(2P)**

4. Using Email Marketing tools (like mailchimp, campaign monitor, mailgun, mandrill, phplist, amazon ses **(2P)**

5. Using Web Analytics tools (like google analytics, compete.com, crazyegg, facebook insights, twitter insights) **(3P)**

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Annexure II

Parvatibai Chowgule College of Arts and Science (Autonomous)
Margao, Goa

Semester III Syllabi for

MSc IT

(2017-2018)

Paper Title: Data Mining

Paper Code : MIT31

Marks: 100

Credits: 4

Course Pre-Requisites:

- An introductory course on DBMS

Course Objectives:

- Identify the key processes of data mining, data warehousing and knowledge discovery process
- Describe the basic principles and algorithms used in practical data mining and understand their strengths and weaknesses
- Apply data mining methodologies with information systems and generate results which can be immediately used for decision making in well-defined business problems

Learning Outcome:

- Understanding of various Data Mining Algorithms.
- Understanding various Data Mining tools such as Weka etc.

Syllabus:

1: Introduction and Background **[6L]**

Introduction to the multidisciplinary field of data mining,. Discussion on the evolution of database technology that has led to the need for data warehousing and data mining. Stress on importance of its application potential. Introduction to the different key words and techniques

2: Data Warehousing And OLAP **[8L]**

Insight of data warehouse and on-line analytical processing, Aggregation Operations, models for data Warehousing, star schema, fact and dimension tables Conceptualization of data warehouse and multidimensional databases. Life cycle of data warehouse development. Relationship between data warehouse and data mining

3: Data Mining Primitives **[8L]**

Data preprocessing including data cleaning, data integration, data transformation. Definition and Specification of a generic data mining task. Description of Data mining query language with few example queries

4: Association Analysis **[9L]**

Different methods(algorithms) for mining association rules in transaction based data bases. Illustration of confidence and support. Multidimensional and multilevel association rules. Classification of association rules. Discussion on few association rule algorithms e.g. Apriori, frequent pattern growth etc.

5: Classification and Predictions **[12L]**

Different Classification algorithm, including C4.5, CART etc., use of genie index, decision tree induction, Bayesian classification, neural network technique of back propagation, fuzzy set theory and genetic algorithms

6: Clustering **[11L]**

Partition based clustering, Hierarchical clustering, model based clustering for continuous and discrete data. Discussion on scalability of clustering algorithms

Web Mining: web usage mining, web content mining, web log attributes, use of web mining in efficient surfing and personalization.

Mining Complex type of data: Data mining issues in object oriented databases, spatial databases and multimedia data bases, time-series data bases, and text data bases

7: Applications of Data Warehousing And Data Mining **[6L]**

Exploration of web sites on data ware housing and data mining applications including bibliography data bases, Corporate Houses and Research labs

LIST OF BOOKS:

1. Jiawei Han and Micheline Kamber, 2001, “Data Mining Concepts and Techniques,” Indian Reprint, Harcourt India Private Limited, ISBN 1-55860-489-8,1st Edition.

2. Vipin Kumar, Margaret Dunham, 2003, “Data Mining: Introductory and Advanced Topics,” Prentice Hall (Pearson Publication), ISBN 0-13-088892-3, 1st Edition.
3. Arun K Pujari, “Data Mining Techniques”. Universities Press
4. Pang-Ning Tan, Michael Steinbach,Vipin Kumar, Introduction to Data Mining, Pearson Education
5. Soumen Chakravarty, Web Mining
6. T. Mitchell, 1997, “Machine Learning”, McGraw Hill
7. S.M. Weiss and N. Indurkhya, 1998, “Predictive Data Mining”, Morgan Kaufmann
8. M. Jarke, M. Lenzerni, Y. Vassiliou, and P. Vassiladis, 2000, “Fundamentals of Data Warehouses”, Springer Verlag, Isbn 3-540-65365-1

Paper Title: Information Retrieval

Paper Code: MIT 32

Marks: 100

Credits: 4

Course Pre-Requisites: Nil

Course Objectives:

- The objective of the course is to introduce students to the theoretical underpinnings of information retrieval (IR), an active and rapid growing branch of applied computational science. Main topics of the course include document representation, document indexing, digital information storage, retrieval, and distribution. Emphasis is given to application of IR theories and practices to web indexing and web search engine

Learning Outcomes:

- Develop system for IR using various models
- Perform Query evaluation and Relevance feedback
- Design systems that included hyperlinks, multimedia and the web

Syllabus:

1.Overview of Information Retrieval **[3L]**

Function of an IR system, Kinds of IR system, Components of an IR system, Problems in designing an IR system.

2.Boolean Model, Term vocabulary and Posting Lists **[6L]**

Term-Document Incidence matrix, Building an inverted index, Processing boolean queries, Obtaining character sequence in a document, Choosing a document unit, Tokenization, Stop word removal, Equivalence classing of terms, Stemming and Lemmatization, Porter's Algorithm for Stemming, Skip Pointers, Biword indexes, Positional indexes

3. Dictionaries and Tolerant Retrieval **[6L]**

Search structures for dictionaries, Wildcard queries, Permuterm indexes, k-gram indexes for wildcard queries, Spelling correction, computation of Levenshtein distance, k-gram indexes for spelling correction, Context-sensitive spelling correction, Phonetic correction, Soundex Algorithm

4. Index Construction and Compression **[5L]**

Blocked sort-based indexing, Single-pass in-memory indexing, Distributed and Dynamic indexing, Statistical properties of terms, Dictionary compression, Postings file compression

5. Vector Space and Probabilistic Models **[6L]**

Term frequency and Weighting, Inverse Document frequency, Computing Similarity Coefficient, Cosine Similarity between query and document vectors, Review of Probability theory, Ranking documents by using probabilistic retrieval

6. Evaluation, Relevance Feedback and Query Expansion **[6L]**

Standard test collections, Evaluation of unranked retrieval sets, Precision, Recall and F-measure, Assessing relevance, Kappa measure for inter-judge agreement, A/B testing, result snippets, relevance feedback and pseudo-relevance feedback, Rocchio algorithm, Global methods for query re-formulation, Query expansion and automatic thesaurus generation

7. XML Retrieval **[7L]**

Basic XML concepts, Challenges in XML retrieval, A Vector Space Model for XML retrieval, Evaluation of XML retrieval, Text-centric versus data-centric XML retrieval

8. Parallel and Distributed IR **[6L]**

Parallel Computing, Performance Measures, MIMD and SIMD architectures, Distributed Computing, Collection partitioning, source selection, Query processing, web issues

9. Multimedia IR **[8L]**

Multimedia data support in commercial DBMSs, MULTOS data model, Query languages, request specification, conditions on multimedia data, uncertainty, proximity and weights in query expressions, spatial access methods, a generic multimedia indexing approach, one-dimensional time-series, two dimensional colour images, automatic feature extraction

10. IR and the World Wide Web **[7L]**

Background and history, web characteristics, web graph, search engine optimization, advertizing as the economic model, size of search engine index, sampling techniques, duplication, web crawling, crawling architecture modules, DNS resolution, URL frontier, anchor text and the web graph

List of Books

1. Christopher Manning, Prabhakar Raghavan and Hinrich Schutze: Introduction to Information Retrieval
2. D. Grossman and O. Frieder.2004, Information Retrieval: Algorithms and Heuristics, Kluwer, Second Edition
3. Ricardo Baeza-Yates and Berthier Ribeiro-Neto: Modern Information Retrieval
4. Korfhage, Robert R , 1997. Information Storage and Retrieval, 191-218. New York: Wiley,
5. C. J. van RIJSBERGEN, INFORMATION RETRIEVAL A ,Group, University of Glasgow (www.dcs.gla.ac.uk)
6. S. Chakrabarti. Morgan Kaufmann, 2002. Mining the Web: Analysis of Hypertext and Semi Structured Data.

Paper Title: Data Mining & Information Retrieval LAB

Paper Code: MIT 36

Marks: 50

Credits: 2

Course Pre-Requisites : Nil

Course Objectives:

- The objective of the course is to introduce students to the actual implementation of latest technologies that are used in the IT industry & implementation of concepts in Information Retrieval and Data Mining Techniques.

Learning Outcomes:

- Knowledge of implementation of Data Mining and Information Retrieval concepts.

List of Experiments

1. Programs to implement Association Rule Mining Algorithms	[2P]
2. Programs to implement Clustering Algorithms	[5P]
3. Programs to implement Classification Algorithms	[4P]
4. Program to implement Sequential Pattern Matching	[3P]
5. Program to implement Temporal Pattern Mining	[3P]
6. Program to compare and contrast Association Measures	[1P]

7. Program to implement Boolean Model (Generate Term Incidence Matrix along with frequency) [1P]

8. Program to implement stop word removal. [1P]

9. Program to implement Porter's stemming algorithm. [1P]

11. Program to implement Permuterm Indexes [2P]

12. Program to implement Vector Space Model (Similarity Coefficient) [3P]

13. Program to implement Vector Space Model (Cosine Similarity) [2P]

14. Program to implement Probabilistic Model [2P]

Use of Apache Lucene/NLTK tools is recommended.

Annexure III

Parvatibai Chowgule College of Arts and Science
(Autonomous)

DEPARTMENT OF COMPUTER SCIENCE

COURSE STRUCTURE

THREE YEAR B.Sc. DEGREE COURSE IN COMPUTER SCIENCE

COMPONENT A:

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	**COM-I.C-1** Mathematical foundation of Computer Science - I	**COM-I.C-2 *** Introduction to Programming	---	---	---	---
II	**COM-II.C-3 **** Object Oriented Programming	**COM-II.C-4 *** Data Structures	---	---	---	---

III	**COM-III.C-5 *** Data Base Management Systems	---	**COM-III. E-1** Software Engineering	**COM-III. E-2** Digital Logic Design	**COM-III. E-3** Mathematical Foundation of Computer Science - II	**COM-III. E-4** Web Designing
IV	**COM-IV.C-6** Computer Architecture and Organization	---	**COM-IV. E-5** Design & Analysis of Algorithms	**COM-IV. E-6** Data Base Application Development	**COM-IV. E-7** Server Side Programming	**COM-IV. E-8** HCI
V	**COM-V.C-7 *** Operating Systems	---	**COM-V. E-9** Embedded Systems	**COM-V. E-10** Mobile Application Developm	**COM-V. E-11** Introduction to Data Science	**COM- V. E-12** Software Testing

				ent		
VI	**COM-VI.C-8 *** Computer Networks	---	**COM-VI. E-13** Network Security	**COM-VI. E-14** Cloud Computin g	**COM-VI. E-15** Multimedia Techniques	**COM-VI. E-16** Digital Marketing

Note: * Core Compulsory papers also offered for minor subject combination.

** Core Compulsory papers also offered for minor subject combination in 4th Semester.

COMPONENT B:

2. GENERAL COMPULSORY (GC-B) - a. Cyber Security

2. INTERDISCIPLINARY (GC-E) - a. Multimedia

b. Python Programming

B.Sc. Computer Science – Syllabus
(from Academic Year 2017-18)

Semester I

Paper Title: Mathematical Foundation of Computer Science I
Paper Code: COM-I.C-1
Marks: 75
Credits: 3

Prerequisite Courses : Nil

Course Objectives:

- To build mathematical foundations that are essential requirement in understanding various concepts related to computer science.

Learning Outcome:

On completion of the course students will learn the concepts of the following:

- Combination and permutation.
- Numbers systems and conversions
- Boolean Algebra and Logic
- Set, Relations and Functions
- Finite Machines

1. **Combinatory:** **[8L]**
Permutations; Combinations; Counting; Summation; generating functions; recurrence relations.

2. **Binary Number System:** **[7L]**
Decimal to binary conversion and vice versa, binary number representation (signed, 1's Complement and 2's complement) binary addition, subtraction, binary to octal, hexadecimal conversion and vice versa. Floating point representation.

3. **Boolean Algebra:** **[7L]**
Boolean functions, truth table, DeMorgan's theorem, logic gates, Realization of Boolean Function using logic gates, Simplification using Karnaugh map.

4. **Set, Relations and Functions:** **[9L]**
Venn diagram, set operations, relations and properties, closures, equivalence relations, Partial ordering, functions, function types, inverse of functions, composition of functions, recursive functions, growth of functions.

5. **Logic:** **[6L]**
Propositional logic, first order logic, mathematical induction, deduction, proof by contradiction, program correctness.

6. **Grammars, Languages and Automation:** **[8L]**

Grammars and languages, finite automation of finite state machines, regular languages, regular expressions.

Text Book:

Rosen H. Kenneth, *Discrete Mathematics and its Applications*, Tata McGraw Hill, seventh edition, 2011.

Reference:

Sarkar Kumar Swapan, *A Textbook of Discrete Mathematics*, S Chand & Company, 2005.

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Practical: Mathematical Foundation of Computer Science I
Credit: 1
Marks: 25

Programs using C Language: (Any one from the choices a), b), c) ….)

1) Generate all permutations of *n* symbols, where $2 \le n \le 5$ is user defined.
2) a) Read an integer. Convert it into binary number.
   b) Read a binary number. Convert it into decimal n umber.
   c) Read a number. Convert it into normalized form.
   d) Read a binary number. Convert it into octal number.

3) Read a string of decimal digits. Find the frequency distribution of digits.
4) Read binary string. Check the occurrence of the pattern 1001 in the string.
5) a)Read two binary numbers. Add them using 1's complement method.
   b) Read two binary numbers. Add them using 2's complement method.
6) Read two integer numbers. Find their GCD using recursion.

7) a) Read the value of *p*. Find the *p*-th Fibonacci number from the following recurrence relation.
   $f(0) = 0, f(1) = 1, f(n) = f(n-1) + f(n-2), n \geq 2$
   b) The Ackermann function is defined as follows:

$$A(m,n) = \begin{cases} n+1 & \text{if } m = 0 \\ A(m-1,1) & \text{if } m > 0 \text{ and } n = 0 \\ A(m-1, A(m,n-1)) & \text{if } m > 0 \text{ and } n > 0. \end{cases}$$

   Find $A(m,n)$ for given m, n.
8) Given two functions $f(x) = x^3 + 2x + 3$, and $g(x) = 3x^2/4 + 10$, find $f \circ g\ (x)$.
9) Read an expression. Check whether it has equal number of '(' and ')' brackets, equal Number of '{' and '}' brackets, and equal number of '[' and ']' brackets.
10) Consider a set consisting of *n* numbers, where *n* is user defined. Read a set. Check whether a given number is a member of the set.

11) a) Read two sets. Find their union.
b) Read two sets. Find their intersection.
12) Read an expression containing on parentheses (and). Check whether it is properly parenthesized.
13) Applications of set theory, finite state machines, matrices, Boolean algebra, gates, …
14) Bit-wise operations using C

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Paper Title: Introduction to Programming

Paper Code: COM-I.C-2

Name of Faculty: Mr. D. Prabakaran

Marks: 75

Credits: 3

Course Objectives:

- To make the student understand the concept of basic computer algorithm and use the algorithm for various problem solving.
- To implement algorithms using high level programming language.
- To understand basic principles of structured programming – example C

Learning Outcomes:

On completion of the course students will learn the following:

- Designing algorithms for a given problem.
- Writing C Programs to implement the algorithms.

Syllabus

1. **Introduction to Computer Problem Solving: [5L]**
   Algorithm, Flowchart, The Problem Solving Aspect, General problem solving strategies, Top-Down Design, Implementation of Algorithms, Efficiency of Algorithms, Recursive algorithms.

2. **Basic Algorithms: [3L]**
   Exchanging the values, Summation of a set of numbers, factorial computation, generation of the Fibonacci series, reversing the digits of an integer, base conversion.

3. **Factoring Methods: [2L]**
   Finding divisors of an integer, finding the Greatest Common Divisor of two integers, generating prime numbers, computing prime factors of an integers.

4. **Sorting and Searching algorithms [2L]**
   Bubble sort, Insertion Sort, Sequential Search and Binary Search.

5. **Introduction to 'C': [3L]**
   History, Structure of a C program, Keywords, Identifiers, variables, constants, data types, Arithmetic Operators & Expressions, Logical operators and Relational Operators, Precedence and Associativity rules.

6. **Conditions and Iterations: [3L]**
   Conditions and Actions, Condition statement, Simple control statement (*if*, *if-else*, *switch*), Iterative control statements (*for*, *while*, *do-while*).

7. **Functions: [5L]**
   What is a function, Advantages of functions, Standard library functions; User defined functions – declaration, definition, function call, parameter passing, return keyword. Scope of variables, Storage classes, Recursion.

8. **Arrays: [4L]**
   One and Two dimensional arrays: Array declaration, initialization, accessing the values, passing arrays to functions.
9. **Pointers: [4L]**
   Pointer declaration, initialization, Pointer arithmetic, Pointer to Pointer, Arrays and Pointers, Functions and Pointers – passing pointers to functions, function returning pointer, dynamic memory allocation.
10. **Strings: [4L]**
    Declaration and initialization, standard library string functions, strings and pointers, array of strings.
11. **Structure and Union: [4L]**
    Creating structures, accessing structure members, array of structures, passing structure to functions, nested structure, pointers and structures, union, difference between structures and unions.
12. **File Handling: [4L]**
    FILE variable, file access modes, operations on files, random access to files, command

line arguments.

13. **Preprocessing:** **[2L]**

Format of Preprocessor directive, File Inclusion directive, Macro substitution, conditional compilation.

Text Books:

1. Dromey R.G., How to solve it by computer, Prentice Hall of India, 2nd Edition, 2004.

2. Kanetkar Yeshwant, Let us C, BPB Publications, 13th Edition, 2012.

3. Behrouz Forouzan, Richard Gilberg, Computer Science: A Structure Programming Approach using C, Cengage Learning 3rd Edition, 2013.

Reference books:

1. Horowith Ellis, Sahni Satraj, Sanguthevar Rajasekaran, *Fundamentals of Computer algorithm*, Orient Longman, 2nd Edition, 2008.
2. Gottfried Byron, *Programming with C*, Tata McGraw Hill, 3rd Edition, 2010.
3. Brain W. Kernighan and Dennis M Ritchie, *The C Programming Language*, Prentice Hall India, 2nd Edition, 1988.

Practical: Introduction to Programming
Credit: 1
Marks: 25

Programs using C language that covers the following concepts:

1. Program to compute a given formula.
2. Conditions
    - if..else

- nested if

3. Iterative Control Statements
    - for
    - while
    - do…while
4. Functions
    - Standard Library functions
    - Call by Value
    - Call by reference
5. Recursive functions
6. Arrays
    - One Dimensional Arrays
    - Two Dimensional Arrays
7. Sorting
    - Bubble sort
    - Insertion sort
8. Searching
    - Sequential search
    - Binary search
9. Pointers
    - Arrays and Pointers
    - Function returning pointers
    - Dynamic memory allocation
10. Strings
    - Standard Library string functions
    - Strings and Pointers
11. Array of Strings
12. Structure
    - Array of structures
    - Passing Structure to functions
    - Nested structure
    - Structure and Pointer
13. Union
14. File Handling
    - Text file
    - Binary file
    - Random Access to a file
    - Command Line arguments
15. C Preprocessing

    - Macro expansion
    - Conditional compilation

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Semester II

Paper Title: Object Oriented Programming
Paper Code: COM-II.C-3
Marks : 75
credits: 3

Prerequisite Courses : Nil

Course Objectives:

- To teach the basic concepts and techniques which form the object oriented programming paradigm
- To introduce object oriented programming (OOP) using Java.

Learning Outcomes:

- Understand the concept and underlying principles of Object-Oriented Programming.
- Understand how object-oriented concepts are incorporated into the Java programming language.
- Develop problem-solving and programming skills using the OOP concept.

Syllabus

Principles of OOP **(3 L)**

Programming paradigms. Basic concepts in OOP. OOP: major principles - encapsulation, abstraction, inheritance, polymorphism. Benefits of OOP. Applications of OOP.

Introduction to Java **(8 L)**

Basics of Java programming, Data types, Variables, Operators, Control structures including selection, Looping, Java methods, Overloading, java.Math class, Arrays in java.

Objects and Classes **(9 L)**

Basics of objects and classes in java, Constructors, Finalizer, Visibility modifiers, Methods and objects, object serialization, Inbuilt classes like String, Character, StringBuffer, File, this reference.

Inheritance and Polymorphism **(9 L)**

Inheritance in java, Super and sub class, Overriding, java.lang.Object class, Polymorphism, Dynamic binding, Generic programming, Casting objects, Instance of operator, Abstract class, Interface in java, Package in java, java.util package.

Event and GUI programming **(6 L)**

Design patterns – what and why? It's classification. Introduce the Observer design pattern. Event handling in java, Event types, Mouse and key events, GUI Basics, Panels, Frames, Layout Managers: Flow Layout, Border Layout, Grid Layout, GUI components like Buttons, Check Boxes, Radio Buttons, Labels, Text Fields, Text Areas, Combo Boxes, Lists, Scroll Bars, Sliders, Windows, Menus, Dialog Box, Applet and its life cycle.

Multithreading in java **(4 L)**
Multithreading in java, Thread life cycle and methods, Runnable interface, Thread synchronization.
Exception handling **(3 L)**
Exception handling – what and why? Try and catch block. Multiple catch blocks. Nested try, finally block, throw keyword, throws keyword. Custom Exception.

Introduction to the Collections Framework. **(3 L)**

Text Book
Paul Deitel & H. Deitel, , Java - How to Program, Prentice Hall Publications 9th Edition,

Suggested Reference material

1. Patrick Naughton, Herbert Schildt, 2000, Java 2 – The Complete ReferenceTMH publications 9th Edition
2. Patrick Naughton, 1997, The Java Handbook –TMH publications
3. E. Balaguruswamy 2009,Programming with Java – A Primer, TMH Publications , 4th Edition
4. D. Flanagan, 2004, "Java Examples in a Nutshell", O'Reilly. 4th Edition
5. Arnold, Gosling & Holmes, 2005 "The Java Programming Language", Addison-Wesley Professional,4th Edition.

Practical: Object Oriented Programming
Credit: 1
Marks: 25

Programming exercises to be assigned based on:
1) Classes and instances (1P)

2) Working with the java.Math class (1P)

3) Controls Structures (Loops, conditional statements) (1P)

4) Array Programming, Inheritance (1P)

5) Polymorphism, abstract classes and interfaces (1P)

6) Constructors/ Visibility modifiers (1P)

7) Utilising the java.util package (1P)

8) Event handling and GUI (2P)

9) Exception handling (1P)

10) Multithreading (1P)

11) Collections framework (1P)

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Paper Title: Data Structures
Paper Code: COM-II.C-4
Marks: 75
Credits: 3

Prerequisite Courses: Introduction to Programming(COM-I.C-2)

Course Objectives:

To understand different methods of organizing data and efficiently implement different data structures.

Learning outcome:

On completion of the course student will learn:

- Different data structures like Stack, Queues, Linked Lists, Graphs and their applications.
- Implementation of data structures.

1. **Introduction to data structures:** **[2L]**
   Concept, Data type, Data object, ADT, Need of Data Structure, Types of Data Structure

2. **Algorithm analysis:** **[2L]**
   Algorithm – definition, characteristics, Space complexity, time complexity, Asymptotic notation (Big O)

3. **Linked List:** **[7L]**
   Introduction to List, Implementation of List – static & dynamic representation, Types of Linked List, Operations on List, Applications of Linked List, polynomial manipulation, Generalized linked list – concept & representation.

4. **Stacks:** **[7L]**

Introduction, Representation-static & dynamic, Operations, Application - infix to postfix & prefix, postfix evaluation, Simulating recursion using stack.

5. **Queues:** **[5L]**

Introduction, Representation -static & dynamic, Operations, Circular queue, priority queue (with implementation), Concept of doubly ended queue.

6. **Trees:** **[10L]**

Concept & Terminologies, Binary tree, binary search tree, Representation – static & dynamic, Operations on BST – create, Insert, delete, traversals (preorder, inorder, postorder), counting leaf, non-leaf & total nodes, non recursive inorder traversal, Expression Tree. Introduction to AVL Trees, Multiway Search Trees, B Tree, B+ Tree.

7. Searching and Sorting : **[6L]**

use of various data structures for searching and sorting, selection sort, merge sort, quick sort, heap sort and hashing.

8. **Graph:** **[6L]**

Concept & terminologies, Graph Representation – Adjacency matrix, adjacency list, Traversals – BFS & DFS, Application of BFS, DFS – Shortest path, Backtracking.

Text Book:

Horowitz Ellis, Sahni Sartaj, 2008, *Fundamentals of Data Structures in C,* University Press, 2nd Edition.

Reference:

1. Langsam Yedidyah, Augenstein J. Moshe, Tenenbaum M. Aaron ,2009, *Data Structures using C,* Pearson Education, 2nd Edition.
2. Gilbeg Richard, Forouzan Behrouz, Data Structures: A Pseudocode Approch with C, Cengage Learning, 2nd Edition.
3. Michael Goodrich, Tamassia Roberto,2001, *Algorithm Design Foundations, Analysis and Internet Examples.* John Wiley and sons.

Practical: Data Structures

Credit: 1

Marks: 25

Programs using C language that covers the following concepts:

1. Stack: Static/Dynamic stack implementation.

2. Stack: infix to postfix.
3. Stack: Evaluation of Postfix expression.
4. Queues: Static and Dynamic Queue Implementation
5. Queues: Circular queue
6. List: Singly Linked List
7. List: Doubly Linked List
8. List: Circular Linked List
9. Linked List: Polynomial addition
10. Trees: Binary Search Tree: create, add, delete, display nodes.
11. Trees: BST traversal.
12. Graph: Representation of Graphs, Graph Traversals.
13. Graph: DFS, BFS.
14. Searching
15. Sorting

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B.A./B.Sc. General Compulsory – Syllabus

Paper Title: Cyber Security
Paper Code: COM I/II.GC-B2
Marks: 100
Credits: 4

Prerequisite Courses : Working knowledge of Computer and Internet.

Course Objectives:

- To develop awareness and understand the concept of Cyber Security.
- To understand the aspects related to Cyber Security.
- To take measures to protect individual privacy and prevent loss/theft of data.

Learning Outcome:

On completion of the course the student will:

- understand the working of a computer network.
- be aware of the various measures that need to be taken in order to protect data/information/privacy in the Cyber world.

1. **Basics of Computer Networking:** **[12L]**

Networking basics, why networking of computer is needed, Introduction to wireless networks, Internet – role and importance, IP Addressing– public Vs Private, Static Vs Dynamic; WWW & related protocols;
(Demonstration: Networking Basics: Connecting to Network, Sharing directories, Connecting to shares, Set up a common storage. Advanced Networking: Identify IP address, ping, Set up a basic firewall, Setup a wireless n/w, Set up a security level, Setup free online backup)

2. **Emerging threats in Cyber Space:** **[12L]**

Threats in Cyber Space**,** Classification of threats**,** BYOD and portable devices threats, 0-day attacks, insider threats, Cyber Warfare, Malware threats, mobile apps threats.

Social media and its safe usages: Social media- its usages, Social networking- types, usages, importance, social networking safety.

(Demonstration: Setting up and maintaining the laptop, data storage devices and smart phone - cyber secure)

3. **Online Privacy:** **[10L]**

Privacy – basic concepts, Sensitive personal information, Privacy policies (case study of Google/Facebook or any other privacy policies), Privacy laws, IPR, Ethics & safe practices.

(Demonstration: Ensuring secure-environments wrt online shopping, wi-fi networks, passwords, social networking and online banking)

4. **Cyber Crimes – an introduction:** **[10L]**

Introduction – Types of cyber crimes (Phishing, Social Engineering, Denial of Service, Cyber stalking, ID-theft, etc), How to report cyber crimes, its impact – social, personal, financial; Cyber Terrorism.

5. **Cyber Laws:** **[8L]**

Evolution and purpose, offence & defence, bailable and non-bailable offences, provisions related to e-commerce, provisions for cyber crimes, adjudicating officers, CERT-IN- its role and powers

6. **Cyber Forensic:** **[8L]**

Data recovery, evidence collection, cloning of devices, media sanitization

Reference Books:

1. Rick Lehtinen and G.T. Gangemi, *Computer Security Basics*, O'Reillly Media, Inc., 2nd edition, 2006
2. Wall, David, *Cybercrime: The Transformation of Crime in the Information Age.* Polity Publishing, 2007.
3. Michael Cross, *Scene of the Cyber Crime: Cyber Forensics Handbook*, Syngress Publishing, 2nd Edition, 2002.
4. Chander, Harish, *Cyber Laws and IT Protection*, Prentice Hall India Learning, 2012.

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Annexure IV

Parvatibai Chowgule College of Arts and Science
(Autonomous)
DEPARTMENT OF COMPUTER SCIENCE
COURSE STRUCTURE
Post Graduate Diploma in Computer Applications(PGDCA)

Semester I (20 credits)

Paper Code	Paper Type	Paper Name	Credits	Student (hrs/week)	
				L	P
DCA11	Core – I	Object Oriented Programming	4	3	1
DCA12	Core – II	DataBase Management Systems	4	3	1
DCA13	Core – III	Client Side Technologies	4	3	1
DCA14	Elective – I	Elective Paper I	4	3	1
DCA15	Elective – II	Elective Paper II	4	3	1

Semester II (20 credits)

Paper Code	Paper Type	Paper Name	Credits	Student (hrs/week)	
				L	P
DCA21	Core – IV	Computer Networks	4	3	1
DCA22	Core – V	Software Engineering	4	3	1
DCA23	Elective – III	Elective Paper III	4	3	1
DCA24	Elective – IV	Elective Paper IV	4	3	1
DCA25	Elective – V	Elective Paper V	4	3	1

L – Lectures ---> 1 Hour Duration

P – Practicals --->2 Hours Duration

List of Elective Papers

EL1. Multimedia

EL2. E-Learning

EL3. Python Programming

EL4. HCI

EL5. E-commerce

EL6. Digital Marketing

EL7. Network Administration

EL8. Software Testing

EL9. Server Side Programming

EL10. Data Structures

EL11. Accounting and Financial Management

Parvatibai Chowgule College of Arts and Science (Autonomous)
Margao, Goa

Semester I & Semester II Syllabi for

PGDCA

(2017-2018)

Paper Title : Object Oriented Programming

Paper Code : DCA11

Marks : 75

Credits : 3

Prerequisite Courses : Nil

Course Objectives:

- To teach the basic concepts and techniques which form the object oriented programming paradigm
- To introduce object oriented programming (OOP) using Java.

Learning Outcome:

- Understand the concept and underlying principles of Object-Oriented Programming.
- Understand how object-oriented concepts are incorporated into the Java programming language.
- Develop problem-solving and programming skills using the OOP concept.

Syllabus

1. Principles of OOP: [6L]
Programming Paradigms, Basic concepts, OOP: major principles - encapsulation, abstraction, inheritance, polymorphism. Benefits of OOP, Applications of OOP.

2. Introduction to Java: [6L]
Basics of Java programming, Data types, Variables, Operators, Control structures including selection, Looping, Java methods, Overloading, java.Math class, Arrays in java.

3. Objects and Classes: [8L]
Basics of objects and classes in java, Constructors, Finalizer, Visibility modifiers, Methods and objects, Inbuilt classes like String, Character, StringBuffer, File, this reference.

4. Inheritance and Polymorphism: [9L]
Inheritance in java, super and sub class, Overriding, java.lang.Object class, Polymorphism, Dynamic binding, Casting objects, Instance of operator, Abstract class, Interface in java, Package in java, java.util package.

5. Event and GUI programming [9L]
Design patterns – what and why? It’s classification. Introduce the Observer design pattern. Event handling in java, Event types, Mouse and key events, GUI Basics, Panels, Frames,

Layout Managers: Flow Layout, Border Layout, Grid Layout, GUI components like Buttons, Check Boxes, Radio Buttons, Labels, Text Fields, Text Areas, Combo Boxes, Lists, Scroll Bars, Sliders, Windows, Menus, Dialog Box, Applet and its life cycle, Introduction to swing.

6. Exception Handling: **[4L]**
Exception handling – what and why? Try and catch block. Multiple catch blocks. Nested try, finally block, throw keyword, throws keyword. Custom Exception.

7. Introduction to the Collections Framework. **[3L]**

Text Book:

Mahesh Matha, **"**Core Java, A Comprehensive Study ", PHI, India

Deitel & Deitel, *Java - How to Program*, Prentice Hall Publications

Reference Books:

1) Patrick Naughton, Herbert Schildt, *Java 2 – The Complete Reference*, McGraw Hill Education (India) Pvt. Ltd., 2002.

2) Patrick Naughton, *The Java Handbook*, McGraw Hill Education (India) Pvt. Ltd., 1996.

3) Balaguruswamy E, *Programming with Java – A Primer*, McGraw Hill Education (India) Pvt. Ltd., 2009.

4) Flanagan David, *Java Examples in a Nutshell*, Spd/O'Reilly Reprint, 2nd Edition.

5) Gosling J, Arnold K, & Holmes D, *The Java Programming Language*, Addison-Wesley Professional, 3rd Edition, 2008.

Lab: Object Oriented Programming
Credit: 1
Marks: 25

Programs using Java language that covers the following concepts:

1) Classes and instances	(1P)
2) Working with the java.Math class	(1P)
3) Inheritance	(2 P)
4) Polymorphism, abstract classes and interfaces	(3P)
5) Utilising the java.util package	(1P)
6) Event handling and GUI	(1P)
7) Applets	(1P)
8) Exception handling	(1P)
9) Collections framework	(1P)

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Paper Title: Data Base Management Systems
Paper Code: DCA12
Marks: 75
Credits: 3

Prerequisite Courses : -
Nil

Course Objectives:
It provides basic knowledge of a database management system. It helps to understand importance of ER diagram. It introduces SQL to query a database.

Learning outcome:

- On completion of the course students will learn Database concepts and structures. They will be able to explain terms related to database design and management. Students will understand data modeling and database development process.
- Students will be able to construct and normalize data models and implement the same using any Relational Database Management System.
- Students will become proficient in using database query language, i.e. SQL.

Syllabus

1**. Overview of database management** [7L]

Data, information, database, database management system; Managing data; File systems versus a DBMS, advantages of a DBMS; Data abstraction, instances and schemas, data models; Data manipulation language, data definition language; Architecture of a DBMS; Users of a DBMS, database administrator.

2**. Database design and the ER model** [10L]

Design phases – conceptual design, logical design, physical design; ER model – entities, attributes, and relationships, mapping cardinalities, keys; ER diagrams – strong entities, weak entities, generalization, specialization, aggregation; Converting ER diagram to relational schemas.

3. **Relational model** [9L]

Relation, properties of relational model; Entities, integrity constraints, referential integrity constraints; Relational algebra – select, project, cross product, set operations, rename operation; Other relational operations – natural join, outer join.

4. **SQL** [10L]

Basic structure of SQL query – Create, select, where, from, rename operation; Set operations; Aggregate functions; Group by, having clauses; Nested queries; Views; Insert, delete, update.

5**. Functional dependency and normalization** [6L]

Atomic domain, nested relation; Key, super key, primary key, candidate key; Functional dependency, axioms, closure of a set of attributes, closure of a set of functional dependencies; Purpose of normalization; 1NF; 2NF; 3NF; BCNF.

6. Introduction to Transactions [3L]

Transaction concept, Transaction state, ACID properties, Concurrent Transactions, Serializability.

Text Book:

- A Silberschatz, H F Korth, S Sudarshan, *Database system concepts,* McGraw-Hill ,sixth Edition

Reference Books:

- Ramakrishan, J Gehrke, "*Database management systems"*, McGraw-Hill , 3rd edition
- R Elmasri, S B Navathe, "*Fundamentals of database Systems"*, Pearson Education , 5th Edition

Lab : Database Management Systems
Credit : 1
Marks : 25

List of Practicals

1. ER diagram
2. ER diagram with specialization/generalization and aggregation.
3. Converting ER diagram to Schemas
4. Converting ER diagram with generalization/specialization, aggregation into schema
5. Studying RDBMS
   a. Understanding Client server architecture
   b. Creating tables
6. SQL
7. Introduction of .NET Framework, Advantages of .Net Framework, Components of .NET Framework, Data type & Operators with examples.

8. Loops, Control Statements, Operators, Data Types
9. Controls : Label, Button, Textbox, Picture Box
10. Controls : Radio button, Checkbox, Timer Control, Scroll Bars
11. Controls : List box, Combo Box, Dropdown list etc.
12. Working on Database
13. Working on Database
14. Normalization
15. Report Writing

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Paper Title: Client Side Technologies

Paper Code: DCA13

Marks: 75

Credits: 3

Prerequisite Courses : Nil

Course Objective:

To develop a high degree of competence as a web designer by learning the client-side techniques.

Learning Outcome:

On completion of the course students will be able to

- Understand basics of Internet.
- Design simple static and dynamic websites.

Syllabus

1. The Internet **[8L]**

Computer Networks: LAN, MAN, WAN, etc., Layout (Ring, bus, star, etc.), IP address: public, private, static, dynamic, Internet protocols and services: http, https, ftp, smtp, nntp, etc, Telnet, dns, dhcp, Intranet & Extranet, Internet Infrastructure, Search Engines, Web Browser, Web server

2. Basic HTML: **[14L]**

Introduction, importance, Basic: HTML Tag, HEADER Tag, META Tag, TITLE Tag, BODY Tag, Text Formatting: PRE Tag, FONT Tag, entities, Image: IMG tag, image maps, Hyperlinks: Anchor tag, Lists: Unordered Lists, Ordered Lists, Definition Lists, Table tags: TABLE, TR and TD Tags, Cell Spacing and Cell Padding, Colspan and Rowspan, Frames: Frameset, FRAME Tag, NOFRAMES Tag, End user Interaction: FORM and INPUT Tag, Text Box, Radio Button, Checkbox, SELECT Tag and Pull Down Lists, TEXTAREA, Hidden, Submit and Reset, Special Tags : COLGROUP, THREAD, TBODY, TFOOT, blank, self, parent, top, IFRAME, LABEL, Attribute for <SELECT>.

3. HTML5: **[6L]**

The <canvas> element for 2D drawing, The <video> and <audio> elements for media playback, Support for local storage, New content-specific elements, like <article>, <footer>, <header>, <nav>, <section>, New form controls, like calendar, date, time, email, url, search.

4. CSS: **[4L]**

Introduction to CSS, Advantages, Types of style sheets: Inline, Internal, External, Multiple Style sheets and Cascading order, Grouping or nesting, Syntax, ID and Class, Pseudo-class, Pseudo-element, CSS units of measurement, Colors.

5. New features in CSS3: **[5L]**

Selectors, Box Model, Backgrounds and Borders, Image Values and Replaced Content, Text Effects, 2D/3D Transformations, Animations, Multiple Column Layout, User Interface.

6. Client side scripting: **[8L]**

Introduction to Javascript, HTML DOM, Core Javascript, form validations, introduction to XML, AJAX and JQuery

Text Book:

- Elisabeth Robson, Eric Freeman, *"Head First HTML with CSS & XHTML A Learner's Companion to HTML, CSS and XHTML"*, O'Reilly Media, 1st Edition, 2005.

References:

- Eric Freeman, "*Head First HTML5 Programming", O'Reilly Media, 1st Edition, 2011*
- Jennifer Niederst, "*Web Design in a Nutshell*", O'Reilly Media, 3rd Edition, 2006

Lab : Client Side Technologies

Credit: 1

Marks: 25

HTML:

1. Text formats. (1 P)
2. Image formats. (1 P)
3. Hyperlink and Listings (1 P)
4. Table formats (2 P)
5. Forms (1 P)

Cascading Style Sheet:

6. Internal and External style implementations (1 P)
7. Creating Dynamic pages using CSS. (2 P)

Javascript:

8. Implementing functions in javascript (alert( ); confirm( ); prompt( )) (1 P)
9. Form Validations using Javascript (1 P)
10. Creating Dynamic pages using Javascript. (1 P)

HTML5:

11. Web site design using HTML5. (1 P)
12. Implementation of canvas. (1 P)
13. Embedding Audio and Video in a Webpage. (1 P)
14. Implementation of additional form controls. (1 P)

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Parvatibai Chowgule College of Arts and Science (Autonomous)
Margao, Goa

Semester II Syllabus for

PGDCA

(2017-2018)

Paper Title : Computer Networks

Paper Code : DCA21

Marks : 75

Credits : 3

Prerequisite Courses : Nil

Course Objectives:

- To provide a strong background of network concepts.
- To create a good foundation covering the physical layer, data link layer, network layer and the transport layer.

Learning Outcomes:

On completion of the course students will be able to understand

- Basic types of networks.
- Set up the Local Area Network.
- Network software layers and their functions.
- IP address and their need.
- Internet subnet structure, working principles and protocols.

1. **Basics of Computer Networks** **[7L]**

Networking of Computer.- Advantages and disadvantages of computer networking. Types of Networks - LAN, MAN, WAN, Wireless; Network Topology – Star, Ring, Bus, Tree, Complete, Irregular; Reference Models - The OSI reference model, the TCP/IP reference model.

Telephone System: Structure of telephone system, the local loops, trunks and multiplexing (FDM and TDM); Switching - Circuit switching, message switching, Packet Switching.

2. **Transmission Media** **[6L]**

Transmission media - Magnetic media, twisted pair, co-axial cable (baseband and broadband), fiber optics principle, transmission of light through fiber, fiber cables, fiber optics network, comparison of fiber optic and copper wire. Wireless Transmission (The electromagnetic spectrum, Radio Transmission, Microwave Transmission, Infrared and Millimeter Waves, Light wave Transmission)

3. **Data Communication Components** **[6L]**

Modem, Repeaters, Hubs, Bridges, Switches, Routers, Gateways. Data Link Protocols: Asynchronous, Synchronous, Character Oriented and Bit Oriented Protocols. Error Control, Internet.

4. **Medium Access Control Sublayer (MAC):** **[8L]**

Multiple Access Protocols, CSMA Protocols, Collision-Free Protocols (Bit Map protocol, Binary countdown), 802.3 Frame Header, Ethernet: Ethernet Cabling, Manchester Encoding, The Ethernet MAC sublayer protocol, The Binary exponential backoff algorithm, Switched Ethernet, Fast Ethernet, Gigabit Ethernet.

5. **IP Addressing** **[14L]**

IP Address class, Network and Host Addressing, Subnet, Subnet Mask. TCP/IP Protocol Suite:

Network Layer: Services, Static vs Dynamic address, Shortest Path Routing Algorithm, IP Protocol Header, Address resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP), Internet Control Message Protocol (ICMP).

Transport Layer: User Datagram Protocol (UDP), UDP Header, Transmission Control Protocol (TCP), Segment Header, Connection Establishment and Release.

6. **Application Layer** **[4L]**

Telnet (TErminaL NETwork), HTTP, File Transfer Protocol (FTP), Simple Mail Transfer Protocol (SMTP).

Text Book:

- Behrouz A. Forouzan, "*Data Communications and Networking*", McGraw Hill Education (India) Pvt. Ltd., 4th Edition, 2006.

Reference Books:

- Andrew S. Tanenbaum, "*Computer Networks"*, Prentice Hall of India, 4th Edition, 2002.
- James F. Kurose & Keith W. Ross, "*Computer Networking: A Top-Down Approach, Pearson India"*, 5th Edition, 2012

Lab : Computer Networks

Credit: 1

Marks: 25

1. Installing OS and drivers (1 P)
2. Cable colour code and crimping, Demonstration of structured cabling (1 P)
3. Setting up of network (TCP/IP configuration) (1 P)
4. Sharing resources (files, printer etc) (1 P)
5. Study of Network Commands (1 P)
6. Setting up of wireless network (Adhoc and Infrastructure mode) (1 P)
7. Network monitoring tool (1 P)
8. Wireshark Tool (1 P)
9. Network simulator tool1 (2 P)
10. Network simulator tool2 (1 P)
11. Simulation of Network Protocols using programming language (2 P)
12. Simple client-server socket program. (2 P)

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Paper Title : Software Engineering

Paper Code : DCA22

Marks : 75

Credits : 3

Prerequisite Courses : Nil

Course Objectives:

On completion of the course the students will develop specific skills and competencies to use various software engineering tools and methods to develop software for medical, industrial, military, communications, aerospace, business, scientific, and general computing applications.

Learning Outcomes:

- Gain knowledge of concepts & principles, methods and tools used in software engineering with an emphasis on object oriented analysis & design using UML
- Appreciate the role of software engineering in the software development industry.
- Be enabled to use various software engineering methods and tools employed during analysis, design, programming, testing and project management

Syllabus

SOFTWARE PROCESS: **[5L]**

Characteristics of software process.

Software Development Processes and Methodologies: waterfall, prototyping, iterative, spiral, unified process.

Benefits of iterative and incremental approach with emphasis on Unified process, CASE Tools, Agile methodologies.

PROJECT MANAGEMENT: **[7L]**

Planning a Software Project – Cost estimation, Project Scheduling, Software configuration management plans, Quality Assurance plans, Project Monitoring plans and Risk Management. Techniques such as Interviewing , Requirement Workshop, brainstorming, prototyping. Characteristics of SRS

OOAD and UML: **[10L]**

OOAD: Definition; object oriented analysis; object oriented design and modeling; Assigning responsibilities.

UML: Main UML diagrams – Class diagram , sequence diagram, activity diagram, use case diagram. Use case model – use case diagram , use case descriptions, use case realization using sequence and activity diagrams. Supplementary requirements. Advanced use case model features.

Requirements: Functional and non-functional

System Design : Class diagram, sequence diagram, activity diagram, state chart diagram, deployment diagram. Brief introduction to other UML diagrams.

SOFTWARE ARCHITECTURE PATTERNS: **[5L]**

Major Architectural Styles (patterns) like Layered Architecture, Pipe and Filter, Shared (Central) Data Store, Event Driven, Model-View-Controller (MVC), "Distributed & Emerging" Service Oriented Architecture (SOA) and Elementary GRASP Patterns.

HUMAN COMPUTER INTERACTION: **[4L]**

HCI Definition; User categories, Interface Design-Internal & External Interface design, user interface design, Interface design guidelines.

CODING: **[2L]**

Coding styles, standards, peer reviews, checklist.

TESTING: **[4L]**

Testing Fundamental, Functional Testing, Structural Testing, Testing Object-Oriented Programs, Testing Process and Metrics.

DOCUMENTATION and MAINTENANCE: **[4L]**

Need for Software Documentation. Types of documentation

Need for Maintenance; Types of Maintenance

REENGINEERING: [4L]

Business Process Reengineering, Software Reengineering, Reverse Engineering, Restructuring, Forward Engineering, The Economics of Reengineering

Text Books:

- Roger Pressman, Software Engineering: A Practitioners Approach, McGraw Hill, (6th Edition), 1997.
- Craig Larman, Applying UML and patterns, Addison Wesley, 2nd Edition, 2003

References :

- Pankaj Jalote, An Integrated Approach to Software Engineering, Narosa Publishing House, 2nd Edition
- Glenford J.Myers, " The Art of Software Testing ", John Wiley & Sons, 1979.
- Sommerville, Software Engineering, Adison Wesley, 7th edition, 1996.
- Martin Fowler, UML Distilled, Addison Wesley, 2nd Edition, 2003
- Thomas T. Barker , "Writing s/w documentation - a task oriented approach", Allyn & Bacon Series of Technical Communication , 1998.
- Steve Mc Connell, Code Complete, Microsoft Press, ISBN 978-0-7356-1967-8 Second Edition (June 2004)

Lab : Software Engineering

Credit : 1

Marks : 25

List of suggested **PRACTICALS** using UML (the numbers in brackets indicate number of practicals) :

5) SRS using IEEE format **[2P]**
6) Draw a USE Case diagram and write Use Case descriptions for the Use Cases **[2P]**
7) Draw a Class Diagram **[2P]**
8) Draw a Sequence Diagram **[2P]**
9) Draw an Activity Diagram **[2P]**
10) Draw a State Chart Diagram **[2P]**

11) Draw a Gantt Chart for a project **[1P]**

12) Develop a mini project/ Case Study **[2P]**

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Parvatibai Chowgule College of Arts and Science (Autonomous)
Margao, Goa

Syllabus for Elective Papers for

PGDCA

(2017-2018)

Paper Title: Multimedia

Marks: 75

Credits: 3

Prerequisite Courses: Nil

Course Objectives:

To learn the basic Multimedia concepts and develop skills and competencies to design graphical images, Audio and Video Capture and Editing using Software tools.

Learning Outcomes:

- Understand the building blocks of Multimedia.
- Develop creativity and publish a self-contained Multimedia Application using multimedia authoring tools in various application areas.

Syllabus

I. Introduction to Multimedia: [4L]

Overview of multimedia, Multimedia building blocks, Digital representation, Interaction techniques and devices, Stages of a Multimedia Project: Planning and Costing, Designing and Producing, Testing and Delivering. The Multimedia team and their roles: Project Manager, Writer, Video specialist, Audio specialist and Multimedia programmer.

Multimedia architecture: [4L]

Introduction to multimedia architectures, User interfaces, Windows multimedia support, Windows API for Multimedia, Multimedia Database Systems, Media streaming, Multimedia authoring tools, Multimedia OS.

II. Multimedia Building Blocks:

Text: **[4L]**

Visual representation of text, Digital representation of text, Text file formats: TXT, DOC, RTF, PDF, ODT Conversion to and from of various text formats, Hypermedia and Hypertext.

Image: [4L]

Basic Image fundamentals, Importance of graphics in multimedia, Vector and Raster graphics, image capturing methods – scanner, digital camera and its types, etc. various attributes of

Images – size, color, depth, resolution, etc, Image data types, image file formats (BMP, JPEG, GIF, TIFF, PNG, DIB, EPS, CIF, PEX, PIC), their features and limitations, graphic file formats conversions.

Sound: **[5L]**

Sound and it Attributes, Mono V/s Stereo sound, Sound channels, Sound and its effect in multimedia, Analog V/s Digital sound, Basics of digital sound-Sampling, Frequency, Sound Depth, Creation of Digital Audio files – recording & editing. Overview of various sound file formats on PC – WAV, VOC, AVI, MP3, MP4, Ogg, Verbose etc. Digital audio vs MIDI and MIDI File format, CD and DVD formats.

Animation: **[6L]**

Basics of animation, Principle and use of animation in multimedia, Effect of resolutions, pixel depth, Images size on quality and storage. Overview of 2-D and 3-D animation techniques and software. Animation on the Web – features and limitations, creating simple animations for the Web. Animation file formats.

Video: **[8L]**

Analog and Digital Video, Video on PC. Introduction to graphics accelerator cards, DirectX Introduction to AV/DV and IEEE1394 cards, Video Broadcast Standards - NTSC, PAL, SECAM, HDTV. Introduction to video capturing, Media & Instrument – Videodisk, DVCAM, Camcorder.

Recording Formats like S-VHA Video, Component (YUV), Component Digital, Composite Digital, Video Hardware Resolutions.

Integrating Computers and Television like Video Overlay Systems, Digitized Video Playback, Differences between Computer and Television Video. Video Tips like shooting platforms, Lighting, Chroma Key or Blue Screen

III. Data Compression: [4L]

Types of compression: Lossy & Lossless, Symmetrical & Asymmetrical, Intraframe & Interframe, Hybrid. Study of different compression techniques for Text (Huffman coding, LZ & LZW), Image, Audio, Video (MPEG and AVI).

IV. Multimedia on the Web: [4L]

Bandwidth relationship, broadband technologies, Text in the web – Dynamic and embedded font technology, Audio on the Web – Real Audio and MP3/MP4, Audio support in HTML, Graphics – HTML safe color palate, Interlaced V/s Non interlaced model, Graphics support in HTML, Image Map, Video on the Web – Streaming video, Real Video, MPEG and SMIL, Virtual Reality on the Web.

V. Assembling and Delivering a Project: [2L]

The four primary navigational structures used in multimedia like linear, hierarchical, non-linear and composite.

Text Book:

Vaughan Tay, "Multimedia: Making it Work", 8th edition, Tata McGraw-Hill

Reference Books:

1. Ralf Stainntetz, Katra Nahrstedt, "Multimedia Computing, communications and application", Pearson Education Services.
2. James E Shuman, "Multimedia In Action", Vikas Publishing House.
3. Jeffcoate Judith, "Multimedia in Practice, Technology and Applications", Prentice Hall India.
4. Buford, J.F. K, "Multimedia Systems", Pearson Education
5. Elson-Cook, "Principles of Interactive Multimedia", McGraw Hill Higher Education.
6. Andreas Holzinger, "Multimedi Basics – Volume – 1 Technology", Firewall Media (Laxmi Publications Pvt. Ltd) New Delhi

Lab: Multimedia

Credit : 1

Marks : 25

Multimedia Software Tools like GIMP, Audacity, Windows Movie Maker, Blender. iMovie (the numbers in brackets indicate number of practicals):

1. Image Handling: Cropping an image, adjusting image size, increasing the size of the work canvas, saving an image. **[2P]**

2. Layers: Adding layers, dragging and pasting selections on to layers, dragging layers between files, viewing and hiding layers, Editing layers, rotating selections, scaling an

object, preserving layers transparency, moving and copying layers, duplicating layers, deleting layers, merging layers, using adjustment layers. **[2P]**

3. Channels and Masks: Channel palette, showing and hiding channels, splitting channels in to separate image, merging channels, creating a quick mask, editing masks using quick mask mode **[1P]**

4. Painting and Editing: Brushes palette, brush shape, creating and deleting brushes, creating custom brushes, setting brush options, saving, loading and appending brushes, Options palette **[2P]**

5. Opacity, pressure, or exposure, paint fade-out rate, making selections, using selection tools, adjusting selections, softening the edges of a selection, hiding a selection border, moving and copying selections, extending and reducing selections, pasting and deleting selections. **[2P]**

6. Recording Sound using Sound Recorder (Capture), Sound capture through sound editing software , Sound editing, Noise correction, Effect enhancement ; Voice Recognition; Importing audio and saving audio from Audio CD. Sound Quality types: CD Quality, Radio Quality, Telephone Quality. **[2P]**

7. Video: Record video from *video capture* devices, webcams, screen capture or even streaming video and Video Editing. **[2P]**

8. Mini Project/Problem Statement/Case Study (integrating the above experiments) like E-Book Design, Product Design. **[2P]**

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Paper Title : E-Learning

Marks : 75

Credits : 3

Prerequisite Courses : Nil

Course Objectives:

- This course is an introduction to ICT (Information Communications Technology) in education.
- It aims at exploring the Instructional Design principles, developing and applying the various concepts of Instructional Design skills learnt wrt E-Learning and develop E-content in various application areas related to ICT and Education.

Learning Outcomes:

On Completion of this course the student will:

- Understand the working of an E-learning module
- Be aware of the various Instructional Design Principles.
- Develop own course material and upload it using an appropriate LMS
- Evaluate and Apply appropriate Assessment techniques to the e-content

Syllabus

1. INTRODUCTION TO E-LEARNING : (7L)

1.1 What is E-learning

1.2 Scope and form of E-learning.

1.3 Role of an E-learning project

1.4 Phases in an E-learning project

2.COURSE DEVELOPMENT FOR E-LEARNING: (12L)

2.1 Instructional Design.

2.2 The process of Designing Instruction.

2.3 Developing Materials. (Story Boarding, Content Integration, and SCORM Compliance).

2.4 Working with L.M.S. (Learning Management System)- Installation and use of the administrator, teacher and student interface. Course Definition, Registration and upload, tracking of results).

3. E-LEARNING AND PEDAGOGICAL APPROACHES: (12L)

3.1 The Behaviorist School of learning and its implications on E-learning.
3.2 The Cognitive School of Learning and its Implication on E-learning.
3.3 The Constructivist School of Learning and its implications on E-learning.
3.4 Blooms Taxonomy of Educational Objectives.
3.5 Types of Learning Objectives.
3.6 Content Analysis (Types- Facts, concepts, process, procedure, principles)
3.7 The Teaching of concepts, procedure, principles, understanding.
3.8 Enabling a motivated Learning Environment.

4. E-LEARNING STRATEGIES: (8L)

4.1 Simulation.
4.2 Drill.
4.3 Interactive Learning.
4.4 Problem Solving.
4.5 Tutorials.

5. ASSESSMENT DESIGN: (6L)

5.1 Rubrics for Assessment- Analytic and Holistic Rubrics.
5.2 Rubrics for Assessment.
5.3 Security and Authentication.

Text Book

Teachers Discovering Computers, Integrating Technology in the Classroom, Second Edition by Shelly Cashman Gunter, (ISBN: 0-7895-6492-0).28

Reference Books:

1. Smith, P. L. & Ragan, T. J. (2004). Instructional design. 3rd edition. New York: John Wiley & Sons. ISBN: 0471393533
2. M.D. Roblyer, Aaron H. Doering, Integrating Educational Technology into Teaching, Student Value Edition (6th Edition), Publisher: Pearson; 6 edition (February 25, 2012) ISBN-10: 013289680X, ISBN-13: 978-0132896801.
3. Dick, W., Carey, L., & Carey, J. O. (2009). The systematic design of instruction (7th ed.). Boston: Allyn and Bacon.
4. Wiggins, G. P., & McTighe, J. (2005). Understanding by design (2nd ed., p. 370). Alexandria, VA: Association for Supervision and Curriculum Development.
5. Christensen, C. M., Horn, M. B., & Johnson, C. W. (2008). Disrupting class: How disruptive innovation will change the way the world learns. New York: McGraw-Hill.

Lab: E-Learning
Credit: 01
Marks: 25

List of suggested **PRACTICALS** using any Multimedia Software (the numbers in brackets indicate number of practicals):

(1) Installing, Creating and Running a complete course using LMS **[3P]**
Course Administration: Creation and using Resources and Planning Activities
Case Study: Create a complete course and work on all the resources and activities. Also the various grade book options etc.

(2) Creating Storyboards (using Movie Maker/PPT or similar FOSS) **[1P]**

(3) Construct a Mindmap (using Freemind or any other FOSS) **[1P]**

(4) Prepare a 10-minute Video tutorial on some system (e.g. how to search for free images in Google) using screen cast. Example tool that can be used: screencast-o-matic).
[2P]

(5) Study a virtual world system like Whyville, and make a 10 slide presentation (using PPT or FOSS on it). **[2P]**

(6) Create a fully tagged 10-question QB on a topic and load onto Moodle. **[2P]**

(7) Build a course using WISE **[2P]**

(8) Design Rubrics (for a given scenario) **[2P]**

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Paper Title : Python Programming

Marks : 75

Credits : 3

Prerequisite Courses : Nil

Course Objectives : To provide skills of data analysis using Python programming language

Learning Outcome:

Students will learn Python programming, and apply it in data analysis & visualization.

Syllabus

Introduction to Python [3L]

Motivation, programming paradigms, What Python can do, Python's technical strength, Python interpreter, Program execution, Execution model variations, How to run programs

Basic Syntax [6L]

Variable and Data Types, Operator, Conditional Statements - if, if- else, Nested if-else. Looping – For, While, Nested loops. Control Statements – Break, Continue, Pass.

String Manipulation [5L]

Accessing Strings, Basic Operations, String slices, Function and Methods.

Lists [3L]

Introduction, Accessing list, Operations, Working with lists, Function and Methods

Tuple [4L]

Introduction, Accessing tuples, Operations, Working, Functions and Methods

Dictionaries [4L]

Introduction, Accessing values in dictionaries, Working with dictionaries, Properties, Functions

Functions [6L]

Defining a function, Calling a function, Types of functions, Function Arguments, Anonymous functions, Global and local variables

Modules [5L]

Importing module. Math module. Random module. Packages. Composition

Input-Output [5L]

Printing on screen, Reading data from keyboard, Opening and closing file, Reading and writing files, Functions

Exception Handling [4L]

Exception. Exception Handling - Except clause, Try ? finally clause. User Defined Exceptions

Text Book:

1. Mark Lutz, Learning Python, O'Reilly Media, Third Edition, 2008

Reference Books:

1. Alex Martelli, Python – A Nutshell, O'Reilly Media, Second Edition, 2006

2. Wes McKinney, Python for Data Analysis, O'Reilly Media, 2012

Lab: Python Programming

Credit: 01

Marks: 25

<u>List of Experiments using Python Language</u>

1) Program to compute a given formula

2) if else

3) nested if else

4) loop

5) loop

6) string manipulation

7) string manipulation

8) list

9) tuple

10) dictionary

11) function

12) module

13) Input-Output

14) Input-Output

15) exception handling

****

Paper Title: Human Computer Interface

Marks: 75

Credits: 3

Prerequisite Courses : Nil

Course Objectives:

To study the different aspects of human computer interaction and the computer interface design concepts.

Learning Outcomes

- To understand the intricacies of human interaction with a computer System
- To understand the concept of a graphical user interface, and its design characteristics
- To recognize the human element its strengths and weakness for computer interaction
- To know the principles of good screen design and layouts
- To know the different navigation schemes on windows based interface; learn the different types of selection devices and components of a window based interface
- To know the different types of interaction devices and media

Syllabus

1. Introduction: Human-Computer Interaction, Evaluating Designs, The Birth of HCI. Importance of user Interface, Importance of good design, Benefits of good design, principles & heuristics of good design (4L)
2. Human interaction with computers, Importance of : Human characteristics, Human consideration, Human interaction speeds, Understanding business functions. User centred design- Need-finding: Participant Observation, Interviewing, Additional Need finding, contextual inquiry & persona. (6L)
3. Rapid Prototyping: story boarding. Paper Prototyping and Mockup, Video Prototyping, Creating and Comparing Alternatives (5L)
4. Direct Manipulation and Representations: various user interaction models- command, menu, Direct Manipulation. Mental Models. Heuristics (guidelines) for design. (7L)

5. Graphical Interface Design: Graphical user interface, standards such as Microsoft windows HCI guidelines, Windows: Navigation schemes selection of window; Selection of devices based and screen based controls, Components, Text and messages, Icons, Multimedia, Colors., controls, Help & error messages design.

(8L)

6. Web user interface design – jessy James Garette five layers of user experience.

(4L)

7. Heuristic Evaluation: Heuristic Evaluation — Why and How? (4L)

8. visualization, Amount of information, Focus and emphasis, Presentation information simply and meaningfully, Information retrieval on web, Statistical graphics

(7L)

Text books:

1. Alan Cooper & Robert Reimann, About Face 2.0: The Essentials of Interaction Design, Wiley
2. Alan Dix, Janet Finlay, Gregory D. Abowd, and Russell Beale, Human-Computer Interaction, Pearson, 3rd Edition, 2004.
3. Ben Shneiderman and Catherine Plaisant, Designing the User Interface: Strategies for Effective Human-Computer Interaction Pearson Addison-Wesley, 5th Edition, 2009
4. Donald A. Norman, The Design of Everyday Things, Basic Books, 2002

Lab : Human Computer Interface

Credit : 1

Marks : 25

Suggested list of practical (Numbers in brackets indicate number of practicals)

1. Paper Prototyping using templates (1P)
2. Conducting survey interview and summarizing the result (1P)
3. Persona- conducting contextual interview and developing persona (1P)
4. GUI design- form design, menu design, help, error messages (2P)
5. Web UI design- pages, navigation, controls, Page submission – Asynchronous (2P)
6. Report designs (2P)
7. Visualization and info graphics (1P)

8. Heuristic evaluation (2P)
9. **Story boarding** (1P)

****

Paper Title: E-Commerce
Marks: 75
Credits: 3

Prerequisite Courses : Nil

Course Objectives:

This course aims to study the working of E-Commerce website and the various background processes involved. As part of the course the student will study the activities associated with e-commerce like buying, selling and payment, understand the various technologies used in e-commerce websites and security mechanisms involved in e-commerce websites.

Learning Outcomes:
On Completion of this course the student will:

- Understand the working of an E-Commerce website
- Be aware of the various E-Commerce Strategies.
- Develop own E-commerce website and operate it.
- Evaluate and Apply appropriate Payment mechanisms to the e-commerce website

1. INTRODUCTION TO ELECTRONIC COMMERCE: (3L)

1.1: The Scope of Electronic Commerce

1.2: Definition of Electronic Commerce

1.3: Electronic Commerce and the Trade Cycle

1.4: Electronic Markets

1.5: Electronic Data Interchange

1.6: Internet Commerce

1.7: Electronic Commerce in Perspective

2. THE VALUE CHAIN: (2L)

2.1: Supply Chains

2.2: Porter’s Value Chain Model

2.3: Inter Organisational Value Chains

3. COMPETITIVE ADVANTAGE: **(3L)**

3.1: Competitive Advantage

3.2: Porter’s Model

3.3: First Mover Advantage

3.4: Sustainable Competitive

3.5: Competitive Advantage using e-commerce

4. BUSINESS STRATEGY: **(6 L)**

4.1: Introduction to Business Strategy: Michael Porter’s 5 force analysis

4.2: Strategic Implications of IT

4.3: Technology

4.4: Business Environment

4.5: Business Capability

4.6: Existing Business Strategy

4.7: Strategy Formulation and Implementation Planning

4.8: e-Commerce Implementation - technical and business

4.9: e-Commerce Evaluation

4.10: Auction methods

5. ELECTRONIC DATA INTERCHANGE (EDI): **(3L)**

5.1: EDI Definition

5.2: EDI Technology

5.3: EDI Standards

5.4: EDI Communications

6. ELECTRONIC PAYMENT SYSTEMS: **(8 L)**

6.1 Overview of the electronic payment technology; limitations of traditional payment instruments.

6.2 Electronic or Digital Cash-Properties of Electronic Cash, Digital Cash in action.

6.3 Electronic Checks-benefits of electronic checks, electronic checks in action,

NetCheck: A Prototype Electronic Check System.

6.4 Online Credit Card-Based Systems- types of credit card payments, Secure Electronic Transactions (SET)

6.5 Other Emerging Financial Instruments: POS (Point of Sale), E-Cash, Net Banking, Credit/Debit Cards and Electronic Benefits and Security Issues.

6.6 Case Studies of the various modes of electronic payment of various types of websites

7. E-BUSINESS: **(6 L)**

7.1 EDI Application in business, E- Commerce Law, Forms of Agreement, Govt. policies and Agenda.

7.2 Case Study of Internet bookshops, Grocery supplies, software supplies and support, electronic newspapers, Internet banking, Virtual auctions, online, share dealing.

7.3 Business to Legal issues: Risks involved; Paper Document vs. Electronic document, Authentication of Electronic document, Laws, Legal issues for Internet Commerce: Trademarks and Domain names, Copyright, Jurisdiction issues, Service provider liability, Enforceable online contract.

8. FIREWALLS AND TRANSACTION SECURITY: **(8L)**

8.1: Firewalls and Network Security: Types of firewalls, Firewall Security Policies,

Emerging Firewall Management Issues.

8.2: Transaction Security: Types of Online Transactions, Requirements for Transaction Security.

8.3: Encryption and Transaction Security: Secret-Key encryption, Public-Key

Encryption, Implementation and Management Issues.

8.4: Digital Certificate

8.5 Security Threats to E Commerce, Virtual Organization, Business Transactions on Web, E Governance and EDI

9. CONSUMER E-COMMERCE: **(3L)**

Consumer trade transaction, Internet, Page on the Web, Elements of E-Commerce with VB, ASP, SQL.

10. M-COMMERCE: **(3L)**

Basic concept and applications, difference with E-Commerce, benefits of integration with ERPs.

BOOKS RECOMMENDED FOR MAIN READING AND REFERENCE:

- e-COMMERCE Strategy, Technologies and Applications by David Whiteley; TataMcGraw Hill
- Electronic Commerce A Manager's Guide by Ravi Kalakota and Andrew B. Whinston. Published by Pearson Education.
- E-Commerce The Cutting Edge of Business by Kamlesh K Bajaj and Debjani Nag. Second Edition; Tata McGraw Hill

Lab: E-COMMERCE
Credit: 01
Marks: 25

List of suggested **PRACTICALS** (the numbers in brackets indicate number of practicals):

ECOMMERCE PLATFORMS: (10P)

1. **WORDPRESS:** Primarily designed for creating blogs but can be used to create online store by adding appropriate themes & plugins. Basic Programming Knowledge in PHP may be required in later stages. (http://www.wordpress.com)
2. **WIX:**Wix is a drag & drop website builder which can also be used to build an ecommerce website without any programming experience. (http://www.wix.com)
3. **SHOPIFY:** Made specially to create online stores, add products, categories & handle payments all without Any Programming knowledge required. (http://www.shopify.com)
4. **BLOGGER** : Similar to WordPress but a blogging service provided by google which again can be customized to create an online store. (http://www.blogger.com)

TOOLS USED TO FACILITATE ECOMMERCE (5P)

1. **GOOGLE ANAYLITICS:** Present in most ecommerce platforms and can be integrated in almost any application, giving the owner insights of the customer base visiting the website. Can also be fine-tuned to give more detailed analysis like how many visits actually got converted into leads etc. (https://www.google.co.in/analytics)
2. **MAIL CHIMP:** A service to send emails to customers. Useful in marketing. (http://www.mailchimp.com)

3. **ZENDESK :**Zendesk is used to setup a support centre for your application users . Users can open a ticket and get their issues resolved. Useful in issue tracking and management. (https://www.zendesk.com/)

4. **APPOINTLET :** A Service integrated with google calendar and helps manage all appointments. Useful in applications where an appointment is required. (https://www.appointlet.com/)

5. **UNBOUNCE :**Used to create landing pages for an application . A good landing page sometimes defines whether a user will visit the site or turn away. (http://www.unbounce.com/)

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Paper Title: Digital Marketing

Marks: 75

Credits: 3

Prerequisite Courses : Client Side Technologies(DCA13)

Course Objectives:

- To Build Accessible Websites that is optimized for the Search Engines.
- To study various online Marketing Strategies.
- Analyze and research Internet to improve the quality and marketability of the Websites.

Learning Outcomes:

On completion of the course students will learn the following:

- Optimize the website for various search engines.
- Market the company/product using Search Engine and Social Media.
- Analyze the Web for improving the marketing strategy.

VII. Search Engine Optimisation (SEO): [10L]

Introduction to Online Search; Function of Search Engines Google Page Rank; Introduction to Search Engine Optimisation; Building Accessible Site; Keyword Research and Optimisation; Link Building Strategies; Useful Tools for SEO; The Past, Present and Future of SEO.

VIII. Search Engine Marketing (SEM): [9L]

Introduction to Internet and Search Engine Marketing; Google Adwords; Adwords Account Structure; Navigating in Google Adwords; Working with Keywords; Creating Ads in Google Adwords; Creating and Managing your First Ad Campaign; Adwords Reporting and Account Performance Reports.

IX. Social Media Marketing (SMM): [9L]

Introduction to the World of SMM; Why Social Media?; Getting Started with Social Media; Building Relationships via Facebook, Twitter, LinkedIn, YouTube; Handling Positive and Negative Comments; Social Media Content Base Creation.

X. Email Marketing: [5L]

Importance of Email marketing; Email Marketing Software's; Subscriber List; Email Marketing Campaign; Newsletters; Measuring the results.

XI. WEB Analytics: [9L]

Web Analytics and Intelligence Tools; Basic Metrics Demystified; Introduction to Google Analytics; Goals and Actionable Insights; Data Management; Social Media Analytics; Social Media Goals and KPI's; Tools for Social Media Analytics.

XII. Marketing Automation: [3L]

Introduction to Marketing Automation; Advantages of using Marketing Automation Software; Issues with Marketing Automation.

Text Books:

- Damian Ryan, *"Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation"*, Kogan Page Publisher, 3 edition, 2014.

Reference Books:

- **Calvin Jones and Damian Ryan, "**The Best Digital Marketing Campaigns in the World:
- Nick Smith, *"Successful SEO and Search Marketing in a Week"*, Teach Yourself Publisher, 2013.
- Lee Odden , *" Optimize: How to Attract and Engage More Customers by Integrating SEO, Social Media, and Content Marketing"*, Wiley Publishing, 1st edition, 2012.
- Avinash Kaushik, *"Web Analytics 2.0: The Art of Online Accountability & Science of Customer Centricity (Sybex)"*, Wiley Publishing, 2nd edition 2013

Lab : Digital Marketing

Credit: 1

Marks: 25

6. Using Search Engine Optimization tools (like google & bing search console, hubspot, webceo, google page speed) (3P)

7. Using Search Engine Marketing tools (like google adwords, google adwords certifications, search, display, remarketing formats, facebook marketing, linkedin advertising) (3P)

8. Using Social Media Marketing tools (like hootsuite, buffer, sproutsocial, klear, twitonomy, socialmention, google alerts, mention) (2P)

9. Using Email Marketing tools (like mailchimp, campaign monitor, mailgun, mandrill, phplist, amazon ses (2P)

10. Using Web Analytics tools (like google analytics, compete.com, crazyegg, facebook insights, twitter insights) (3P)

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Paper Title: Network Administration

Marks: 75

Credits: 3

Prerequisite Courses: Nil

Course Objective:

To be able to understand the working principle of network, setting up of network, Configuring network and administration of network.

Learning outcome:

On completion of the course students will be able to

- Set up and manage networks
- Configure servers and firewall

Syllabus

1. **Introduction:** **[15L]**
   Basics of TCP/IP, IP address (IPv4 and IPv6), Internet Architecture, peer to peer and client server networks, subnetting, supernetting , and basic Network commands.

2. **Administration**: **[6L]**
   Managing users and Groups, adding/removing software/hard ware, display settings, folder options, setting up mail client, Device manager, Resource sharing. Basic Data recovery concepts : Disk repair tools, recovering files and directories, correcting errors reported by Scandisk

3. **Routing:** **[8L]**
   Overview of routing, static and dynamic routing, adding and deleting static routes, routing protocols, RIP, OSPF and IGP

4. **Application Layer:** **[12L]**
   DHCP (Dynamic host control protocol): Overview of DHCP , DHCP protocol, features of DHCP, Monitoring and troubleshooting, using DHCP in non routed and routed network. DNS (Domain Name Service): Overview of DNS protocol, DNS name space, Zone of authority and name resolutions, features of DNS server, Reverse lookup, Placement of DNS server, Installation and Configuring of DNS server and client.

   WWW: Architectural overview: server side and client side technology. Mail server: Electronic mail, architecture and services, user agent, message transfer, Final delivery.

5. **VLAN:** **[2L]**

   Introduction, basics of VLAN, uses of LANs, working principle, types of VLANs, frame processing.

6. **Firewall**: **[2L]**
   Overview of firewall, types of firewall, working principles of firewall, filters.

Text book:

Craig Hunt, “*TCP/IP Network Administration*”, O'Reilly; 3rd edition, 2002

Reference Books:

1. Man pages of linux
2. Andrew S. Tanenbaum, Computer Networks, Prentice Hall of India, 4th Edition, 2002.

Lab: Network Administration

Credit: 1

Marks: 25

1. Managing users: creating/Deleting groups, users, setting passwords, setting permissions to groups and users, Device Manager (1 P)
2. Setting up client server network (Installing server OS) (1 P)
3. Configuring Telnet and ftp server. (1 P)
4. Remote desktop connection (1 P)
5. Router (2 P)
6. DHCP server Configuration (1 P)
7. Web server Installation (1 P)
8. DNS server configuration (1 P)
9. Firewall Configuring (1 P)
10. Samba server (1 P)
11. VLAN configuration____ (1 P)

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Paper Title: Software Testing

Marks: 75

Credits: 3

Prerequisite Courses : Nil

Course Objectives:

- To study fundamental concepts in software testing, including software testing objectives, process, criteria, strategies, and methods.
- To discuss various software testing issues and solutions in software unit test; integration, regression, and system testing.
- To learn how to plan a test project, design test cases and data, conduct testing operations, manage software problems and defects, generate a testing report.

Learning Outcomes:

On Completion of this course the student will:

- Have an ability to understand and identify various software testing problems, and solve these problems by designing and selecting software test models, criteria, strategies, and methods.
- Have an ability to use software testing methods and modern software testing tools for their testing projects.

Syllabus

Software testing principles - Software Testing- Need for testing, Psychology of testing**,**Testing economics**,** SDLC and Testing**,**Verification & Validation**.**Quality Assurance, Quality Control (2L)

Testing strategies and types - White box testing techniques - Statement coverage, Branch Coverage , Condition coverage, Decision/Condition coverage , Multiple condition coverage ,Dataflow coverage, Automated code coverage analysis, Inspections, Walkthroughs Code Review (4L)

Black box testing techniques - Boundary value analysis**,**Robustness testing **,**Equivalence partitioning**,**Syntax testing**,**Finite state testing**,**Levels of testing**,**Unit, Integration and System Testing**,**Compatibility Testing**,**Domain Testing**,**Adhoc Testing **,**Use of Requirement,Traceability Matrix (5L)

Integration Testing Waterfall - Top-down ,Bottom up ,Big bang,Sandwich (2L)

System and Performance Testing - Types of system testing ,Functional and non-functional testing Acceptance Testing ,Setting entry and exit criteria for phases and typical product release scenarios ,Basic factors governing performance testing, Methodology for performance testing ,Tools for performance testing (4L)

Regression Testing - Purpose **,**Timinng,Choice of tests **,**Smoke tests **,**Best practices

(2L)

Internationalization and Localization testing - Preliminary concepts,Adhoc testing,Pair testing, Extreme testing, Agile testing, Exploratory testing,Defect seeding (3L)

Usability Testing - Factors in usability testing ,Aesthetics testing ,Accessibility testing , Tools for usability testing (2L)

Testing object oriented software - Definitions and Challenge differences from testing non-OO Software,Class testing strategies Class Modality,State-based Testing,Message Sequence Specification (3L)

People and organizational issues in testing - Common people issues and myths in testing, Providing career paths in testing,Organizational structures for testing teams,Geographically distributed testing teams and success factors (5L)

Test Management and Automation- Test Planning,Test Management,Test Process,Test Reporting,Test Automation,Factors to consider in automation,Challenges in test automation,Test Metrics,Product Metrics,Process Metrics,Progress Metrics
Use of metrics in ascertaining product release (5L)

Importance of documentation-, Need for Software Documentation,Different types of documentation,Understanding task orientation,Analyzing users ,Writing user scenarios , User informational needs ,Document goals , User work motivations ,User analysis checklist (3L)

Maintenance- The Context Of Maintenance- Definitions, Economics of Maintenance, Evolution of Software Products,Maintaining systems effectively, categorizing Software products, Deployment Models, types of maintenance (3L)

Software Configuration Management – Baseline, Identification,Accounting, control, Audit, Source and Version Control (2L)

References:

1.Software Testing- Principles and Practices ,Srinivasan Desikan and Gopalaswamy Ramesh

2. Integrated Approach to Software Engineering , Pankaj Jalote, Narosa Edition

3. Software Engineering – A Practitioners Approach, Roger Pressman

Lab: Software Testing
Credit: 01
Marks: 25

List of suggested **PRACTICALS** using any testing tool such as QuickTest Professional or equivalent :

8. Planning Test Cases	(1P)
9. Generating Test Cases/Test Suite	(2P)
10. Enhancing Tests	(3P)
11. Debugging Tests	(2P)
12. Running Tests	(2P)
13. Analyzing Results	(1P)
14. Reporting Defects	(1P)

****

Paper Title : Server Side Programming

Marks : 75

Credits : 3

Prerequisite Courses: Client Side Technologies(DCA13)

Course Objective:

To give an understanding the web software development: how it is different, issues involved in it.

Learning Outcomes:

Students will be able to develop dynamic web pages.

Syllabus

Principles of OOP: [4L]
OOP: major principles - encapsulation, abstraction, inheritance, polymorphism. Benefits of OOP, Applications of OOP.

Web Technologies: [3L]

Introduction to Web technology, Web pages and Browsing, Dynamic Web Pages,Java script, Dynamic web document technologies - PHP, JSP, ASP, Active web pages and Active Web technologies.

Tags, Escaping from HTML, Types: [4L]

Resources, NULL, Callbacks, Type juggling.

Variables: [4L]

Basics, Predefined variables and Scope, Constants: Syntax, Magic constants,Expressions.

Operators, Control structures, Functions, Predefined exceptions [4L]

Security: [9L]

Introduction, General considerations, Installed as CGI binary, Installed as an Apache module, File system Security, Database Security, Error Reporting, Using Register Globals, User Submitted Data, Hiding PHP

Features: [12L]

HTTP authentication with PHP, Cookies, Sessions, Handling file uploads, Connection handling, Persistent Database Connections, DTrace Dynamic Tracing

Ajax : [5L]

request object creation, forwarding the request, accepting response object and display on webpage

<u>Reference Books</u>

1. Steven Holzner, "PHP: The Complete Reference", Tata Mcgraw Hill
2. **Timothy Boronczyk** , **Martin E. Psinas**, "PHP and MYSQL: Create - Modify – Reuse", Wiley India Private Limited
3. Tim Converse, "PHP 5 and MySQL Bible", Wiley India Private Limited
4. Meloni J.C., "Teach yourself PHP, MySQL and Apache all in one", Pearson Education
5. Stephen J. Schrader, "AJAX", imported edition.

<u>Web Reference:</u>

1. http://in1.php.net/manual/en/index.php for PHP v 5.5 and above

Lab : ServerSide Programming

Credit : 1

Marks : 25

Suggested list of practical (Numbers in brackets indicate number of practicals)

1. Creating dynamic web pages with PHP (3P)
2. Authentication, Cookies, Session management (1P)
3. Error handling (1P)
4. Database connectivity (1P)
5. Using framework like CodeIgniter (1P)
6. Ajax implementation (1P)
7. File uploading (1P)
8. Uploading and images to and from server (1P)

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Paper Title: Data Structures
Marks: 75
Credits: 3

Prerequisite Courses : Knowledge of Programming

Course Objectives:
To understand different methods of organizing data and efficiently implement different data structures.

Learning outcome:
On completion of the course student will learn:

- Different data structures like Stack, Queues, Linked Lists, Graphs and their applications.
- Implementation of data structures.

Syllabus

1. **Introduction to data structures:** **[3L]**
Concept, Data type, Data object, ADT, Need of Data Structure, Types of Data Structure

2. **Algorithm analysis:** **[3L]**
Algorithm – definition, characteristics, Space complexity, time complexity, Asymptotic notation (Big O)

3. **Linked List:** **[8L]**
Introduction to List, Implementation of List – static & dynamic representation, Types of Linked List, Operations on List, Applications of Linked List, polynomial manipulation, Generalized linked list – concept & representation.

4. **Stacks:** **[8L]**
Introduction, Representation-static & dynamic, Operations, Application - infix to postfix & prefix, postfix evaluation, Simulating recursion using stack.

5. **Queues:** **[5L]**
Introduction, Representation -static & dynamic, Operations, Circular queue, priority queue (with implementation), Concept of doubly ended queue.

6. **Trees:** **[10L]**
Concept & Terminologies, Binary tree, binary search tree, Representation – static & dynamic, Operations on BST – create, Insert, delete, traversals (preorder, inorder, postorder), counting leaf, non-leaf & total nodes, non recursive inorder traversal, Expression Tree.

7. **Graph:** **[8L]**
Concept & terminologies, Graph Representation – Adjacency matrix, adjacency list, Traversals – BFS & DFS, Application of BFS, DFS – Shortest path, Backtracking.

Text Book:

Horowitz Ellis, Sahni Sartaj, *Fundamentals of Data Structures in C*, University Press, 2nd Edition, 2008.

Reference:

1. Michael T. Goodrich, Roberto Tamassia , *Data Structures and algorithms in Java, John Wiley & sons inc.,5th Edition, International Student version.*

2. Langsam Yedidyah, Augenstein J. Moshe, Tenenbaum M. Aaron , *Data Structures using C and C++*, Pearson Education, Second Edition ,2009

3. Gilbeg Richard, Forouzan Behrouz, Data Structures: A Pseudocode Approch with C++, Cengage Learning, Second Edition

Lab : Data Structures
Credit: 1
Marks: 25

Programs using C language / Java Language that covers the following concepts:
1. Stack: Static/Dynamic stack implementation.
2. Stack: infix to postfix.
3. Stack: Evaluation of Postfix expression.
4. Queues: Static and Dynamic Queue Implementation
5. Queues: Circular queue
6. List: Singly Linked List,
7. List: Doubly Linked List
8. List: Circular Linked List
9. Linked List: Polynomial addition
10. Trees: Binary Search Tree: create, add, delete, display nodes.
11. Trees: BST traversal.
12. Graph: Representation of Graphs, Graph Traversals.
13. Graph: DFS, BFS.

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Paper Title: Accounting and Financial Management
Marks: 75
Credits: 3

Prerequisite Courses : Knowledge of Accounting

Course Objectives:

This course aims to produce knowledge, skills and understanding of accounting and financial management. It gives detail knowledge about the most important components of accountancy i.e. financial statements and Budgeting.

Learning outcome:

On completion of the course:

1. Student will develop the skills of accountancy and book keeping with the help of software.
2. Student will be independently able to prepare budget and business plan for the firms.

Syllabus

Financial Accounting: An Introduction **[4L]**

Meaning and Nature of Accounting, Accounting as language of Business and Accounting as information system. Accounting processes and final output of Accounting system. Principles of Accounting and double entry system. Recording of Transaction in Journal, Posting of transaction to Ledger and preparation of Trial Balance.

Preparation of Final Financial Statement **[6L]**

Preparation of Final Accounts – Profit and Loss account and Balance Sheet. Preparation of statement of changes in Financial Statements – Funds Flow Statement and Cash flow statement.

Analysis of Financial Statements **[4L]**

Horizontal (Trend) analysis and Vertical (Common-Size) analysis. Ratio Analysis – Liquidity ratio, Turnover ratio, Profitability ratio.

Cost Accounting: An Introduction **[7L]**

Meaning, nature and importance of cost Accounting system in an Organization. Elements of Cost and various cost Concept – Direct and indirect cost, Fixed and Variable costs, Sunk Cost Opportunity Cost, Out of Pocket and Imputed cost, Preparation of cost sheet. Understanding the nature of variable cost and fixed cost (total as well as per unit). Contribution, P/V ratio, Break Even Point. Assumptions of Cost-Volume - Profit Analysis and studying the relationship between Cost, Volume and Profit.

Budgeting **[2L]**

Meaning, Importance and Objective of budgeting in an Organization, Different types of Budgets including preparation of cash Budget, fixed and flexible budget, Zero based budgeting.

Financial Management: An Introduction **[4L]**

Nature, Objective and Scope, Financial decision making and type of financial decision. Role of Finance Manager in Organization. Basic axioms of Financial Management. Risk-Return framework for financial decision making.

Time Value of Money and Mathematics of Finance **[4L]**

Time Value of Money and Opportunity cost of Money, Present value and future value and Interest rate and discount rate Annuities and their types, Numerical related to the calculation of present values and future values.

Capital Budgeting Decisions **[4L]**

Nature and kinds of Capital budgeting decisions. Techniques of evaluating Capital budgeting decisions – Payback Period, Accounting rate of return, NPV, IRR and Profitability Index.

Cost of Capital and Sources of Finance **[4L]**

Basic valuation Model, Concept of Cost Capital – Weighted average Cost and Marginal Cost, Cost of debt and cost of Equity, Various long term sources of funds for a Organization.

Capital Structure and Dividend Decisions **[4L]**

Concept of Capital Structure, Financial Leverage and Capital Structure, Determinants of Capital Structure, Dividend and its forms – cash dividend, right and bonus shares and buy-back of shares, determinants of Dividend Policy of firm.

Working Capital Management **[2L]**

Basics of Working Capital management: Meaning of Gross and Networking Capital, Components of Working Capital. Risk-Return framework for Working Capital Decisions.

Main Reading

1 Pandey I. M., “Financial Management”, 7th Edition, 2002, Vikas Publishing Pvt Ltd.

2 M. Y. Khan and P.K. Jain, “Management: Accounting” 2nd Edition1995, Tata McGraw-Hill Publishing, New Delhi

3 Maheshwari S.N. “Accounts” 2002, Vikas Publishing Pvt. Ltd.

Lab : Accounting and Financial Management
Credit: 1
Marks: 25

1. Journal entry	(1P)
2. Book keeping using software.	(2P)
3. Balance sheet	(2P)
4. Balance sheet using software.	(2P)
5. Numerical related to the calculation of present values and future values	(2P)
6. Preparation of budget of a hypothetical firm	(2P)
7. Returns on share of a hypothetical firm	(2P)
8. Dividend policy of a hypothetical firm	(2P)

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Annexure I

Parvatibai Chowgule College of Arts and Science (Autonomous)

DEPARTMENT OF COMPUTER SCIENCE

COURSE STRUCTURE
THREE YEAR B.Sc. DEGREE COURSE IN COMPUTER SCIENCE

COMPONENT A:

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
	COM-I.C-1	**COM-I.C-2 ***				
I	Mathematical foundation of Computer Science – I	Introduction to Programming	---	---	---	---
	COM-II.C-3 **	**COM-II.C-4 ***				
II	Object	Data	---	---	---	---

	Oriented Programming	Structures				
III	**COM-III.C-5 *** Data Base Management Systems	---	**COM-III. E-1** Software Engineering	**COM-III. E-2** Digital Logic Design	**COM-III. E-3** Mathematical Foundation of Computer Science - II	**COM-III. E-4** Web Designing
IV	**COM-IV.C-6** Computer Architecture and Organization	---	**COM-IV. E-5** Design & Analysis of Algorithms	**COM-IV. E-6** Data Base Application Development	**COM-IV. E-7** Server Side Programming	**COM-IV. E-8** HCI
	COM-V.C-7 *		**COM-V. E-9**	**COM-V. E-10**	**COM-V. E-11**	**COM- V. E-12**

V	Operating Systems	---	Embedded Systems	Mobile Application Development	Introduction to Data Science	Software Testing
VI	**COM-VI.C-8 *** Computer Networks	---	**COM-VI. E-13** Network Security	**COM-VI. E-14** Cloud Computing	**COM-VI. E-15** Multimedia Techniques	**COM-VI. E-16** Digital Marketing

Note: * Core Compulsory Courses also offered for minor subject combination.

** Core Compulsory Courses also offered for minor subject combination in 4th Semester.

COMPONENT B:

1. **GENERAL COMPULSORY (GC-B) -** a. Cyber Security

2. **INTERDISCIPLINARY (GC-E) –** a. Multimedia

   b. Web Designing

Syllabus for

Interdisciplinary Courses

(2018-2019)

Course Title: Multimedia
Marks: 100
Credits:4
Duration: 60 Hrs.

Prerequisite Courses : Nil

Course Objectives:

On completion of the course the students will develop specific skills and competencies by making them proficient in Designing Graphical Images, Audio and Video Capture and Editing using Software tools

Learning Outcomes:

To study Multimedia Concepts
To develop their Creativity and publish a self-contained multimedia Application using multimedia authoring tools in various application areas.

Syllabus

INTRODUCTION TO MULTIMEDIA: [8 Hrs]

Commonly used terms associated with multimedia like CDROM, Storyboard, Script and Authoring tools.

Stages of a Multimedia Project: Planning and Costing, Designing and Producing, Testing and Delivering.

The Multimedia team and their roles: Project Manager, Writer, Video specialist, Audio specialist and Multimedia programmer.

Multimedia Software. Multimedia Hardware

MULTIMEDIA AUTHORING TOOLS: [5 Hrs]

Types of Authoring tools - card or page based tools, icon-based, event-driven tools, time-based and presentation tools and object-oriented tools.

MULTIMEDIA BUILDING BLOCKS:

TEXT [5 Hrs]

Designing with Text, menus and buttons for navigation

Animating text

Hypermedia and Hypertext

SOUND [7 Hrs]

Basic Sound Concepts

Music

Speech

MIDI and Digital Audio

IMAGES [10 Hrs]

Making still images, Bitmaps, Clipart,

Capturing and Editing Images

Scanning Images

Vector Drawing

3D Drawing and Rendering

Image File formats

ANIMATION [11 Hrs]

Principles of Animation- persistence of vision, animation file formats

Computer animation-kinematics and morphing

Making animations that work- a rolling ball, a bouncing ball and creating an animated scene

VIDEO [11 Hrs]

Video Broadcast Standards- NTSC, PAL, SECAM, HDTV

Integrating Computers and Television like Video Overlay Systems, Digitized Video Playback, Differences between Computer and Television Video

Recording Formats like S-VHA Video, Component (YUV), Component Digital, Composite Digital, Video Hardware Resolutions

Video Tips like Shooting platforms, Lighting, Chroma Key or Blue Screen

Video Compression methods like MPEG and DVI

ASSEMBLING AND DELIVERING A PROJECT [3 Hrs]

The four primary navigational structures used in multimedia like linear, hierarchical, non-linear and composite

Demo to be done using Proprietary or FOSS for Text, Image, Audio and Video Editing. For example Scribus, GIMP, Audacity, Movie maker, Openshot, etc.

Text Book:

Vaughan, Tay , ―Multimedia: Making it Work‖, 3rd edition, Tata McGraw-Hill

Reference Books:

1. Jeffcoate, Judith, ―Multimedia in Practice, Technology and Applications‖, Prentice Hall India.

2. Buford, J.F. K , ―Multimedia Systems‖, Pearson Education

3. Elson-Cook, ―Principles of Interactive Multimedia‖, McGraw Hill Higher Education. ISBN- 13: 978-0077096106

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Course Title: Web Designing
Marks: 100
Credits:4
Duration: 60 Hrs.

Prerequisite Courses : Nil

Course Objective:

To develop a high degree of competence as a web designer by learning the client-side techniques.

Learning Outcome:

On completion of the course students will be able to

- Understand basics of Internet.
- Design simple static and dynamic websites.

Syllabus

1. The Internet **[10** Hrs**]**

Computer Networks: LAN, MAN, WAN, etc., Layout (Ring, bus, star, etc.), IP address: public, private, static, dynamic, Internet protocols and services: http, https, ftp, smtp, nntp, etc, Telnet, dns, dhcp, Intranet & Extranet, Internet Infrastructure, Search Engines, Web Browser, Web server

2. Basic HTML: **[16** Hrs**]**

Introduction, importance, Basic: HTML Tag, HEADER Tag, META Tag, TITLE Tag, BODY Tag, Text Formatting: PRE Tag, FONT Tag, entities, Image: IMG tag, image maps, Hyperlinks: Anchor tag, Lists: Unordered Lists, Ordered Lists, Definition Lists, Table tags: TABLE, TR and TD Tags, Cell Spacing and Cell Padding, Colspan and Rowspan, Frames: Frameset, FRAME Tag, NOFRAMES Tag, End user Interaction: FORM and INPUT Tag, Text Box, Radio Button, Checkbox, SELECT Tag and Pull Down Lists, TEXTAREA, Hidden, Submit and Reset, Special Tags : COLGROUP, THREAD, TBODY, TFOOT, blank, self, parent, top, IFRAME, LABEL, Attribute for <SELECT>.

3. HTML5: **[8** Hrs**]**

The <canvas> element for 2D drawing, The <video> and <audio> elements for media playback, Support for local storage, New content-specific elements, like <article>, <footer>, <header>, <nav>, <section>, New form controls, like calendar, date, time, email, url, search.

4. CSS: **[8** Hrs**]**

Introduction to CSS, Advantages, Types of style sheets: Inline, Internal, External, Multiple Style sheets and Cascading order, Grouping or nesting, Syntax, ID and Class, Pseudo-class, Pseudo-element, CSS units of measurement, Colors.

5. New features in CSS3: **[7** Hrs**]**

Selectors, Box Model, Backgrounds and Borders, Image Values and Replaced Content, Text Effects, 2D/3D Transformations, Animations, Multiple Column Layout, User Interface.

6. Frameworks and Content Management System **[11** Hrs**]**

Text Book:

- Elisabeth Robson, Eric Freeman, *"Head First HTML with CSS & XHTML A Learner's Companion to HTML, CSS and XHTML",* O'Reilly Media, 1st Edition, 2005.

Reference Books:

- Eric Freeman, "*Head First HTML5 Programming",* O'Reilly Media, 1st Edition, 2011
- Jennifer Niederst, "*Web Design in a Nutshell*", O'Reilly Media, 3rd Edition, 2006

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Annexure IV

Parvatibai Chowgule College of Arts and Science (Autonomous)

DEPARTMENT OF COMPUTER SCIENCE

COURSE STRUCTURE

THREE YEAR B.Sc. DEGREE COURSE IN COMPUTER SCIENCE

COMPONENT A:

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	**COM-I.C-1** Mathematical foundation of Computer Science – I	**COM-I.C-2 *** Introduction to Programming	---	---	---	---
II	**COM-II.C-3 **** Object Oriented Programming	**COM-II.C-4 *** Data Structures	---	---	---	---

III	**COM-III.C-5 *** Data Base Management Systems	---	**COM-III. E-1** Software Engineerin g	**COM-III. E-2** Digital Logic Design	**COM-III.** **E-3** Mathematical Foundation of Computer Science - II	**COM-III.** **E-4** Web Designing
IV	**COM-IV.C-6** Computer Architecture and Organization	---	**COM-IV. E-5** Design & Analysis of Algorithms	**COM-IV. E-6** Data Base Applicatio n Developm ent	**COM-IV.** **E-7** Server Side Programming	**COM-IV.** **E-8** HCI
V	**COM-V.C-7 *** Operating Systems	---	**COM-V.** **E-9** Embedded Systems	**COM-V. E-10** Mobile Applicatio n Developm	**COM-V.** **E-11** Introduction to Data	**COM- V.** **E-12** Software Testing

				ent	Science	
VI	**COM-VI.C-8 *** Computer Networks	---	**COM-VI. E-13** Network Security	**COM-VI. E-14** Cloud Computin g	**COM-VI. E-15** Multimedia Techniques	**COM-VI. E-16** Digital Marketing

Note: * Core Compulsory Courses also offered for minor subject combination.

** Core Compulsory Courses also offered for minor subject combination in 4th Semester.

COMPONENT B:

2. **GENERAL COMPULSORY (GC-B) -** a. Cyber Security

2. **INTERDISCIPLINARY (GC-E) –** a. Multimedia

   b. Web Designing

S.Y.B.Sc. Computer Science – Syllabus
(from Academic Year 2018-19)

Semester III

Course Title: Data Base Management Systems

Course Code: COM-III.C-5

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisites: -
--Nil--

Course Objectives:
It provides basic knowledge of a database management system. It helps to understand importance of ER diagram. It introduces SQL to query a database.

Learning outcome:

- On completion of the course students will learn Database concepts and structures. They will be able to explain terms related to database design and management. Students will understand data modeling and database development process.
- Students will be able to construct and normalize data models and implement the same using any Relational Database Management System.
- Students will become proficient in using database query language, i.e. SQL.

Syllabus

1**. Overview of database management** [7 **Hrs**]

Data, information, database, database management system; Managing data; File systems versus a DBMS, advantages of a DBMS; Data abstraction, instances and schemas, data models; Data manipulation language, data definition language; Architecture of a DBMS; Users of a DBMS, database administrator

2**. Database design and the ER model** [10 **Hrs**]

Design phases – conceptual design, logical design, physical design; ER model – entities, attributes, and relationships, mapping cardinalities, keys; ER diagrams – strong entities, weak entities, generalization, specialization, aggregation; Converting ER diagram to relational schemas

3. **Relational model** [9 **Hrs**]

Relation, properties of relational model; Entities, integrity constraints, referential integrity constraints; Relational algebra – select, project, cross product, set operations, rename operation; Other relational operations – natural join, outer join

4. **SQL** [10 **Hrs**]

Basic structure of SQL query – Create, select, where, from, rename operation; Set operations; Aggregate functions; Group by, having clauses; Nested queries; Views; Insert, delete, update.

5**. Functional dependency and normalization** [6 **Hrs**]

Atomic domain, nested relation; Key, super key, primary key, candidate key; Functional dependency, axioms, closure of a set of attributes, closure of a set of functional dependencies; Purpose of normalization; 1NF; 2NF; 3NF; BCNF

6. Introduction to Transactions [3**Hrs**]

Transaction concept, Transaction state, ACID properties, Concurrent Transactions, Serializability.

Text Book:

1. A Silberschatz, H F Korth, S Sudarshan, *Database system concepts*, McGraw-Hill ,sixth Edition

Reference Books:

Ramakrishan, J Gehrke, "*Database management systems"*, McGraw-Hill , 3rd edition
R Elmasri, S B Navathe, "*Fundamentals of database Systems"*, Pearson Education , 5th Edition

Lab : Database Management Systems
Credit : 1
Marks : 25

List of Practicals

1. ER diagram
2. ER diagram with specialization/generalization and aggregation.
3. Converting ER diagram to Schemas
4. Converting ER diagram with generalization/specialization, aggregation into schema
5. Studying RDBMS
   a. Understanding Client server architecture
   b. Creating tables
6. SQL
7. SQL

8. Introduction of .NET Framework, Advantages of .Net Framework, Components of .NET Framework, Data type & Operators with examples.
8. Loops, Control Statements, Operators, Data Types
9. Controls : Label, Button, Textbox, Picture Box
10. Controls : Radio button, Checkbox, Timer Control, Scroll Bars
11. Controls : List box, Combo Box, Main Menu Dropdown list etc.
12. Working on Database
13. Working on Database
14. Normalization
15. Report Writing

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Course Title: Software Engineering

Course Code: COM-III.E-I

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisite Courses : Nil

Course Objectives:

On completion of the course the students will develop specific skills and competencies to use various software engineering tools and methods to develop software for medical, industrial, military, communications, aerospace, business, scientific, and general computing applications.

Learning Outcomes:

- Gain knowledge of concepts & principles, methods and tools used in software engineering with an emphasis on object oriented analysis & design using UML
- Appreciate the role of software engineering in the software development industry.
- Be enabled to use various software engineering methods and tools employed during analysis, design, programming, testing and project management

Syllabus

SOFTWARE PROCESS: **[5 Hrs]**

Characteristics of software process.

Software Development Processes and Methodologies: waterfall, prototyping, iterative, spiral, unified process.

Benefits of iterative and incremental approach with emphasis on Unified process, CASE Tools, Agile methodologies.

PROJECT MANAGEMENT: [7 Hrs]

Planning a Software Project – Cost estimation, Project Scheduling, Software configuration management plans, Quality Assurance plans, Project Monitoring plans and Risk Management. Techniques such as Interviewing , Requirement Workshop, brainstorming, prototyping. Characteristics of SRS

OOAD and UML: [10 Hrs]

OOAD: Definition; object oriented analysis; object oriented design and modeling; Assigning responsibilities.

UML: Main UML diagrams – Class diagram , sequence diagram, activity diagram, use case diagram. Use case model – use case diagram , use case descriptions, use case realization using sequence and activity diagrams. Supplementary requirements. Advanced use case model features.

Requirements: Functional and non-functional

System Design : Class diagram, sequence diagram, activity diagram, state chart diagram, deployment diagram. Brief introduction to other UML diagrams.

SOFTWARE ARCHITECTURE PATTERNS: [5 Hrs]

Major Architectural Styles (patterns) like Layered Architecture, Pipe and Filter, Shared (Central) Data Store, Event Driven, Model-View-Controller (MVC), "Distributed & Emerging" Service Oriented Architecture (SOA) and Elementary GRASP Patterns.

HUMAN COMPUTER INTERACTION: [4 Hrs]

HCI Definition; User categories, Interface Design-Internal & External Interface design, user interface design, Interface design guidelines.

CODING: [2 Hrs]

Coding styles, standards, peer reviews, checklist.

TESTING: **[4 Hrs]**

Testing Fundamental, Functional Testing, Structural Testing, Testing Object-Oriented Programs, Testing Process and Metrics.

DOCUMENTATION and MAINTENANCE: **[4 Hrs]**

Need for Software Documentation. Types of documentation

Need for Maintenance; Types of Maintenance

REENGINEERING: **[4 Hrs]**

Business Process Reengineering, Software Reengineering, Reverse Engineering, Restructuring, Forward Engineering, The Economics of Reengineering

Text Books:

- Roger Pressman, Software Engineering: A Practitioners Approach, McGraw Hill, (6th Edition), 1997.
- Craig Larman, Applying UML and patterns, Addison Wesley, 2nd Edition, 2003

References :

- Pankaj Jalote, An Integrated Approach to Software Engineering, Narosa Publishing House, 2nd Edition
- Glenford J.Myers, “ The Art of Software Testing “, John Wiley & Sons, 1979.
- Sommerville, Software Engineering, Adison Wesley, 7th edition, 1996.
- Martin Fowler, UML Distilled, Addison Wesley, 2nd Edition, 2003
- Thomas T. Barker , "Writing s/w documentation - a task oriented approach", Allyn & Bacon Series of Technical Communication , 1998.
- Steve Mc Connell, Code Complete, Microsoft Press, ISBN 978-0-7356-1967-8 Second Edition (June 2004)

Lab : Software Engineering

Credit : 1

Marks : 25

List of suggested **PRACTICALS** using UML (the numbers in brackets indicate number of practicals) :

- SRS using IEEE format **[2P]**
- Draw a USE Case diagram and write Use Case descriptions for the Use Cases **[2P]**
- Draw a Class Diagram **[2P]**
- Draw a Sequence Diagram **[2P]**
- Draw an Activity Diagram **[2P]**
- Draw a State Chart Diagram **[2P]**
- Draw a Gantt Chart for a project **[1P]**
- Develop a mini project/ Case Study **[2P]**

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Course Title: Digital Logic Design

Course Code: COM-III. E-2

Marks: 75

Credits: 3

Duration: 45 Hrs.

Course objectives:

To understand the basics of Boolean algebra and the *operation* of logic components, combinational, sequential circuits and *design* of digital systems.

Learning Outcome:

- Apply the principles of Boolean algebra to manipulate and minimize logic expressions.
- Use K-maps to minimize and optimize two-level logic functions.
- Understand the operation of latches, flip-flops, counters, registers, and register transfers.
- Analyze the operation of sequential circuits built with various flip-flops.
- Apply the above concepts to develop digital systems.

Syllabus

1. **Introduction to Number Systems and codes:** [3 **Hrs**]
Decimal, Binary, Hexadecimal, and Octal number systems; BCD Code, Gray Code, Excess-3 Code, ASCII code, Unicode.

2. **Boolean Algebra:** [8 **Hrs**]
Basic Boolean functions, Postulates and theorems of Boolean Algebra, logic gates, Sum-of-Products and Product-of-Sums forms of Boolean functions; Canonical and Standard forms. Simplification of Boolean Functions, Plotting of K-Maps, POS and SOP Simplification, NAND and NOR implementation.

3. **Combinational Logic:** [8 **Hrs**]
Design procedure for combinational logic circuits; design and analysis of Half Adder, Full Adder; their use in designing other combinational logic circuits; Analysis & Design of Encoders and Decoders; Multiplexer and demultiplexers; their use in designing combinational circuits.

4. **Sequential Circuits:** [9 **Hrs**]
SR, JK, T, D Flip-flops and Latches, their schematic symbols, Truth tables. Shift Registers - SISO, SIPO, PISO, PIPO, Bi-directional Shift Registers, Loading methods for Shift Registers.

5. **Sequential Circuit Design:** [8 **Hrs**]
Design procedure for sequential circuits using state diagrams, State Tables; State assignments and State minimization methods; Circuit implementation. Design and analysis of Counters, Synchronous Counters; Modulo Counters, Asynchronous, Ripple and Ring Counters; Application of Counters.

6. **D/A & A/D Converters:** [4 **Hrs**]
Digital to Analog converter – Introduction, Weighted-Resistor & R-2R Ladder,
Analog to Digital Converter – Introduction, Successive Approximation method.

7. **Semiconductor memories:** [5 **Hrs**]
Memory organization and operation, expanding memory size, Classification and characteristics of memories, RAM, ROM, Synchronous DRAM (SDRAM), Double Data Rate SDRAM, Synchronous SRAM, DDR and QDR SRAM, Content Addressable Memory.

Text Book:

1. R.P. Jain , “Modern digital electronics” , 3rd edition , 12th reprint TMH Publication, 2007.

Reference Books:

1. D.P. Leach, A.P. Malvino, G.Saha, Digital Principles and Applications, 7th Edition, Mc. Graw Hill (SiE)
2. M. Morris Mano, Digital Logic and Computer Design.
3. Herbert Taub and Donald Schilling, Digital Integrated Electronics, McGraw-Hill.

**Lab : ** Digital Logic Design
Credits : 1
Marks : 25

1. Introduction to digital ICs, specifications, verification of the truth tables of logic gates1.
2. Introduction to digital ICs, specifications, verification of the truth tables of logic gates2.
3. Implementation of the given Boolean function using logic gates in SOP form.
4. Implementation and verification of Decoder using logic gates.
5. Implementation of Multiplexer using logic gates.
6. Implementation and verification of De-multiplexer and Encoder using logic gates.
7. Implementation of Binary Adders.
8. Implementation of 4-bit parallel adder.
9. Verification of state tables of RS, JK, T and D flip-flops.
10. Implementation of Shift Registers using flip-flops.
11. Design and verification of the 4-bit synchronous counter1.
12. Design and verification of the 4-bit synchronous counter2.
13. Design and verification of the 4-bit asynchronous counter1.
14. Design and verification of the 4-bit asynchronous counter2.
15. Design and implementation of combinational logic using MUX and DEMUX ICs.

Course Title: Mathematical Foundation of Computer Science - II

Course Code: COM-III.E-3

Credits: 3

Marks: 75

Duration: 45 Hrs.

Course Objectives:

The objectives of this Course are to build mathematical foundations in the areas namely graph theory and numerical analysis being closely related to topics of computer science.

Learning Outcomes:

On completion of the course, students will learn the following concepts: graph theory and numerical analysis

Syllabus

Graph Theory

1. Graphs, Subgraphs and Components **[3 Hrs]**

Graphs, subgraphs, and some special graphs; Graph properties; Paths, cycles, and components

2. Trees and Cycles **[4 Hrs]**

Trees; Spanning trees; Algorithms to find MST; Cycles; Generation of Trees and Cycles

3. Connectivity **[3 Hrs]**

Cut vertices, Cut edges and Blocks; Eccentricity sequences and Sets; Connectivity parameters

4. Planarity **[4 Hrs]**

Planar embeddings; Bridges; two characterization theorems

5. Eulerian graphs **[3 Hrs]**

Introduction; Eulearian and traversable graphs; Non-Eulearian graphs

6. Digraphs **[4 Hrs]**

Basic definitions; types of connectedness; Covers and bases; Connectivity; Acyclic digraphs

Numerical Analysis

1. Interpolation with Equal Intervals **[6 Hrs]**

Introduction; Various methods of interpolation; Various methods of curve fitting; Newton's method of forward interpolation formula; Newton's method of backward interpolation formula

2. Interpolation with Unequal Intervals **[2 Hrs]**

Introduction; Lagrange's formula

3. Numerical Integration **[5 Hrs]**

Introduction; General quadrature formula; Trapezoidal rule; Simpson's one-third rule; Simpson's three-eighth rule; Weddle's rule

4. Solutions to algebraic and transcendental equations **[5 Hrs]**

Introductions; Graphical method; Bisection method; Method of false position; Secant method; Newton-Raphson method

Linear Algebra **[6 Hrs]**

Adjoint, inverse of a matrix; Rank; Linear equations; Characteristics roots and vectors

Text Books:

1. K R Parthasarathy, Basic Graph Theory, Tata McGraw-Hill Publishing, 1994

2. B S Goel, S K Mittal, Numerical Analysis, Pragati Prakashan, 13^{th} Edition, 1998

3. S.N. Iyengar, Matrices, Anmol Publications, 2010

Reference Books:

1. J Clark, D A Holton, A First Look at Graph Theory, World Scientific, 1991

2. P N Chatterjee, Numerical Analysis, Rajhans Prakashan Mandir, 3^{rd} Edition, 1996

3. V. Krishnamurthy, Introduction to Linear Algenra, Affiliated East-West Press, First Edition, New Delhi, 1976

Lab : Mathematical Foundation of Computer Science - II

Credit: 1

Marks: 25

List of Experiments

Graph Theory

1) Read a graph, and check if it is connected.

2) Find the components of a graph.

3) Check the existence of cycle in a graph.

4) Read a weighted graph. Find the minimum spanning tree

5) Identify cut vertices and cut edges in a graph

6) Find maximum distance between two vertices in a graph

7) Read a digraph, and check if it is connected.

8) Find the strongly connected components of a digraph.

Numerical Analysis

1. Find the value of dependent variable using Newton's forward formula for a given value of independent variable.
2. Use Newton's backward formula to estimate a value
3. Estimate a value using Lagrange's formula
4. Integrate a function using Simpson's one-third rule
5. Apply Simpson's three-eighth rule to find the value of integration
6. Find the value of a root using method of false position
7. Estimate root of an equation by secant method
8. Apply Newton-Raphson method to estimate the root of a equation

Linear Algebra

1) Find the rank of a matrix

2) Find solutions of a system of equations

Course Title: Web Designing

Course Code: COM-III.E-4

Credits: 3

Marks: 75

Duration: 45 Hrs.

Course objectives:

How to design good user interfaces covering importatant design principles such as learnability, visibility, error prevention, efficiency and graphic design

Learning Outcomes:

Implementation of user interfaces following design principles and using technologies such as HTML, CSS, JavaScript and Jquery.

Syllabus

Unit I : User Interface – Introduction, its importance, design principles – learnability, visibility, error prevention, efficiency, graphic design. Design Patterns for GUI – View tree, Listener, Widget, Model-View-Controller. Approaches to GUI programming – Procedural, Declarative, Direct Manipulation. Web UI – HTML, Javascript, Jquery. [6 **Hrs**]

Unit II : Structure and Style with HTML and CSS

HTML [6 **Hrs**]

Introduction. The development process, basic HTML, formatting and fonts, commenting code, color, hyperlink, lists, tables, images, simple HTML forms, web site structure, Meta tags, Character entities, frames and frame sets.

HTML5 [6 **Hrs**]

Introduction, New Elements, Canvas, SVG, Drag/Drop, Geolocation, Video, Audio, Input types, form elements, form attributes, semantic, web storage, app cache, web workers, SSE

CSS [5 **Hrs**]

Introduction – Syntax, Id & Class, Backgrounds, Text, Fonts, Links, Lists, Tables. CSS Box Model – Border, Outline, Margin, Padding. Advanced - Grouping/Nesting, Dimension, Display, Positioning, Floating, Align, Pseudo-class, Pseudo-element, Navigation Bar, Image Gallery, Image Opacity, Image Sprites, Media Types, Attribute Selectors.

CSS3 [5 **Hrs**]

Introduction, Borders, Backgrounds, Gradients, Text Effects, Fonts, 2D Transforms, 3D Transforms, Transitions, Animations, Multiple Columns.

Unit 3 : Javascript [10 **Hrs**]

Introduction - What is JavaScript, Understanding Events, JavaScript Example, External JavaScript. Basic Elements – Comment, Variable, Global Variable, Data Types, Operators, If Statement, Switch, Loop: for and while, Function. JavaScript Objects – objects, Array. Browser Object Model - Browser Objects, Window Object, Document Object – getElementById, getElementsByName, getElementsByTagName, innerHTML property, inner Text property. Validation- form validation, email validation.

Unit 4 : Introducing jQuery [7 **Hrs**]

JQuery : Introduction - Syntax, Selectors, Events. Effects- Hide/Show, Fade, Slide, Animate, stop(), Callback, Chaining. HTML/CSS- Add, Remove, CSS Classes, css(), Dimensions, slider. Traversing – ancestors, descendants, siblings, filtering.

Reference books:

Elisabeth Robson, Eric Freeman, “Head First HTML and CSS”, O'Reilly

Ivan Bayross, “HTML 5 and CSS 3 Made Simple”, BPB publication

Kogent Learning Solutions Inc., “HTML5 Black Book: Covers CSS3, Javascript, XML, XHTML, Ajax, PHP and Jquery”, Pearson Education.

Steven M. Jacobs, Ben Shneiderman, “Designing the User Interface : Strategies for effective human-computer interaction”, 5th Edition, Pearson Education

Lab : Web Designing

Marks: 25

Credits: 1

List of Assignments: (the numbers in brackets indicate number of practicals) :

1) Case studies to review UI designs [2 P]

2) Create a HTML page with the following : [3 P]

   a) title heading paragraph emphasis strong and image elements

   b)complex HTML table

   c)simple HTML Form covering major form elements

   d)Embed Video in an HTML page

3) Using CSS do the following : [3 P]

   a)Create a Navigation bar (with dropdown) with CSS

   b)Create a CSS Grid

   c)Create a CSS3 based button

   d)make an image rounded shape

   e)Create a CSS based sticky footer

   f)Create CSS3 Corner Ribbon

   g)Create CSS3 blurry text effect

   h)Create CSS3 speech bubble shape

   i)Create image cross fade with CSS3 transition

   j)Set style for link hover active and visited states of hyperlink

4)Write JavaScript functions to : [4 P]

   a) accept a string as a parameter and converts the first letter of each word of the string in upper case

b) check whether a given credit card number is valid or not.

c) check whether a given value is an valid url or not.

d) check whether a given email address is valid or not.

e) print an integer with commas as thousands separators

f) remove items from a dropdown list.

5)Use JQuery to : [3 P]

a) Disable buttons

b) Make textbox read only

c) Uncheck check boxes

d) Confirm again

e) Sort

f) Switch rows and columns

A mini project combining all the technologies learnt using a front-end development framework such as bootstrap is recommended.

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Semester IV

Course Title: Computer Architecture and Organization

Course Code: Com-IV. C-6

Marks: 75

Credits : 3

Duration: 45 Hrs.

Objectives:

To have a thorough understanding of the basic structure and operation of a digital computer.

Learning Outcome:

- Understand the CPU organization and the instruction set of 8086 processor.
- Study the hierarchical memory system including cache memories.
- Study the different ways of communicating with I/O devices and standard I/O interfaces.
- Briefly study the different types of parallel processing.
- Design, execute and debug assembly language programs for 8086 processor.

Syllabus

1. **Computer System:** [3 **Hrs**]
   Function and structure of a computer, Interconnection of components, Performance of a computer. Computer Architecture – Princeton (Von Neumann) and Harvard architecture.

2. **Processing Unit:** [6 **Hrs**]
   Architecture of 8086 processor - Registers, ALU and Control unit, Data path in a CPU. Instruction cycle, Organization of a control unit – Block Diagram of Hardwired and Microprogrammed control unit.

3. **Representation of Instructions:** [10 **Hrs**]
   Machine instructions characteristics, Types of operations-data transfer, arithmetic, logical, conversion, I/O, system control, transfer of control; 8086 Instruction Set and Assembly language: Addressing modes-immediate, direct, indirect, register, register indirect, displacement, stack. Instruction formats - instruction length, allocation of bits, variable length instructions, Instruction set architectures - CISC and RISC architectures.

4. Memory Subsystem: [10 **Hrs**]

Characteristics of memory system, the memory hierarchy, Semiconductor memories, Types of ROM & RAM, Cache memory unit - Concept of cache memory, Organization of a cache memory unit, Mapping methods, replacement algorithms, write policy, block size.

5. Input/Output Subsystem: [8 **Hrs**]

General block diagram of External device & I/O module, Programmed I/O,

Interrupt driven I/O, DMA, I/O channels and I/O processors. I/O interfaces –

Serial port, Parallel port, PCI bus, SCSI bus, USB bus, Firewire and Infiniband.

6. Parallel Processing: [8 **Hrs**]

Classifications, Introduction to pipeline processing: Instruction pipeline & Arithmetic pipeline, Introduction to Array & Vector processors, Introduction to Multiprocessors.

Text Book:

1. William Stallings, "Computer Organization and Architecture - Designing for performance", EEE, PHI, 9th Edition.

Reference Books:

1. M. Morris Mano, "Computer System Architecture", Pearson Education, 3rd Edition, 2008

2. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design – The Hardware/Software Interface", Morgan Kaufmann, 4th Edition.

3. Douglas V. Hall, "**Microprocessors and its Interfacing",** McGraw Hill Education (India) Private Limited, 3rd Edition.

Lab **:** Computer Architecture and Organization

Credits : 1

Marks : 25

1. Study of Motherboard, Peripherals and the Computer System.
   O.S. Installation (Dual Boot):

   BIOS; Manage disk partitions: understand MBR-style partitions, (primary, extended, logical); list/create/delete partitions;

   Manage logical volumes: create/remove physical volumes, create/delete logical volumes, Boot loader

   Installation of drivers; updating software packages

2. DOS Commands, Tools for Computer Management (Disk Management, Disk Cleanup, Defragmentation, Performance Monitor, System Restore etc).

Assembly language programs for 8086 using MASM / compatible assembler or Simulator, either in Windows or Linux.

3. Study of addressing modes.
4. Programs for arithmetic operations1
5. Programs for arithmetic operations2
6. Programs for arithmetic operations3
7. Programs for data transfer operations
8. Programs for logical operations1
9. Programs for logical operations2
10. Programs code conversion1
11. Programs code conversion2
12. Programs on sorting
13. Programs on searching
14. DOS/BIOS – Programming1
15. DOS/BIOS – Programming2

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Course Title : Design and Analysis of Algorithms

Course Code : COM-IV.E-5

Marks : 75

Credits : 3

Duration: 45 Hrs.

Course Objectives:

- To study paradigms and approaches used to analyze and design algorithms and to appreciate the impact of algorithm design in practice.
- To ensure that students understand how the worst-case time complexity of an algorithm is defined, how asymptotic notation is used to provide a rough classification of algorithms and compare with one another, and how there are still some problems for which it is unknown whether there exist an efficient algorithm, and how to design efficient algorithms.

Learning Outcomes:

On completion of the course students will learn the following:

- To explain basic concepts related to the design and analysis of algorithms
- To describe classical algorithms and their complexity.
- To design and analyse selected algorithms.

Syllabus

1. Introduction [8 **Hrs**]

What is an Algorithm?, Rules for writing Algorithms, Properties of Algorithms, Framework for design and analysis of algorithms(RAM model of computation),Recursive Algorithms, Space and Time Complexity by Tabular method(Performance Analysis).

2. Divide and Conquer [7 **Hrs**]

Elements of Divide and Conquer Algorithms, QuickSort algorithm, Merge sort analysis, Strassen's algorithm for matrix multiplication, Analysis of Binary Search,The Maximum subarray Problem.

3. Dynamic programming [8**Hrs**]

General Method, caching v/s computation, Fibonacci numbers by recursion, Fibonacci numbers by cashing, Fibonacci numbers by dynamic programming,Optimal Binary Search Tree,Rod Cutting Problem.

4. Greedy algorithms [5**Hrs**]

Elements of greedy strategy, Activity-selection problem, Job sequencing with deadlines.

Knapsack problem.

5. Basic Traversal and Search Technique [7 **Hrs**]

Techniques for Binary Trees, Techniques for Graphs(Breadth First search and Traversal, Depth First Search and Traversal)

6. Graph Algorithms [6**Hrs**]

Elementary graph algorithms- Minimum spanning tree, growing a spanning tree, Kruskal and Prim algorithms.

7. Complexity Classes [2 **Hrs**]

Introduction to polynomial time algorithms, NP, NP Complete, NP Hard

8. Introduction to Randomisation and approximation. [2 **Hrs**]

Text books

Thomas H. Cormen, charles E. Leiserson, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, “Introduction to Algorithms”, EEE, PHI, Third Edition

Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, “Fundamentals of Computer Algorithms”, Galgotia, 2nd Edition

Reference Books

A. Aho, J. Hopcroft, J. Ullman, “The Design and Analysis of Computer Algorithms”, Pearson Education, Eighth Edition

<u>Lab : Design and Analysis of Algorithms</u>

Credit : 1

Marks : 25

Lab Assignments are to be done using a Programming Language for the following :

1 Program to find GCD of 2 numbers using Iterative approach and Recursive approach
2 Program for quickSort
3 Program to perform Binary Search using Recursive approach
4 Program to generate Fibonacci numbers using Dynamic Programming approach.
5 Program to implement Activity Selection Problem.
6 Program to implement job sequencing with Deadlines.
7 Program to implement Knapsack Problem
8 Program to implement Rod Cutting Problem.
9 Program to implement Binary Tree.
10 Program to implement Optimal Binary Search Tree.
11 Program to represent graph using matrix.
12 Program to represent graph using Linked List.
13 Program to implement BFS/DFS Traversal on graph.
14 Program to implement Kruskal's Algorithm
15 Program to implement Prim's Algorithm

****

Course Title: Data Base Application Development

Course Code: COM-IV.E-6

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisites: - Data Base Management Systems

Course Objectives:
To provide advance database solutions.

Learning outcome:
On completion of the course student will learn:

- Advance SQL
- Concept of Big data.
- Developing a database application.

Syllabus

1**. Advanced SQL** [15 **Hrs**]

SQL data types and schemas, Integrity constraints, Authorization, Embedded SQL, Dynamic SQL, Triggers, Stored Procedures, views

2**. Indexing and Hashing** [7 **Hrs**]

Basic concepts**,** Ordered Indices, Dense and Sparse Indices. B and B+ trees Hashing – Static hashing, Dynamic Hashing, Extendable hashing, Comparison of Ordered Indexing and Hashing.

3. Transaction, Concurrency Control, Recovery System. [10 **Hrs**]

Transaction: Transaction concept, Transaction state, Implementation of Atomicity and Durability, concurrency. Serializability, conflict serializability.

Concurrency Control : Lock-Based Protocol

Recovery System: Failure Classification, Storage structure, Stable storage implementation, Recovery and Atomicity: Log-Based Recovery.

4. Introduction to Big data and NoSQL [13**Hrs**]

Introduction to the Big Data problem. Current challenges, trends, and applications

Comparison between SQL and NOSQL Databases

Types and examples of NoSQL databases- Column, Document, Key-value, Gtraph, Multi-model

Introduction to Document type NoSQL database such as MongoDb. - Introduce concepts of collection and documents, Advantages, Data types, Projections, indexing, Sharding .

Text Book:

A Silberschatz, H F Korth, S Sudarshan, *Database system concepts*, McGraw-Hill ,sixth Edition

Reference Books :
Ramakrishan, J Gehrke, "*Database management systems"*, McGraw-Hill , 3rd edition
R Elmasri, S B Navathe, "*Fundamentals of database Systems"*, Pearson Education , 5th Edition
Kristina Chodorow *MongoDB : The Definitive Guide (English)* O'Reilly 2nd Edition

Lab : Database Application Development

Credits : 1

Marks : 25

Practical should cover following concepts

1. SQL Revision
2. Advance SQL- Dynamic SQL, Triggers
3. Advance SQL- Stored Procedures
4. Using ODBC API for insertion of record into database.
5. Using ODBC API for deletion of record.
6. Using ODBC API for modification of data.
7. Using ODBC API for data retrieval.
8. Installing and Creating a document using MongoDb concept
9. Performing Indexing using MongoDb
10. Performing aggregation functions on MongoDb
11. Implementation of Master-Slave approach.
12. Connection of MongoDb using Java
13. Insertion, modification, deletion using MongoDb

14. Data retrieval using MongoDb
15. Shrading using Java and MongoDb.

Course Title: Server Side Programming

Course Code: COM-IV.E-7

Marks: 75

Credits : 3

Duration: 45 Hrs.

Prerequisite Courses:

Object Oriented Programming (COM-II.C-3)

Software Engineering (COM-III.E-1)

Course Objectives:

- Provide an in depth understanding of object oriented approaches to software development, in particular to the analysis and design phases of the software life cycle.
- Design and implement basic server-side scripts
- Create data documents using XML
- Create and manipulate databases using SQL and server side technologies Understand how rich internet applications are implemented using AJAX and XML/JSON.

Learning Outcomes:

- Understand the basic underlying concepts in World Wide Web: web server, 3-tier web applications, server side scripting and programming languages, rich internet applications, AJAX and web services
- Understand and apply supporting and emerging web technologies: access to databases, AJAX, rich client user interfaces.

Syllabus

Review of OOAD: **[6 Hrs]**

Object Oriented Concepts - Class, Object, member variable, member function, Inheritance, Polymorphism,

overloading, Data Abstraction, Encapsulation.
Review of object oriented design and modeling

Server-side technologies: **[15 Hrs]**

Static vs. Dynamic web pages, Need for Server Side technologies, Multitier Web Architecture. Common Gateway Interface standard, server-side includes, server APIs, server-side scripting – working principles, and implicit objects. Database and file access. Comparison of Web servers.

Ajax-Enabled Rich Internet Applications with XML and JSON **[15 Hrs]**

AJAX – introduction, purpose, advantages and disadvantages. Key elements of AJAX – introduction to XML. XML processing with server sidescript. XSL, transforms and templates. The XMLHttpRequest object – methods and properties. Creating and using XMLHttpRequest objects. Using XSLT with AJAX.

JSON – Syntax, mixing literals, Array, object, encoding/decoding, JSON versus XML, server-side JSON tools.

Web Services: **[9 Hrs]**

Introduction, its role. Basics – Creating, Publishing, Testing and Describing a Web services (WSDL)-Consuming a web service. SOAP - introduction, requests and responses. Role of UDDI – accessing registries. REST based web services – building, deploying and consuming

Reference Books:

1.Andrea Steelman and Joel Murach, Murach's Java Servlets and JSP, 2nd Edition

2.Bryan Basham and Kathy Sierra, Head First Servlets and JSP

3.Dana Moore, Edward Benson, Professional Rich Internet Applications: Ajax And Beyond (English), Wiley India

4. Schmelzer, XML and Web Services Unleashed, Pearson India

Lab : Server Side programming

Credit : 1

Marks : 25

List of suggested **PRACTICALS** (the numbers in brackets indicate number of practicals)

1)Using server side programming and following OOAD principles develop a dynamic web application. [11 P]

2) Add AJAX and Web service(s) to the application. [4 P]

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Course Title: Human Computer Interface

Course Code: COM-IV.E-8

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisites: Nil

Course Objectives:

To study the different aspects of human computer interaction and the computer interface design concepts.

Learning Outcomes

- To understand the intricacies of human interaction with a computer System
- To understand the concept of a graphical user interface, and its design characteristics
- To recognize the human element its strengths and weakness for computer interaction

- To know the principles of good screen design and layouts
- To know the different navigation schemes on windows based interface; learn the different types of selection devices and components of a window based interface
- To know the different types of interaction devices and media

Syllabus

1. Introduction: Human-Computer Interaction, Evaluating Designs, The Birth of HCI. Importance of user Interface, Importance of good design, Benefits of good design, principles & heuristics of good design [4 **Hrs**]
2. Human interaction with computers, Importance of : Human characteristics, Human consideration, Human interaction speeds, Understanding business functions. User centred design- Need-finding: Participant Observation, Interviewing, Additional Need finding, contextual inquiry & persona. [6 **Hrs**]
3. Rapid Prototyping: story boarding. Paper Prototyping and Mockup, Video Prototyping, Creating and Comparing Alternatives [5**Hrs**]
4. Direct Manipulation and Representations: various user interaction models- command, menu, Direct Manipulation. Mental Models. Heuristics (guidelines) for design. [7**Hrs**]
5. Graphical Interface Design: Graphical user interface, standards such as Microsoft windows HCI guidelines, Windows: Navigation schemes selection of window; Selection of devices based and screen based controls, Components, Text and messages, Icons, Multimedia, Colors., controls, Help & error messages design. [8**Hrs**]
6. Web user interface design – jessy James Garette five layers of user experience. [4**Hrs**]
7. Heuristic Evaluation: Heuristic Evaluation — Why and How? [4**Hrs**]
8. visualization, Amount of information, Focus and emphasis, Presentation information simply and meaningfully, Information retrieval on web, Statistical graphics [7**Hrs**]

<u>Text books:</u>

1. Alan Cooper & Robert Reimann, About Face 2.0: The Essentials of Interaction Design, Wiley
2. Alan Dix, Janet Finlay, Gregory D. Abowd, and Russell Beale, Human-Computer Interaction (3rd Edition), Pearson, 2004.
3. Ben Shneiderman and Catherine Plaisant, Designing the User Interface: Strategies for Effective Human-Computer Interaction (5th Edition), 5th ed., Pearson Addison-Wesley, 2009
4. Donald A. Norman, The Design of Everyday Things, Basic Books, 2002

Lab : Human Computer Interface

Credit : 1

Marks : 25

Suggested list of practical (Numbers in brackets indicate number of practicals)

1. Paper Prototyping using templates (1 P)
2. Conducting survey interview and summarizing the result(1 P)
3. Persona- conducting contextual interview and developing persona(1 P)
4. GUI design- form design, menu design, help, error messages(2 P)
5. Web UI design- pages, navigation, controls, (Ajax) (2 P)
6. Report designs (2 P)
7. Visualization and info graphics (1 P)
8. Heuristic evaluation(2 P)
9. Story boarding (1 P)

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Annexure V

Parvatibai Chowgule College of Arts and Science (Autonomous)

DEPARTMENT OF COMPUTER SCIENCE

COURSE STRUCTURE

THREE YEAR B.Sc. DEGREE COURSE IN COMPUTER SCIENCE

COMPONENT A:

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	**COM-I.C-1** Mathematical foundation of Computer Science – I	**COM-I.C-2 *** Introduction to Programming	---	---	---	---
II	**COM-II.C-3 **** Object Oriented Programming	**COM-II.C-4 *** Data Structures	---	---	---	---

III	**COM-III.C-5 *** Data Base Management Systems	---	**COM-III. E-1** Software Engineering	**COM-III. E-2** Digital Logic Design	**COM-III. E-3** Mathematical Foundation of Computer Science - II	**COM-III. E-4** Web Designing
IV	**COM-IV.C-6** Computer Architecture and Organization	---	**COM-IV. E-5** Design & Analysis of Algorithms	**COM-IV. E-6** Data Base Application Development	**COM-IV. E-7** Server Side Programming	**COM-IV. E-8** HCI
V	**COM-V.C-7 *** Operating Systems	---	**COM-V. E-9** Embedded Systems	**COM-V. E-10** Mobile Application Development	**COM-V. E-11** Introduction to Data Science	**COM- V. E-12** Software Testing

VI	**COM-VI.C-8 *** Computer Networks	---	**COM-VI. E-13** Network Security	**COM-VI. E-14** Cloud Computin g	**COM-VI. E-15** Multimedia Techniques	**COM-VI. E-16** Digital Marketing

Note: * Core Compulsory Courses also offered for minor subject combination.

** Core Compulsory Courses also offered for minor subject combination in 4th Semester.

COMPONENT B:

3. **GENERAL COMPULSORY (GC-B) -** a. Cyber Security

2. **INTERDISCIPLINARY (GC-E) –** a. Multimedia

   b. Web Designing

T.Y.B.Sc. Computer Science – Syllabus

(from Academic Year 2018-19)

Semester V

Course Title: Operating Systems

Course Code: COM-V.C-7

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisite Courses :

- Introduction to Programming(COM-I.C-2)
- Data structures(COM-II.C-4)

Course Objectives:

This course aims at understanding functions of operating system. As part of the course students will study different aspects of operating system such as Memory management, CPU scheduling, Concurrency, Storage management etc.

Learning Outcomes:

On completion of the course

- Students will understand Memory Management
- Students will become familiar with different CPU scheduling algorithms
- They will learn about how concurrent transactions are handled by operating system.
- Students will be able to implement algorithms for CPU scheduling, memory management, Deadlocks etc.

Syllabus :

1. **Introduction to Operating System:** [4 **Hrs**]

Basic elements of a computer system: Processor, Main Memory, I/O Modules, System Bus, Instruction Execution; Operating Systems: Definition, Operating system Structure, operating system operations, Relationship between Kernel, OS, and Hardware, Operating system services, System calls, Types of system calls, System programs.

2. **Process Management:** **[10 Hrs]**

Process Definition, Process Control Block, Process States, Operations on Process; Interprocess communication, Threads and Microkernels: Definition, Multi-threading Model Process Scheduling, Scheduling Criteria, Scheduling Algorithms, Multi-Processor Scheduling;

3. **Process Coordination** **[10 Hrs]**

Process Synchronization, Principles, Mutual Exclusion, The Critical-Section Problem, Petersons Solution, Semaphores, Monitors, Readers/Writers Problem; Classic Problems of Synchronization, Dining Philosopher's problem

Deadlocks- system models, Deadlock characterization , Deadlock Handling Methods, Prevention, Avoidance, Detection, Recovery From Deadlock

4. **Memory Management:** **[13 Hrs]**

Introduction, Swapping, Contiguous Memory Allocation, Paging, Page Table, Segmentation

Virtual Memory: Introduction, Demand Paging, Page Replacement, Allocation of Frames, Thrashing

5. **Storage Management** **[5 Hrs]**

File System, Concepts, File Organization and Access Methods, Directory and Disk Structure.

Secondary Storage Structure - Overview, disk structure, Disk attachment, Disk scheduling

6. **Protection and Security** **[3 Hrs]**

System Protection :Goals of protection, Principles, domain of protection, Access Matrix, Implementation of Access Matrix.

Text Book:

1. A. Silberchatz, Galvin, Gagne, 2008, Operating System Concepts, Wiley publication 8^{th} Edition.

Reference Book:

William Stallings, Operating Systems: Internals and Design Principles,Prentice Hall, 6^{th} Edition

Lab : Operating Systems
Credit : 1
Marks : 25

Suggested list of Practical

1. Demo/Review of Installing Linux / Windows Operating System, Partitioning and formatting disk, Installing applications device drivers, working with files, mounting file systems, checking system space, creating, modifying and deleting user accounts (1P)
2. Study of Basic commands of Linux. (1P)
3. Shell Programming in Unix/Linux, arithmetic operations, loops (1P)
4. Shell Programming – advanced (1P)
5. Menu Driven Shell scripting (1P)
6. Filters and Pipes in LINUX (1P)

7. Implementation of Inbuilt Linux/UNIX commands like cp, rename etc. (1P)
8. Implementation of CPU scheduling policies (3P)
9. Implementation of Memory allocation techniques: (2P)
10. Implementation of Banker's algorithm. (Resource Allocation Graph) (1P)

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Course Title: Embedded Systems

Course Code: COM-V.E-9

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisite Courses:

- Digital Logic Design(COM-III.E-2)
- Knowledge of Programming

Course Objectives:

- To have a thorough understanding of Embedded Systems and their applications.

Learning Outcome:

After completion of the course students will be able to:

- Gain knowledge about the world of Embedded Systems, their characteristics and applications.
- Understand the function and use of Embedded System hardware and Interfacing I/O devices.
- Identify various sensors, actuators and their use.

- Understand the need for Real Time Operating Systems
- Develop Embedded Applications.

Syllabus :

1. **Introduction: [6 Hrs]**

   Introduction to Embedded Systems, Microprocessors and Micro-controllers. Components of Embedded System & its Classification, Characteristic of embedded system.

   Introduction to embedded processor, Digital Signal Processor, Application Specific System Processor, Design Process in Embedded System, Design metrics, Steps in design process. Challenges in Embedded System design, Design Examples. Advances in Embedded Systems.

2. **System hardware: [10 Hrs]**

   System hardware, Interrupt structure and Applications, ARM Processor - Architecture, Programmer's model, Modes of operation, Interrupt**,** Handling Interrupts, Comparison of ARM7 & ARM9.
   Components of Embedded Systems**-**Management of Power Supply, Clocking Unit, Real Time Clock and Timers, Reset Circuitry and Watchdog Timer. Processor and Memory Selection, Memory Map of Embedded System, Interfacing Processors, Memories and I/O – Analog vs Digital. Overview of Arduino, Intel Edison and Raspberry Pi boards.

3. **Sensors and Actuators (Overview): [12 Hrs]**

   Sensors / Transducers: Principles – Classification – Parameters – Characteristics – Environmental Parameters (EP) – Characterization.

   Thermal Sensors: Introduction – Gas thermometric Sensors – Thermal Expansion Type Thermometric Sensors.

   Magnetic sensors: Introduction – Sensors and the Principles Behind – Magneto-resistive Sensors, Semiconductor Magnetoresistors.

   Smart Sensors: Introduction – Primary Sensors – Excitation – Amplification – Filters – Converters – Compensation – Information Coding/Processing - Data Communication – Standards for Smart Sensor Interface – The Automation.

   Sensors Applications: Introduction – On-board Automobile Sensors (Automotive Sensors) – Home Appliance Sensors – Aerospace Sensors — Sensors for Manufacturing – Sensors for environmental Monitoring.

Actuators: Overview of Pneumatic and Hydraulic Actuation Systems, Mechanical Actuation Systems, Electrical Actuation Systems

4. **I/O Interfacing and Communication: [10 Hrs]**
   I/O interfacing and Communication Buses, Serial vs Parallel Communication, Serial Data Communication RS-232/UART.
   I/O devices, ADC / DAC, Optical Devices such as LED / LCD Display devices, Opto-Isolator, Relays, DC motor, Stepper motor, Timers/Counters, Parallel ports - Device interfacing.
   Serial communication Protocols - UART Protocols, I^2C, CAN, USB & ZigBee – Protocol Architecture, Topology, Packets, Communication Cycle, Arbitration, Applications and comparison.

5. **Internet of Things (IoT): [3 Hrs]**
   Introduction to IoT, **M2M to IoT**-The Vision-Introduction, M2M towards IoT- the global context, IoT **Architectural Overview, Potential and Challenges.**

   1. **Real Time Operating System: [4 Hrs]**
   Introduction to RTOS, architecture of kernel, task and task scheduler, interrupt service routines in RTOS Environment.

Text Books

1. Rajkamal, "Embedded Systems – Architecture, Programming and Design", Tata McGraw Hill, Second Edition, 2008.
2. D. Patranabis, "Sensors and Actuators", 2nd Ed., PHI, 2013.

Reference Book:

1. Dr. K. V. K. K. Prasad, "Embedded / Real Time System : Concepts, Design, & Programming – Black Book‖", Dreamtech Press Publication.
2. David E Simon, "An Embedded Software Primer", Pearson India, 1st Edition.
3. Tammy Noergaard, "Embedded Systems Architecture", Elsevier
4. D. Patranabis, "Sensors and Transducers", PHI Learning Private Limited.
5. Dr. K. V. K. K. Prasad, Gupta Dass, Verma, "Programming for Embedded system", Wiley – Dreamtech India Pvt. Ltd.

6. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.

Lab : Embedded Systems

Credit: 1

Marks: 25

Programs to be executed on some of the embedded boards like Arduino, Intel Edison, Raspberry Pi, Bolt, etc., that covers the following tasks:

1) Interfacing sensors (3P)
2) Interfacing output devices (1P)
3) Interfacing input devices (1P)
4) Interfacing actuators (1P)
5) Building obstacle avoiding Robot (1P)
6) Line Following Robot (1P)
7) Programming with Raspberry Pi (2P)
8) Monitoring Data over Cloud (1P)
9) Building Web app to control devices. (1P)
10) Mini Project

****

Course Title: Mobile Application Development

Course Code: COM-V.E-10

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisite Courses :

- Object Oriented Programming(COM-II.C-3)

- Web Designing(COM-III.E-4)

Course Objective:

Students learn how to develop applications for mobile devices, including smart phones and tablets. Students are also introduced to the current mobile platforms, mobile application development environments and mobile device input methods. Students will design and build a variety of apps on a popular platform throughout the course to reinforce learning and to develop real competency.

Learning Outcome :

Upon successful completion of the course, the student will demonstrate the ability to:

1. Explain mobile devices, including their capabilities and limitations.
2. Review current mobile platforms and their architectures.
3. Develop mobile applications on a popular mobile platform.
4. Evaluate development with another mobile platform.

Syllabus :

Introduction to mobile devices [3 Hrs]

Mobile devices vs. desktop devices, Why we Need Mobile App, Different Kinds of Mobile Apps, ARM and intel architectures, Power Management, Screen resolution, Touch interfaces, Application deployment - App Store, Google Play, Windows Store, Development environments – Android Studio, PhoneGAP, Native vs. web applications.

Review of HTML5/JS/CSS3 [2 Hrs]

Quick recap of technologies, Mobile-specific enhancements, Browser-detection, Touch interfaces, Geolocation, Screen orientation, Mobile browser “interpretations” (Chrome/IE).

Mobile OS Architectures **[3 Hrs]**

Comparing and Contrasting architectures of Android, iOS and Windows, Underlying OS(Darwin vs. Linux vs. Windows), Kernel structure and native level programming, Runtime (Objective-C vs. Dalvik vs. WinRT), Approaches to power management, Security.

Android overview **[2 Hrs]**

Introduction to Android.Overview of android stack, Introduction to OS layers, Android features.

Linux Kernel, Libraries, Android Runtime, Application Framework, Dalvik VM

Android Components – Introduction **[3 Hrs]**

Activities, Services, Broadcast Receivers, Content Providers.

Building UI with Activities **[4Hrs]**

Activities, Views, layouts and Common UI components, Creating UI through code and XML,

Activity life cycle, Intents, Communicating data among Activities.

Advanced UI **[5Hrs]**

Selection components (GridView, ListView, Spinner), Adapters, Custom Adapters, Menus,

Toast, Custom Toast,Dialogs, Status bar Notifications.

Multithreading **[4 Hrs]**

Using Java Mutithreading classes, AsyncTask, Handler, Post.

Intent, Intent Filters and Broadcast Receivers **[4 Hrs]**

Role of filters, Intent-matching rules, Filters in your manifest, Filters in dynamic Broadcast

Receivers, Creating Broadcast receiver, Receiving System Broadcast, Understanding Broadcast action, category and data, Sending Broadcast.

Data Storage **[5 Hrs]**

Shared Preferences, Android File System, Internal storage, External storage. SQLite Introducing SQLite, SQLiteOpenHelper and creating a database, Opening and closing a database, Working with cursors, inserts, updates, and deletes.

Content Providers **[5 Hrs]**

Accessing built in content providers, Content provider MIME types, Searching for content, Adding, changing, and removing content, Creating content provider, Working with content files.

Services **[5 Hrs]**

Overview of services in Android, Implementing a Service, Service lifecycle, Inter Process Communication (AIDL Services).

Web Services and WebView - Consuming web services, Receiving HTTP Response (XML, JSON), Parsing JSON and XML, Using WebView.

Reference books:

1. Beginning Android 4 Development, Wei-Ming Lee(John Wiley & Sons)
2. Pro Android 4 ; Satya Komateneni, Dave MacLean (Apress)
3. Hello Android - Introducing Google's Mobile Development platform - Ed Brunette (The Pragmetic Bookshelf)
4. Android Apps with Eclipse 1st Edition, Onur Cinar(Apress)
5. Android- A Programmer'S Guide, Dimarzio, J.F.(Tata McGraw Hill)

Web References:

1. http://developer.android.com/index.html
2. http://www.appinventor.org/

Lab : Mobile Application Development

Credit: 1

Marks: 25

<u>List of practicals</u>

1. Getting Started with Android – Installing the Development Environment, Configuring Android Stack
   (1P)
2. Creating the First Android Application - Creating a Simple Android Project, Debugging Application through DDMS. setting up environment. AVD Creation, Executing Project on Android Screen. (1P)
3. Android application development - Use of GUI components to implement a simple application such as a Calculator. (1P)
4. Review the earlier application making use of the advanced UI components. (1P)
5. Implementing Data storage application - an application to make Insert , update , Delete and retrieve operation on the database. (2P)
6. Understanding content providers and permissions: Read phonebook contacts using content providers and display them suitably. (1P)
7. Optimizing your app performance with Services/Multithreading/Multiprocessing

   (2P)
8. Course Project (3P)

****

Course Title: Introduction to Data Science

Course Code: COM-V.E-11

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisite courses:

Students are expected to have basic knowledge of algorithms and reasonable programming experience, and some familiarity with basic linear algebra and basic probability and statistics.

Course Objectives:

Become familiar with methods of data science and their practical usefulness.

Learning outcomes:

At the conclusion of the course, students should be able to:
• Describe what Data Science is and the skill sets needed to be a data scientist.
• Explain in basic terms what Statistical Inference means. Identify probability distributions commonly used as foundations for statistical modeling. Fit a model to data.
• Use R to carry out basic statistical modeling and analysis.

<u>Syllabus :</u>

Introduction **[4 Hrs]**

What is Data Science?,Big Data and Data Science hype -and getting past the hype, Why now? –Datafication,Current landscape of perspectives,Skill sets needed

Statistical Inference [6 **Hrs**]
Populations and samples,Statistical modeling, probability distributions, fitting a model, Intro to R

Exploratory Data Analysis and the Data Science Process [6 **Hrs**]
Basic tools (plots, graphs and summary statistics) of EDA,Philosophy of EDA, The Data Science Process, Case Study: RealDirect (online real estate firm)

Three Basic Machine Learning Algorithms [6 **Hrs**]
Linear Regression,k-Nearest Neighbors (k-NN),k-means

Feature Generation and Feature Selection (Extracting Meaning From Data) [6 **Hrs**]
Motivating application: user (customer) retention,Feature Generation (brainstorming, role of domain expertise, and place for imagination) , Feature Selection algorithms ,Filters; Wrappers; Decision Trees; Random Forests

Mining Social-Network Graphs [6 **Hrs**]
Social networks as graphs,Clustering of graphs,Direct discovery of communities in graphs, Partitioning of graphs, Neighborhood properties in graphs

Data Visualization [6 **Hrs**]
Basic principles, ideas and tools for data visualization,Examples of inspiring (industry) projects, Exercise: create your own visualization of a complex dataset

Data Science and Ethical Issues [5 **Hrs**]
Discussions on privacy, security, ethics, A look back at Data Science,Next-generation data scientists

Text Book:

Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline, O'Reilly, 2014.

References Books :

• Jure Leskovek, Anand Rajaraman and Jeffrey Ullman, Mining of Massive Datasets v2.1, Cambridge University Press, 2014 (free online)

• Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, ISBN 0262018020, 2013.

• Foster Provost and Tom Fawcett, Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking, ISBN 1449361323, 2013.

• Trevor Hastie, Robert Tibshirani and Jerome Friedman. Elements of Statistical Learning, Second Edition, ISBN 0387952845, 2009 (free online)

• Avrim Blum, John Hopcroft and Ravindran Kannan. Foundations of Data Science. (Note: this is a book currently being written by the three authors. The authors have made the first draft of their notes for the book available online. The material is intended for a modern theoretical course in computer science.)

• Mohammed J. Zaki and Wagner Miera Jr, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, 2014.

• Jiawei Han, Micheline Kamber and Jian Pei, Data Mining: Concepts and Techniques, Third Edition, ISBN 0123814790, 2011.

Lab : Introduction to Data Science

Credit: 1

Marks: 25

List of practicals

1: Implementation of probabilty distribution	[1P]
2: Sampling and re-sampling.	[1P]
3: Linear Models	[1P]
4: K-Nearest neighbour	[2P]
5: K-Means	[1P]
6: Feature Selection Algorithm	[2P]
7: Filters and Wrappers	[1P]
8: Decision Trees	[1P]

All the experiments will be implemented using Excel /R-Tool/ or equivalent.

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Course Title: Software Testing

Course Code: COM-V.E-12

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisite courses: Introduction to Programming (COM-I.C-2)

Course Objectives:

- To study fundamental concepts in software testing, including software testing objectives, process, criteria, strategies, and methods.
- To discuss various software testing issues and solutions in software unit test; integration, regression, and system testing.
- To learn how to plan a test project, design test cases and data, conduct testing operations, manage software problems and defects, generate a testing report.

Learning Outcomes:

On Completion of this course the student will:

- Have an ability to understand and identify various software testing problems, and solve these problems by designing and selecting software test models, criteria, strategies, and methods.
- Have an ability to use software testing methods and modern software testing tools for their testing projects.

Syllabus :

Software testing principles - Software Testing- Need for testing, Psychology of testing**,**Testing economics**,** SDLC and Testing**,**Verification & Validation**.**Quality Assurance, Quality Control **[3 Hrs]**

Testing strategies and types - White box testing techniques - Statement coverage, Branch Coverage , Condition coverage, Decision/Condition coverage , Multiple condition coverage, Dataflow coverage, Automated code coverage analysis, Inspections, Walkthroughs Code Review **[5 Hrs]**

Black box testing techniques - Boundary value analysis**,**Robustness testing **,**Equivalence partitioning**,**Syntax testing**,**Finite state testing**,**Levels of testing**,**Unit, Integration and System Testing**,**Compatibility Testing**,**Domain Testing**,**Adhoc Testing **,**Use of Requirement,Traceability Matrix **[6 Hrs]**

Integration Testing Waterfall - Top-down ,Bottom up ,Big bang,Sandwich **[3 Hrs]**

System and Performance Testing - Types of system testing ,Functional and non-functional testing Acceptance Testing ,Setting entry and exit criteria for phases and typical product release scenarios , Basic factors governing performance testing, Methodology for performance testing ,Tools for performance testing **[4 Hrs]**

Regression Testing - Purpose **,**Timing, Choice of tests **,**Smoke tests **,**Best practices **[3 Hrs]**

Internationalization and Localization testing - Preliminary concepts,Adhoc testing,Pair testing, Extreme testing, Agile testing, Exploratory testing,Defect seeding **[3 Hrs]**

Usability Testing - Factors in usability testing ,Aesthetics testing ,Accessibility testing ,Tools for usability testing **[3 Hrs]**

Testing object oriented software - Definitions and Challenge differences from testing non-OO Software,Class testing strategies Class Modality,State-based Testing,Message SequenceSpecification **[4 Hrs]**

People and organizational issues in testing - Common people issues and myths in testing, Providing career paths in testing,Organizational structures for testing teams,Geographically distributed testing teams and success factors **[6 Hrs]**

Test Management and Automation- Test Planning,Test Management,Test Process,Test Reporting,Test Automation,Factors to consider in automation,Challenges in test automation,Test Metrics,Product Metrics,Process Metrics,Progress Metrics
Use of metrics in ascertaining product release **[5 Hrs]**

References:

1. 1.Software Testing- Principles and Practices ,Srinivasan Desikan and Gopalaswamy Ramesh , Pearson Publication
2. Integrated Approach to Software Engineering , Pankaj Jalote, Narosa Publishing House
3. Software Engineering – A Practitioners Approach, Roger Pressman, McGraw Hill Publication

Lab: Software Testing
Credit: 01
Marks: 25

List of suggested **PRACTICALS** using any testing tool such as Selenium or equivalent :

1. Planning Test Cases (1P)
2. Generating Test Cases/Test Suite (2P)
3. Enhancing Tests (3P)
4. Debugging Tests (2P)
5. Running Tests (2P)
6. Analyzing Results (1P)
7. Reporting Defects (1P)

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Semester VI

Course Title: Computer Networks

Course Code: COM-VI. C-8

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisite Courses :

- Introduction to Programming (COM-I.C-2)
- Object Oriented Programming (COM-II.C-3)

Course Objectives:

- To understand the basic concepts of Computer Networking
- Be familiar with the components required to build and design different types of networks.

Learning outcome:

- Gain Knowledge of the Reference models
- Understand basic concepts of data transmission over wired medium Compare various routing, transport protocols and Identify suitable protocol for a given network.
- Able to design the basic Computer network and maintain the networks
- Develop client server programs for different applications

Syllabus :

1. Introduction **[8 Hrs]**

Basics of Computer Networks, Classification: transmission technology, scale; Applications; Data Communications: data, signal, bandwidth, bit interval and bit rate, Modes of Communication.

Layered network architecture, Networks models: OSI model, TCP / IP protocol suite; Guided and Unguided Transmission media, Multiplexing: FDM, TDM. Switching: Circuit switching, message switching, Packet Switching.

2. Data link layer [12 Hrs]

Data link control: Framing:Character Count, Character Stuffing, Bit Stuffing; , Error Detection and correction, Flow and error control, HDLC; Multiple access: Random access – Controlled access , ALHOA, CSMA, CSMA/CD and CSMA/CA; Ethernet : IEEE standards, standard Ethernet, Fast Ethernet, Gigabit Ethernet; Connecting devices: repeater/hub, bridge, router and gateway, Backbone networks - Virtual LANS

3. Network layer [14 Hrs]

Functions of Network layer; Network Service types: Virtual Circuits, Datagrams; Logical addressing: IPv4, private and public IP addressing, special IP addresses, subnetting, IPV6 addressing Internet Protocol: Internetworking:IPv4, Fragmentation and reassembly , Address mapping : ARP, RARP, BOOTP, DHCP, ICMP . Routing: classification of routing, Shortest path routing, Distance Vector routing, Link State routing;

4. Transport layer and Application layer [9 Hrs]

Process-to-Process delivery: User Datagram Protocol (UDP), Transmission ControlProtocol (TCP), Quality of services (QoS); Application Layer: Domain Name System (DNS) , E-mail, FTP, HTTP.

5. Wireless Networks [2 Hrs]

Basics of wireless networking.

TEXT BOOK:

1. Andrew S. Tanenbaum, David J. Wetherall "Computer Networks", Prentice-Hall, 5th Edition.

REFERENCES:

1. Behrouz A. Forouzan, "Data communication and Networking", Tata McGraw – Hill, 2011, 4th Edition.
2. James F. Kurose, Keith W. Ross, "Computer Networking – A Top-Down Approach Featuring the Internet", Pearson Education, 2009, 5th Edition,
3. Nader. F. Mir, "Computer and Communication Networks", Pearson Prentice Hall Publishers, 2010.
4. Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, "Computer Networks: An Open Source Approach", Mc Graw Hill Publisher, 2011.
5. Larry L. Peterson, Bruce S. Davie, "Computer Networks: A Systems Approach", Morgan Kaufmann Publishers, 2011, 5th Edition

Lab : Computer Networks
Credits : 1
Marks : 25

List of Practicals

1. Installing virtual machines, Ethernet cabling
2. Study of network commands ping, ipconfig, netstat, traceroute
3. Setting up of LAN Network
4. IP address manipulation -Extract network id and Host id given netmask
5. Mini Project / Packet capture tool/ packet generator tool
6. UDP Socket programming (c/c++/Java/ perl)
7. TCP Socket programming -I
8. Configuring VLAN (DLink Switch)/ TCP Socket programming –II
9. Configuring routing tables
10. Configuring DHCP server/client
11. Mini Project / Simulation of IP fragmentation
12. Mini Project/Configuring E-Mail/DNS

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Course Title: Network Security

Course Code: COM-VI. E-13

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisite Courses:

Introduction to Programming(COM-I.C-2)/Object Oriented Programming(COM-II.C-3)

Course Objectives:

- To understand the theory and concepts of Network Security

Learning outcome:

- Gain Knowledge of the threats, vulnerabilities and system risks
- Understand cryptography, ciphers and encryption algorithms
- Know about viruses, Trojan horses, worms, program flaws and the defenses against them

Syllabus :

1. Concepts of Security & Classical Encryption Techniques [8 Hrs]

Introduction, The need for security, Security Approaches, Security Attacks, Security Services, Security Mechanisms, A Model for Network Security. Symmetric Cipher Models – Substitution techniques, Transposition techniques, Steganography, Block Cipher Operation, Electronic Code Book, Cipher Block Chaining, Block Cipher Principles, The Data Encryption Standard

2. Public Key Cryptography and Cryptographic Hash Functions [8 Hrs]

Introduction To Number Theory, Modular Arithmetic, Prime Numbers, Euler's Totient Function, Principles of Public Key Cryptosystems, The RSA Algorithm, Other Public key cryptosystems, Diffie Hellman Key Exchange.

Applications of Cryptographic Hash Functions, Two Simple Hash Functions, Hash Functions Based on Cipher Block Chaining, MD5 Message Digest Algorithm, Secure Hash Algorithm SHA 512.

3. Message Authentication Codes and Digital Signatures [8 Hrs]

Message Authentication Requirements – Message Authentication Functions –Requirements for Security of MACs, MACs Based on Hash Functions, HMAC, MACs Based on Block Ciphers, Data Authentication Algorithm. Digital Signatures, Digital Signature Standard.

4. Key Management & Distribution And User Authentication [8 Hrs]

Introduction, Digital Certrificate,Private key Management, The PKIX Model,Public key cryptographic standards,XML,PKI and security

5. Program Security [7 Hrs]

Flaws, Malicious code: viruses, Trojan horses, worms, Program flaws: buffer overflows, time-of-check to time-of-use flaws, incomplete mediation. Defenses: Software development controls, Testing techniques.

6. Firewall and Virtual Private Network [6 Hrs]

Introductionto network security techniques: IP Security, firewalls, virtual private networks.

TEXT BOOKS:

1. William Stallings, —Cryptography and Network Security – Principles and Practices‖, Prentice Hall of India, Fifth Edition

2. Kahate Atul, "Cryptography and Network Security" Tata McGraw-Hill.

3. Charles P. Pfleeger and Shari L. Fleeger, —Security in Computing‖. Prentice-Hall.2003, (3rd edition)

4. Menezes A. J., P.C. Van Oorschot and S.A. Vanstone, "Handbook of Applied Cryptrography"

Lab : Network Security

Credits : 1

Marks : 25

List of Practicals

1. Implementation of Caesar Cipher
2. Implementation of One-Time Pad
3. Implementation of Playfair Cipher
4. Implementation of Hill Cipher
5. Implementation of Data Encryption Standard Algorithm
6. Implementation of Image Steganography
7. Implementation of RSA Algorithm
8. Implementation of Digital Signatures using RSA Algorithm
9. Design Network protocol analyzer tool to analyse network traffic.
10. Mini Project/ Case Study

****

Course Title: Cloud Computing

Course Code: COM-VI. E-14

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisite Courses:

Operating Systems(COM-V.C-7)

Course Objectives:

- To make students understand the key elements of cloud computing.
- To understand the difference between deploying applications on the cloud and the local infrastructure.
- To understand various cloud service models.

Learning Outcomes:

On completion of the course students will be able to:

- Explain the core concepts of the cloud computing paradigm.
- Characterize the different cloud services ie. Infrastructure, Platform and Software as a Service (IaaS, PaaS, SaaS).

Syllabus :

1. **Overview of Computing Paradigm** [**7 Hrs**]
   Recent trends in Computing: Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing.

2. **Introduction to cloud computing:** **[7 Hrs]**
   Cloud Computing definition, History of Cloud Computing, How Cloud Computing Works, Benefits and challenges of cloud computing, Issues for Cloud Computing.

3. **Cloud Computing Architecture** **[10 Hrs]**
   Comparison with traditional computing architecture (client/server), Cloud Computing Service Models, Deployment Models- Public cloud, Private cloud, Hybrid cloud and Community cloud, Key drivers to adopting cloud, Impact of cloud on users, Governance in the cloud.

4. **Infrastructure as a Service(IaaS)** [**7 Hrs**]
   Introduction to IaaS: IaaS definition, Introduction to virtualization, Different approaches to virtualization, Hypervisors, Machine Image, Virtual Machine(VM). Resource Virtualization: Server, Storage, Network. Examples: Amazon EC2.

5. Platform as a Service(PaaS) **[7 Hrs]**
Introduction to PaaS: What is PaaS, Service Oriented Architecture (SOA).Cloud Platform and Management: Computation, Storage, Examples: Google App Engine, Microsoft Azure, SalesForce.com.

6. Software as a Service(PaaS) **[7 Hrs]**
Introduction to SaaS, Web services,Web 2.0, Web OS, Introduction to MapReduce, Case Study on SaaS.

Text Books:

1. Tim mather, subrakumarswamryandsharhedLatif, “Cloud Computing Security and Privacy”, O’Reilly publication.
2. Richard Hill, Laurie Hirsch, Peter Lake, SiavashMoshiri, “Guide to Cloud Computing Principles and Practices”, Springer, 2013.
3. RajkumarBuyya, James Broberg, Andrzej M. Goscinski, “Cloud Computing: Principles and Paradigms”, Wile,2011.
4. Nikos Antonopoulos, Lee Gillam“Cloud Computing: Principles, Systems and Applications”, Springer, 2012.
5. Ronald L. Krutz, Russell Dean Vines,“Cloud Security: A Comprehensive Guide to Secure Cloud Computing”, Wiley-India, 2010

Lab : Cloud Computing

Credit : 1

Marks : 25

1. Create virtual machines that access different programs on same platform. [1P]

2. Create virtual machines that access different programs on different platforms. [1P]
3. Install a C compiler in the virtual machine and execute a sample program. [1P]
4. Working on tools used in cloud computing online- [2P]
a) Storage

b) Sharing of data

c) Manage your calendar, to-do lists,

d) A document editing tool

5. Working with any cloud service to make spreadsheet and notes and collaborate online in real time and chat with other collaborators. [1P]
6. Exploring Public Cloud. [1P]
7. Exploring Cloud IDE’s. [1P]
8. Installation and Working of Google App Engine [1P]
9. Web Service deployment and usage over cloud. [2P]

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Course Title: Multimedia Techniques

Course Code: COM-VI. E-15

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisite Courses: Nil

Course Objectives:

On completion of the course the students will develop specific skills and competencies by making them proficient in Designing Graphical Images, Audio and Video Capture and Editing using Software tools

Learning Outcomes:

On Completion of this course the student will:

- Study Multimedia Concepts
- Develop their Creativity and publish a self-contained multimedia Application using multimedia authoring tool in various application areas.

Syllabus :

1. Introduction to Multimedia: [8 Hrs]

Commonly used terms associated with multimedia like CDROM, Storyboard, Script and Authoring tools.

Stages of a Multimedia Project-Planning and Costing, Designing and Producing, Testing and Delivering.

The Multimedia team and their roles- Project Manager, Writer, Video specialist, Audio specialist and Multimedia programmer.

Multimedia Software. Multimedia Hardware.

Social & Ethical considerations, Digital Representations & Standards.

2. Introduction to Computer Graphics: [8 Hrs]

Vector graphics fundamentals, shapes, transforms and filters,

Bitmapped graphics: resolution, image compression, manipulation, Geometrical transformations

3. Text and Layout: [5 Hrs]

Text in graphics, character set, fonts, layout

4. Sound: [8 Hrs]

Basic Sound Concepts, Digitising and processing sound, Music, Speech, Compression, formats, MIDI and Digital Audio

5. Color Science and Color Models: [8 Hrs]

Human vision, Camera systems, Gamma correction, Color matching, different Color models – RGB, CYMK, Transformations among color model

6. Video: [8 Hrs]

Digitising video, streamed video, video standards, compression: mpeg, dv, codec comparison, introduction to Animation: captured, sprite, key frame, web, 3-D. Virtual reality: VRML

Text Book:

1. Nigel Chapman, Jenny Chapman; Digital Multimedia; Wiley India Edition, 2^{nd} Edition
2. Ze-Nian Li & Mark S Drew; Fundamentals of Multimedia; Pearson Education

International Edition

3. Vaughan, Tay; Multimedia: Making it Work; Tata McGraw-Hill, 3rd edition

4. Jeffcoate, Judith; Multimedia in Practice, Technology and Applications, PHI

Lab: MULTIMEDIA TECHNIQUES

Credit: 01

Marks: 25

List of suggested **PRACTICALS** (the numbers in brackets indicate number of practicals):

Practical can be done using Proprietary or FOSS for Text, Image, Audio and Video Editing. For example Scribus, GIMP, Audacity, Movie maker, Openshot, etc.

1. Design a Brochure for a given product, give details. Learn about different Image file Formats (2P)
2. Design a Poster with given information and learn about Image compression (2P)
3. Learn to prepare Images for Print, Web and Video. (1P)
4. Edit the Sound file and Learn about Effects and Filters of sound (3P)
5. Record Your voice and learn about Audio Compression. (1P)
6. Record an Audio Program and Learn about streaming an audio content. (1P)
7. Learn about Video editing – Prepare video with rough cut (2P)
8. Prepare Video content with title and special effects. (1P)
9. Record Video content and learn about video compressions. (1P)
10. Prepare Video content for streaming. (1P)

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Course Title: Digital Marketing

Course Code : COM-VI.E-16

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisite Courses: Web Designing(COM-III.E-4)

Course Objectives:

- To study various online Marketing Strategies.
- Analyze and research Internet to improve the quality and marketability of the Websites.

Learning Outcomes:

On completion of the course students will learn the following:

- Optimize the website for various search engines.
- Market the company/product using Search Engine and Social Media.
- Analyze the Web for improving the marketing strategy.

Syllabus :

I. Search Engine Optimisation (SEO): [10 Hrs]

Introduction to Online Search; Function of Search Engines Google Page Rank; Introduction to Search Engine Optimisation; Building Accessible Site; Keyword Research and Optimisation; Link Building Strategies; Useful Tools for SEO; The Past, Present and Future of SEO.

II. Search Engine Marketing (SEM): [9 Hrs]

Introduction to Internet and Search Engine Marketing; Google Adwords; Adwords Account Structure; Navigating in Google Adwords; Working with Keywords; Creating Ads in Google Adwords; Creating and Managing your First Ad Campaign; Adwords Reporting and Account Performance Reports.

III. Social Media Marketing (SMM): [9 Hrs]

Introduction to the World of SMM; Why Social Media?; Getting Started with Social Media; Building Relationships via Facebook, Twitter, LinkedIn, YouTube; Handling Positive and Negative Comments; Social Media Content Base Creation.

IV. Email Marketing: [5 Hrs]

Importance of Email marketing; Email Marketing Software's; Subscriber List; Email Marketing Campaign; Newsletters; Measuring the results.

V. WEB Analytics: [9 Hrs]

Web Analytics and Intelligence Tools; Basic Metrics Demystified; Introduction to Google Analytics; Goals and Actionable Insights; Data Management; Social Media Analytics; Social Media Goals and KPI's; Tools for Social Media Analytics.

VI. Marketing Automation: [3 Hrs]

Introduction to Marketing Automation; Advantages of using Marketing Automation Software; Issues with Marketing Automation.

Text Books:

- Damian Ryan, 2014 ***"Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation",*** Kogan Page Publisher, 3rd Edition.

Reference Books:

- Calvin Jones and Damian Ryan, 2012 "The Best Digital Marketing Campaigns in the World:
- Nick Smith, 2013 , ***"Successful SEO and Search Marketing in a Week",*** Teach Yourself Publisher,.
- Lee Odden,2012,"***Optimize: How to Attract and Engage More Customers by Integrating SEO, Social Media, and Content Marketing",*** Wiley Publishing, 1st Edition.
- Avinash Kaushik, 2013, ***"Web Analytics 2.0: The Art of Online Accountability & Science of Customer Centricity (Sybex)",*** Wiley Publishing, 2nd edition .

Practical: Digital Marketing

Credit: 1

Marks: 25

1. Using Search Engine Optimization tools (like google & bing search console, hubspot, webceo, google page speed) **(3P)**

2. Using Search Engine Marketing tools (like google adwords, google adwords certifications, search, display, remarketing formats, facebook marketing, linkedin advertising) **(3P)**

3. Using Social Media Marketing tools (like hootsuite, buffer, sproutsocial, klear, twitonomy, socialmention, google alerts, mention) **(2P)**

4. Using Email Marketing tools (like mailchimp, campaign monitor, mailgun, mandrill, phplist, amazon ses **(2P)**

5. Using Web Analytics tools (like google analytics, compete.com, crazyegg, facebook insights, twitter insights) **(3P)**

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PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE AUTONOMOUS

DEPARTMENT OF COMPUTER SCIENCE

PART B: Resolutions/Recommendations of BoS that require consideration / approval Of Academic Council:

1. Generic Elective courses syllabus for B.A/B.Sc is presented in **Annexure I**.

2. Updated syllabus of B.Sc. (COM III E-2 Digital Logic Design and COM VI- E 13 Network Security) are presented in **Annexure II.** Summary of changes incorporated in the syllabus are in **Annexure A-B.Sc.**

3. Revised list of courses of B.Sc. Computer Science course structure to be implemented for students taking admission for F.Y. B.Sc. from 2019-20 is presented in **Annexure III.**

4. No new elective courses were added to the existing list of elective courses

5. Program outcomes, Course outcomes and revised list of Practicals is presented in **Annexure IV A** for B.Sc. Computer Sc. and **Annexure IV B** for PGDCA.

6. BOS members felt that students can take courses offered by Swayam/NPTEL beyond the regular syllabus**.** List of online courses can be made available depending on what courses are offered online from time to time.

7. Syllabi of two new Elective courses (2 credits) for Semester III of M.Sc. (IT) as suggested at the previous BOS and syllabus of new elective course Machine Learning is Presented in **Annexure V.**

8.Program outcomes, Course outcomes, revised course structure of M.Sc.(IT) is presented in **Annexure VI**. Summary of changes incorporated in the syllabus are in **Annexure A -M.Sc.(IT)**

ANNEXURE I

Parvatibai Chowgule College of Arts and Science
(Autonomous)
DEPARTMENT OF COMPUTER SCIENCE

LIST OF GENERIC ELECTIVES TO BE OFFERED BY DEPARTMENT OF COMPUTER SCIENCE

1. MultiMedia
2. E-Learning
3. Cyber Security
4. Web Designing
5. E-commerce

SYLLABUS

Course Title: Multimedia

Course Code: COM-GEC.1

Marks: 100

Credits: 4

Duration: 60 HRS

Prerequisite Courses: Nil

Course Objectives:

To learn the basic Multimedia concepts and develop skills and competencies to design graphical images, Audio and Video Capture and Editing using Software tools.

Course Outcomes:

On completion of this course the student will be able to:

CO1 : Understand the building blocks of MultiMedia.

CO2 : Develop various MultiMedia Systems applicable in real time.

CO3 : Design interactive MultiMedia software.

CO4 : Develop creativity and publish a self-contained Multimedia Application using Multimedia authoring tools in various application areas.

Syllabus

Introduction to Multimedia: **[5Hrs]**

Overview of multimedia, Multimedia building blocks, Digital representation, Interaction techniques and devices, Stages of a Multimedia Project: Planning and Costing, Designing and Producing, Testing and Delivering. The Multimedia team and their roles: Project Manager, Writer, Video specialist, Audio specialist and Multimedia programmer.

Multimedia Architecture: **[5Hrs]**

Introduction to multimedia architectures, User interfaces, Windows multimedia support, Windows API for Multimedia, Multimedia Database Systems, Media streaming, Multimedia authoring tools, Multimedia OS.

Multimedia Building Blocks:

Text: **[5Hrs]**

Visual representation of text, Digital representation of text, Text file formats: TXT, DOC, RTF, PDF, ODT Conversion to and from of various text formats, Hypermedia and Hypertext.

Image: **[6Hrs]**

Basic Image fundamentals, Importance of graphics in multimedia, Vector and Raster graphics, image capturing methods – scanner, digital camera and its types, etc. various attributes of Images – size, color, depth, resolution, etc, Image data types, image file formats (BMP, JPEG, GIF, TIFF, PNG, DIB, EPS, CIF, PEX, PIC), their features and limitations, graphic file formats conversions.

Sound:

[7Hrs]

Sound and it Attributes, Mono V/s Stereo sound, Sound channels, Sound and its effect in multimedia, Analog V/s Digital sound, Basics of digital sound-Sampling, Frequency, Sound Depth, Creation of Digital Audio files – recording & editing. Overview of various sound file formats on PC – WAV, VOC, AVI, MP3, MP4, Ogg, Verbose etc. Digital audiovs MIDI and MIDI File format, CD and DVD formats.

Animation: **[8Hrs]**

Basics of animation, Principle and use of animation in multimedia, Effect of resolutions, pixel depth, Images size on quality and storage. Overview of 2-D and 3-D animation techniques and software. Animation on the Web – features and limitations, creating simple animations for the Web. Animation file formats.

Video: **[10Hrs]**

Analog and Digital Video, Video on PC. Introduction to graphics accelerator cards, DirectX Introduction to AV/DV and IEEE1394 cards, Video Broadcast Standards - NTSC, PAL, SECAM, HDTV. Introduction to video capturing, Media & Instrument – Videodisk, DVCAM, Camcorder.

Recording Formats like S-VHA Video, Component (YUV), Component Digital, Composite Digital, Video Hardware Resolutions.

Integrating Computers and Television like Video Overlay Systems, Digitized Video Playback, Differences between Computer and Television Video. Video Tips like shooting platforms, Lighting, Chroma Key or Blue Screen

Data Compression: **[5Hrs]**

Types of compression: Lossy & Lossless, Symmetrical & Asymmetrical, Intraframe & Interframe, Hybrid. Study of different compression techniques for Text (Huffman coding, LZ & LZW), Image, Audio, Video (MPEG and AVI).

Multimedia on the Web: **[6Hrs]**

Bandwidth relationship, broadband technologies, Text in the web – Dynamic and embedded font technology, Audio on the Web – Real Audio and MP3/MP4, Audio support in HTML, Graphics – HTML safe color palate, Interlaced V/s Non interlaced model, Graphics support in HTML, Image Map, Video on the Web – Streaming video, Real Video, MPEG and SMIL, Virtual Reality on the Web.

Assembling and Delivering a Project: **[3Hrs]**

The four primary navigational structures used in multimedia like linear, hierarchical, non- linear and composite.

Text Book:

Vaughan Tay, "Multimedia: Making it Work", 8th edition, Tata McGraw-Hill

Reference Books:

Ralf Stainntetz, Katra Nahrstedt, "Multimedia Computing, communications and application", Pearson Education Services.

James E Shuman, "Multimedia In Action", Vikas Publishing House.

Jeffcoate Judith, "Multimedia in Practice, Technology and Applications", Prentice Hall India.

Buford, J.F. K, "Multimedia Systems", Pearson Education

Elson-Cook, "Principles of Interactive Multimedia", McGraw Hill Higher Education.

Andreas Holzinger, “Multimedia Basics – Volume – 1 Technology”, Firewall Media (Laxmi Publications Pvt. Ltd) New Delhi

List of Demonstrations and suggested activities:

Activities can be done using Proprietary or FOSS for Text, Image, Audio and Video Editing. For example Scribus, GIMP, Audacity, Movie maker, Openshot, etc.

1. Design a Brochure for a given product, give details. Learn about different Image file

Formats

2. Design a Poster with given information and learn about Image compression

3. Study various formats/styles of text and it’s applications in various Multimedia Products

4. Edit the Sound file and Learn about Effects and Filters of sound

5. Record Your voice and learn about Audio Compression.

6. Record an Audio Program and Learn about streaming an audio content.

7. Learn about Video editing – Prepare video with rough cut

8. Prepare Video content with title and special effects.

9. Record Video content and learn about video compressions.

10. Create basic Animation file.

****

Course Title: E-Learning

Course Code: COM-GEC.2

Marks: 100

Credits: 4

Duration: 60 HRS

Prerequisite Courses: Nil

Course Objectives:

To learn different Instructional Design principles, developing and applying the various concepts of Instructional Design skills learnt wrt E-Learning and develop E-content in various application areas related to ICT and Education.

Course Outcomes:

On completion of this course the student will be able to:

CO1: Understand the working of an E-learning module.

CO2: Be aware of the various Instructional Design Principles.

CO3: Develop own course material and upload it using an appropriate LMS

CO4: Evaluate and apply appropriate Assessment techniques to thee-content

Syllabus

INTRODUCTION TOE-LEARNING: [9Hrs]

What is E-learning?

Scope and form of E-learning.

Role of an E-learning project

Phases in an E-learning project

COURSE DEVELOPMENTFORE-LEARNING: [14Hrs]

Instructional Design.

The process of Designing Instruction.

Developing Materials.(Story Boarding, Content Integration, and SCORM Compliance).

Working with L.M.S. (Learning Management System)- Installation and use of the administrator, teacher and student interface. Course Definition, Registration and upload, tracking of results).

E-LEARNING ANDPEDAGOGICALAPPROACHES: [13Hrs]

The Behaviorist School of learning and its implications on E-learning.

The Cognitive School of Learning and its Implication on E-learning.

The Constructivist School of Learning and its implications on E-learning.

Blooms Taxonomy of Educational Objectives.

Types of Learning Objectives.

Content Analysis (Types- Facts, concepts, process, procedure, principles)

The Teaching of concepts, procedure, principles, understanding.

Enabling a motivated Learning Environment.

E-LEARNINGSTRATEGIES: [14Hrs]

Simulation.

Drill.

Interactive Learning.

ProblemSolving.

Tutorials.

ASSESSMENTDESIGN: [10Hrs]

Rubrics for Assessment- Analytic and Holistic Rubrics.

Rubrics for Assessment.

Security and Authentication.

Text Book:

Teachers Discovering Computers, Integrating Technology in the Classroom, Second Edition by Shelly Cashman Gunter, (ISBN: 0-7895-6492-0).28

Reference Books:

Smith, P. L. & Ragan, T. J. (2004).Instructional design.3rd edition. New York: John Wiley & Sons. ISBN:0471393533

M.D. Roblyer, Aaron H. Doering, Integrating Educational Technology into Teaching, Student Value Edition (6th Edition), Publisher: Pearson; 6 edition (February 25, 2012) ISBN-10: 013289680X, ISBN-13:978-0132896801.

Dick, W., Carey, L., & Carey, J. O. (2009). The systematic design of instruction (7th ed.). Boston: Allyn and Bacon.

Wiggins, G. P., & McTighe, J. (2005).Understanding by design (2nd ed., p. 370). Alexandria, VA: Association for Supervision and Curriculum Development.

Christensen, C. M., Horn, M. B., & Johnson, C. W. (2008). Disrupting class: How disruptive innovation will change the way the world learns. New York: McGraw- Hill.

List of demonstrations and suggested activities:

(1) Installing, Creating and Running a complete course using LMS Course Administration: Creation and using Resources and Planning Activities. Case Study: Create a complete course and work on all the resources and activities. Also the various grade book options etc.

(2) Creating Storyboards (using Movie Maker/PPT or similar FOSS).

(3) Construct a Mindmap (using Freemind or any other FOSS).

(4) Prepare a 10-minute Video tutorial on some system (e.g. how to search for free images in Google) using screen cast. Example tool that can be used: screencast-o-matic).

(5) Study a virtual world system like Whyville, and make a 10 slide presentation (using PPT or FOSS on it).

(6) Create a fully tagged 10-question QB on a topic and load onto Moodle.

(7) Build a course using WISE.

(8) Design Rubrics (for a given scenario).

****

Course Title: Cyber Security

Course Code: COM-GEC.3

Marks: 100

Credits: 4

Duration: 60 Hrs.

Prerequisites : Nil

Course Objectives:

- To develop awareness and understand the concept of Cyber Security.
- To understand the aspects related to Cyber Security.
- To take measures to protect individual privacy and prevent loss/theft of data.

Course Outcome:

On completion of this course the student will be able to:

CO1: Understand the working of a computer network.
CO2: Be aware of the various measures that need to be taken in order to protect data.
CO3: Understand and analyze various forms of crimes in cyber world.
CO4: Gain knowledge about various rights given to the individual to protect their intellectual property.

Syllabus

1.Basics of Computer Networking: **[12Hrs]**

Networking basics, why networking of computer is needed, Introduction to Wireless networks, Internet – role and importance, IP Addressing– public Vs Private, Static Vs Dynamic, www & related protocols.

2. Emerging threats in Cyber Space: **[12Hrs]**

Threats in Cyber Space, Classification of threats, BYOD and portable devices threats, 0-day attacks, insider threats, Cyber Warfare, Malware threats, mobile apps threats. Social media and its safe usages: Social media- its usages, Social

Networking - types, usages, importance, social networking safety.

3. Online Privacy: **[10Hrs]**

Privacy – basic concepts, Sensitive personal information, Privacy policies (case study of Google/Facebook or any other privacy policies), Privacy laws, IPR, Ethics & safe practices.

4. Cyber Crimes – An Introduction: **[10Hrs]**

Introduction – Types of cyber crimes (Phishing, Social Engineering, Denial of Service, Cyber stalking, ID-theft, etc), How to report cyber crimes, its impact– social, personal, financial; CyberTerrorism.

5. Cyber Laws: **[8Hrs]**

Evolution and purpose, offense; defense, bailable and non-bailable offenses,provisions related to e-commerce, provisions for cyber crimes, adjudicating officers, CERT-IN- its role and powers

6. Cyber Forensic: **[8Hrs]**

Data recovery, evidence collection, cloning of devices, media sanitization

Reference Books:

1. Rick Lehtinen and G.T. Gangemi, Computer Security Basics, O'ReilllyMedia, Inc.,2nd edition, 2006
2. Wall, David, Cybercrime: The Transformation of Crime in the InformationAge. Polity Publishing, 2007.
3. Michael Cross, Scene of the Cyber Crime: Cyber Forensics Handbook, Syngress Publishing, 2ndEdition, 2002.
4. Chander, Harish, CyberLaws and IT Protection, Prentice Hall IndiaLearning, 2012

List of suggested Demonstrations and Activities

1. Connecting to Network, Sharing directories.
2. Connecting to shares, Set up a common storage.
3. Advanced Networking: Identify IP address, ping
4. Set up a basic firewall, Setup a wireless n/w, Set up a security level, Setup free online backup
5. Setting up and maintaining the laptop, data storage devices and smart phone.

6. Ensuring secure-environments with respect to online shopping, wi-fi networks, passwords, social networking and online banking)

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Course Title: Web Designing

Course Code: COM-GEC.4

Credits: 4

Marks: 100

Duration: 60 Hrs.

Prerequisites : Nil

Course objectives:

- To design a good Static Website with Responsive design.

Course Outcomes:

At the end of the course students should be able to:

CO1: Describe the role of Web technologies used to design Website.

CO2: Design a static website using HTML.

CO3: Apply the style sheets to the website, using CSS.

CO4: Implement additional features to enrich the website with HTML5 and CSS3.

CO5: Design a responsive webpage using bootstrap.

CO6: Implement the above technologies and design a real-time website.

Syllabus

1. Introduction to Web Technologies: **[6Hrs]**

Careers in Web Technologies and Job Roles, Website and it function, Client and Server Scripting Languages, Domains and Hosting, Responsive Web Designing, Types of Websites (Static and Dynamic Websites), Web Standards and W3C recommendations.

2. Hyper Text Markup Language (HTML): [14Hrs]

Markup Language, Basic Structure of HTML, Head Section and Elements of Head Section, Meta Tags, CSS Tags, Script Tag, Table Tag, Div Tag, Header Tags, Paragraph, Span, Pre TagsAnchor Links and Named Anchors, Image Tag, Object Tag, Iframe Tag, Forms, Form Tag, Attributes of Form, POST and GET Method, Fieldset and Legend, Text input, Text area Checkbox and Radio Button, Dropdown, List and Optgroup, File Upload and Hidden Fields Submit, Image, Normal, Reset Button, Creating a Live Website Form, HTML Validations.

3. Cascading Style Sheet (CSS): [12Hrs]

Introduction to Cascading Style Sheets, Types of CSS, CSS Selectors, Universal Selector, ID Selector, Tag Selector, Class Selector, Sub Selector, Child Combinatory Selector, Adjacent Sibling Selector, Attribute Selector, Group selector, First-line and First-letter selector, Before and After Selector, CSS Properties, Type Properties: Background, Block, Box, List, Border, Positioning, Image, Conversion of Table to CSS Layout, CSS Menu Design (Horizontal, Vertical), Form Designing.

4. HTML5 [10Hrs]

Introduction to HTML5, Features of HTML5, HTML5 DocType, New Structure Tags, Section, Nav, Article, Aside, Header, Footer, Designing a HTML page structure, New Media Tags, Audio Tag, Video Tag, Canvas and SVG Tag, Introduction to HTML5 Forms, New Attributes, Placeholder Attribute, Require Attribute, Pattern Attribute, Autofocus Attribute, email ,tel, url types, number type, date type, range type, voice search, Examples of forms

5. CSS3 [10Hrs]

New CSS 3 Selectors, Attribute Selectors, First-of-type, Last-of-type, Nth-child, New CSS3 Properties, Custom Fonts, Text-Shadow Property , Text-Stroke Property, Rounded Corners, Box Shadows, CSS Gradients, Multiple Columns, CSS Multiple backgrounds, Opacity Property, Transition effect, Transform effect, Animation effects, CSS Media Queries, Using CSS3 in Practical Layout

6. Responsive Web Design with Bootstrap [8Hrs]

Introduction to Responsive Design, Mobile first design concepts, Common device dimensions , View-port tag, Using css media queries, Menu conversion script, Basic Custom Layout, Introduction to Bootstrap, Installation of Bootstrap, Grid System, Forms, Buttons, Icons Integration

Reference books:

1. Elisabeth Robson, Eric Freeman, “Head First HTML and CSS”, O'Reilly
2. Ivan Bayross, “HTML 5 and CSS 3 Made Simple”, BPB publication
3. Kogent Learning Solutions Inc., “HTML5 Black Book: Covers CSS3, Javascript, XML, XHTML, Ajax, PHP and Jquery”, Pearson Education.

List of suggested Demonstrations and Activities:

1. Use of HTML tags to implement - headers, text format, image, imagemap, div, span, table designs, hypertext, hyperimage, rules, forms.

2. Use of CSS to implement - css syntax, types (internal and external), class, id, selector types, properties of Text, font, border, background, box, image, position, Pseudo class, pseudo element, layout, menu design.

3. Use of HTML5 tags to implement - structure, audio and video, canvas properties, new form elements.

4. Use of CSS3 tags to implement - css3 properties - text shadow, box shadow, rounded corners, transform effect transition effect, animation, multiple column, multiple backgrounds, gradients, opacity.
5. Use of framework to implement responsive design.

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Course Title: E-Commerce

Course Code: COM-GEC.5

Marks: 100

Credits: 4

Duration : 60 Hrs

Prerequisites: Nil

Course Objectives:

To learn the working of E-Commerce website and the various background processes involved to study the activities associated with e-commerce like buying, selling and payment, understand the various technologies used in e-commerce websites and security mechanisms involved in e-commerce websites.

Course Outcomes:

On completion of this course the student will be able to:

CO1: Be aware of the various E-Commerce Strategies.

CO2: Understand the working of an E-Commerce Website.

CO3: Evaluate the various Payment Mechanisms.

CO4: Develop an E-Commerce Website.

Syllabus

1. INTRODUCTION TO ELECTRONIC COMMERCE: [4Hrs]

1.1: The Scope of Electronic Commerce

1.2: Definition of Electronic Commerce

1.3: Electronic Commerce and the Trade Cycle

1.4: Electronic Markets

1.5: Electronic Data Interchange

1.6: Internet Commerce

1.7: Electronic Commerce in Perspective

2. THE VALUE CHAIN: [4Hrs]

2.1: Supply Chains

2.2: Porter's Value Chain Model

2.3: Inter Organizational Value Chains

3. COMPETITIVE ADVANTAGE: [5Hrs]

3.1: Competitive Advantage

3.2: Porter's Model

3.3: First Mover Advantage

3.4: Sustainable Competitive

3.5: Competitive Advantage using e-commerce

4. BUSINESS STRATEGY: [8Hrs]

4.1: Introduction to Business Strategy: Michael Porter's 5 force analysis

4.2: Strategic Implications of IT

4.3: Technology

4.4: Business Environment

4.5: Business Capability

4.6: Existing Business Strategy

4.7: Strategy Formulation and Implementation Planning

4.8: e-Commerce Implementation - technical and business

4.9: e-Commerce Evaluation

4.10: Auction methods

5. ELECTRONIC DATA INTERCHANGE (EDI): [5Hrs]

5.1: EDI Definition

5.2: EDI Technology

5.3: EDI Standards

5.4: EDI Communications

6. ELECTRONIC PAYMENT SYSTEMS: [10Hrs]

6.1 Overview of the electronic payment technology; limitations of traditional payment instruments.

6.2 Electronic or Digital Cash-Properties of Electronic Cash, Digital Cash in action.

6.3 Electronic Checks-benefits of electronic checks, electronic checks in action, NetCheck: A Prototype Electronic Check System.

6.4 Online Credit Card-Based Systems- types of credit card payments, Secure Electronic Transactions (SET)

6.5 Other Emerging Financial Instruments: POS (Point of Sale), E-Cash, Net Banking, Credit/Debit Cards and Electronic Benefits and Security Issues.

6.6 Case Studies of the various modes of electronic payment of various types of websites

7. E-BUSINESS: **[8Hrs]**

7.1 EDI Application in business, E- Commerce Law, Forms of Agreement, Govt. policies and Agenda.

7.2 Case Study of Internet bookshops, Grocery supplies, software supplies and support, electronic newspapers, Internet banking, Virtual auctions, online, share dealing.

7.3 Business to Legal issues: Risks involved; Paper Document vs. Electronic document, Authentication of Electronic document, Laws, Legal issues for Internet Commerce: Trademarks and Domain names, Copyright, Jurisdiction issues, Service provider liability, Enforceable online contract.

8. FIREWALLS AND TRANSACTION SECURITY: **[8Hrs]**

8.1: Firewalls and Network Security: Types of firewalls, Firewall Security Policies, Emerging Firewall Management Issues.

8.2: Transaction Security: Types of Online Transactions, Requirements for Transaction Security.

8.3: Encryption and Transaction Security: Secret-Key encryption, Public-Key Encryption, Implementation and Management Issues.

8.4: Digital Certificate.

8.5 Security Threats to E Commerce, Virtual Organization, Business Transactions on Web, E Governance and EDI.

9. CONSUMER E-COMMERCE: **[4Hrs]**

Consumer trade transaction, Internet, Page on the Web, Elements of E-Commerce with VB, ASP, SQL.

10. M-COMMERCE: **[4Hrs]**

Basic concept and applications, difference with E-Commerce, benefits of integration with ERPs.

BOOKS RECOMMENDED FOR MAIN READING AND REFERENCE:

- e-COMMERCE Strategy, Technologies and Applications by David Whiteley; TataMcGraw Hill

- Electronic Commerce A Manager's Guide by Ravi Kalakota and Andrew B. Whinston. Published by Pearson Education.

- E-Commerce The Cutting Edge of Business by Kamlesh K Bajaj and Debjani Nag. Second Edition; Tata McGraw Hill

List of Demonstrations and Suggested Activities:

1. **WORDPRESS:** Create blogs and create online stores by adding appropriate themes & plugins.

   (http://www.wordpress.com)

2. **WIX:** Using drag & drop features of this website builder to build an ecommerce website.

   (http://www.wix.com)

3. **SHOPIFY:** Create online stores, add products, categories & handle payments.

   (http://www.shopify.com)

4. **BLOGGER** : Using this blogging service provided by google, customize to create an online store. (http://www.blogger.com)

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ANNEXURE II

Semester III

Course Title: Digital Logic Design

Course Code: COM-III. E-2
Marks: 75
Credits: 3
Duration: 45 Hrs.

Course objectives:
To understand the basics of Boolean algebra and the operation of logic components, combinational, sequential circuits and design of digital systems.

Course Outcome:

After completing this course, students will be able to:

CO1: Convert values between decimal, binary, hexadecimal, and octal number systems.

CO2: Develop the minimized logic expression for a digital system using Boolean algebra.

CO3: Implement combinational circuits using simple gates, complex gates, or universal gates.

CO4: Simplify the logic function and create the digital logic circuit.

CO5: Design the sequential logic circuit.

CO6: Design efficient digital logic circuit for a particular application.

Syllabus

1. **Introduction to Number Systems and codes:** [3Hrs]
Decimal, Binary, Hexadecimal, and Octal number systems; BCD Code, Gray Code, Excess-3 Code, ASCII code, Unicode.

2. **Boolean Algebra:** [8Hrs]
Basic Boolean functions, Postulates and theorems of Boolean algebra, logic gates, Sum-of-Products and Product-of-Sums forms of Boolean functions; Canonical and Standard forms. Simplification of Boolean Functions, Plotting of K-Maps, POS and SOP Simplification, NAND and NOR implementation.

3. **Combinational Logic:** [8Hrs]
Design procedure for combinational logic circuits; design and analysis of Half Adder, Full Adder; their use in designing other combinational logic circuits; Analysis & Design of Encoders and Decoders; Multiplexer and demultiplexers; their use in designing combinational circuits.

4. **Sequential Circuits:** [17Hrs]
SR, JK, T, D Flip-flops and Latches, their schematic symbols, Truth tables. Shift

Registers - SISO, SIPO, PISO, PIPO, Bi-directional Shift Registers, Loading Methods for Shift Registers. Design and analysis of Counters: Synchronous Counters, Modulo Counters, Asynchronous, Ripple and Ring Counters; Application of Counters.

5. D/A & A/D Converters: [4Hrs]
Digital to Analog converter – Introduction, Weighted-Resistor & R-2R Ladder, Analog to Digital Converter – Introduction, Successive Approximation method.

6. **Semiconductor memories:** [5Hrs]
Memory organization and operation, expanding memory size, Classification and characteristics of memories, RAM, ROM, Synchronous DRAM (SDRAM), Double Data Rate SDRAM, Synchronous SRAM, DDR and QDR SRAM, Content Addressable Memory.

Text Book:
1. R.P. Jain , ―Modern digital electronics‖ , 3rd edition , 12th reprint TMH Publication, 2007.

Reference Books:
1. D.P. Leach, A.P. Malvino, G.Saha, Digital Principles and Applications, 7th Edition, Mc. Grew Hill (SiE)
2. M. Morris Mano, Digital Logic and Computer Design.
3. Herbert Taub and Donald Schilling, Digital Integrated Electronics, McGraw-Hill.

Lab : Digital Logic Design
Credits: 1
Marks: 25

1. Introduction to digital ICs, specifications, verification of the truth tables of logic gates1.
2. Introduction to digital ICs, specifications, verification of the truth tables of logic gates2.
3. Implementation of the given Boolean function using logic gates in SOP form.
4. Implementation and verification of Decoder using logic gates.
5. Implementation of Multiplexer using logic gates.
6. Implementation and verification of De-multiplexer and Encoder using logic gates.

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Semester VI

Course Title: Network Security

Course Code: COM-VI. E-13

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisite Courses:

Introduction to Programming (COM-I.C-2)/Object Oriented Programming (COM-II.C-3)

Course Objectives:

· To understand the theory and concepts of Network Security

Course outcome:

At the end of the course students will be able to:

CO1: Gain Knowledge of the threats, vulnerabilities and system risks

CO2: Understand cryptography, ciphers and encryption algorithms

CO3: Compare and contrast symmetric and asymmetric encryption systems

CO4: Know about viruses, Trojan horses, worms, program flaws and the defenses against them

Syllabus :

1. Concepts of Security & Classical Encryption Techniques **[6Hrs]**

Introduction, The need for security, Security Approaches, Security Attacks, Security Services, Security Mechanisms, A Model for Network Security, Classical Encryption Techniques : Substitution techniques, Transposition techniques, Steganography.

2. Design Principle of Block Cipher **[6Hrs]**

Block Cipher Operation: Electronic Code Book, Cipher Block Chaining, Cipher Feedback, Output Feedback, Counter, Feistel Cipher, The Data Encryption Standard.

3. Cryptography

i. Mathematical Tools **[3Hrs]**

Introduction to Number Theory, Modular Arithmetic, Prime Numbers, Euler's Totient Function.

ii. Public Key Cryptography **[3Hrs]**

Principles of Public Key Cryptosystems, The RSA Algorithm, Other Public key cryptosystems, Diffie Hellman Key Exchange.

iii. Cryptographic Hash Functions **[7Hrs]**

Applications of Cryptographic Hash Functions, Two Simple Hash Functions, Hash Functions Based on Cipher Block Chaining, MD5 Message Digest Algorithm, Secure Hash Algorithm SHA 512.

4. Message Authentication Codes and Digital Signatures **[8Hrs]**

Message Authentication Requirements – Message Authentication Functions –Requirements for Security of MACs,MACs Based on Hash Functions, HMAC, MACs Based on Block Ciphers, Data Authentication Algorithm. Digital Signatures, Digital Signature Standard.

5. Key Management & Distribution And User Authentication **[6Hrs]**

Introduction, Digital Certificate, Private key Management, The PKIX Model, Public key cryptographic standards ,XML, PKI and security

6. Program Security **[3L]**

Flaws, Malicious code: viruses, Trojan horses, worms, Program flaws: buffer overflows, time-of-check to time-of-use flaws, incomplete mediation.

7. Firewall and Virtual Private Network **[3L]**

Introduction to network security techniques: IP Security, firewalls, virtual private networks.

TEXT BOOKS:

1. William Stallings, ―Cryptography and Network Security – Principles and Practices‖, Prentice Hall of India, Fifth Edition

2. KahateAtul, "Cryptography and Network Security" Tata McGraw-Hill.

3. Charles P. Pfleeger and Shari L. Fleeger, ―Security in Computing‖. Prentice-Hall.2003, (3rd edition)

4. Menezes A. J., P.C. Van Oorschot and S.A. Vanstone, "Handbook of Applied Cryptography"

Lab: Network Security

Credits: 1

Marks: 25

1. Implementation of Caesar Cipher
2. Implementation of One-Time Pad
3. Implementation of Playfair Cipher
4. Implementation of Hill Cipher
5. Implementation of Data Encryption Standard Algorithm
6. Implementation of Image Steganography
7. Implementation of RSA Algorithm
8. Implementation of Digital Signatures using RSA Algorithm
9. Design Network protocol analyzer tool to analyze network traffic.

10. Mini Project/ Case Study

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ANNEXURE A- B.Sc. (Computer Sc)

(Summary of changes incorporated in the syllabus of B.Sc. Comp Sc.)

Semester	Course Title	Existing (Indicate only the unit where the change is proposed)	Changes Proposed	Specify the reason for the change
III	Digital Logic Design	5. Sequential Circuit Design: Design procedure for sequential circuits using state diagrams, State Tables; State assignments and State minimization methods; Circuit implementation. Design and analysis of Counters, Synchronous Counters; Modulo Counters, Asynchronous, Ripple and Ring Counters; Application of Counters.	Design and analysis of Counters: Synchronous Counters, Modulo Counters, Asynchronous: Ripple and Ring Counters; Application of Counters.	Instead of general sequential circuit better to concentrate on design of Counters

(Summary of changes incorporated in the syllabus of B.Sc. Comp Sc.)

Semester	Course Title	Existing (Indicate only the unit where the change is proposed)	Changes Proposed	Specify the reason for the change
VI	Network Security	Unit I : Concepts of Security & Classical Encryption Techniques	Removing Block Cipher Operations and forming a new chapter on Block Cipher with modes of operation, feistel cipher and DES	1. It is better to understand basics of encryptions with stream ciphers and then be able to differentiate it with the functioning of block cipher in the next chapter. 2. The number of lectures required to understand all concepts in existing unit 1 are more then the allotted.

		Unit V : Program Security and Unit VI : Firewall and VPN	1. Reduced number of lectures for unit V and VI and assigned to Unit III. 2. Reduced the content of Unit V and VI	Students already cover some concepts from Unit V and VI therefore those concepts were removed and some lectures were allowed to unit III which requires more time.

ANNEXURE III

Parvatibai Chowgule College of Arts and Science (Autonomous)

DEPARTMENT OF COMPUTER SCIENCE

COURSE STRUCTURE

THREE YEAR B.Sc. DEGREE COURSE IN COMPUTER SCIENCE

(To be offered to students taking admission to First Year B.Sc. from 2019-20)

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	**COM-I.C-1** Mathematical foundation of Computer Science – I	**COM-I. C-2 *** Introduction to Programming	---	---	---	---
II	**COM-II. C-3A **** Database Management System I	**COM-II.C-4 *** Data Structures	---	---	---	---

III	**COM-III.C-5A *** Object Oriented Programming	---	**COM-III.E-1** Software Engineering	**COM-III. E-2** Digital Logic Design	**COM-III. E-3** Mathematical Foundation of Computer Science – II	**COM-III. E-4** Web Designing
IV	**COM-IV.C-6** Computer Architecture and Organization	---	**COM-IV.E-5** Design & Analysis of Algorithms	**COM-IV.E-10** Mobile Application Development	**COM-IV. E-7** Server Side Programming	**COM-IV. E-8** HCI
V	**COM-V.C-7 *** Operating Systems	---	**COM-V. E-9** Embedded Systems	**COM-V. E-06** Data Base Management System II	**COM-V. E-11** Introduction to Data Science	**COM-V. E-12** Software Testing

VI	**COM-VI.C-8 *** Computer Networks	---	**COM-VI. E-13** Network Security	**COM-VI. E-14** Cloud Computin g	**COM-VI. E-15** Multimedia Techniques	**COM-VI. E-16** Digital Marketing

Note: * Core Compulsory Courses also offered for minor subject combination.

** Core Compulsory Courses also offered for minor subject combination in 4^{th} Semester.

Programme Specific Outcome (PSO) for B.Sc. Computer Science

At the end of the programme the students will be able to:

PSO1: Analyze a Software problem, design, implement a solution and evaluate the proposed solution to ensure that it meets customer needs and Software standard.

PSO2: Use and Apply appropriate current technologies, techniques and modern tools necessary for computing practice.

PSO3: Embark on an Entrepreneurial venture or be eligible for employment in IT industry or pursue higher education.

PSO4: Apply the concept of networking and security features in designing the systems.

Parvatibai Chowgule College of Arts and Science (Autonomous)

Margao, Goa

B.Sc. Computer Science – Syllabus

(To be offered to students taking admission to First Year B.Sc. from 2019-20)

Semester I

Course Title: Mathematical Foundation of Computer Science I

Course Code: COM-I.C-1

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisite Courses: Nil

Course Objectives:

- To build mathematical foundations that are essential requirement in understanding various concepts related to computer science.

Course Outcome:

At the end of the course students will be able to:

CO1: Apply counting principles to determine probabilities.

CO2: Demonstrate an understanding of relations and functions and determine their properties.

CO3: Evaluate Boolean functions and simplify expressions using the properties of Boolean algebra.

CO4: Write an argument using logical notation and determine if the argument is valid or not.

CO5: Construct and analyze finite state automata.

Syllabus:

1. Combinatory: **[8Hrs]**

Permutations; Combinations; Counting; Summation; generating functions; recurrence relations.

2. Binary Number System: **[7Hrs]**

Decimal to binary conversion and vice versa, binary number representation (signed, 1's Complement and 2's complement) binary addition, subtraction, binary to octal, hexadecimal conversion and vice versa. Floating point representation.

3. Boolean Algebra: **[7Hrs]**

Boolean functions, truth table, De Morgan's theorem, logic gates, Realization of Boolean Function using logic gates, Simplification using Karnaugh map.

4. Set, Relations and Functions: **[9Hrs]**

Venn diagram, set operations, relations and properties, closures, equivalence, relations, ordering, functions, function types, inverse of functions, composition of Partial functions, recursive functions, growth of functions.

5. Logic: **[6Hrs]**

Propositional logic, first order logic, mathematical induction, deduction, proof by contradiction, program correctness.

6. Grammars, Languages and Automation: **[8 Hrs]**

Grammars and languages, finite automation of finite state machines, regular languages, regular expressions.

Text Book:

Rosen H. Kenneth, *Discrete Mathematics and its Applications*, Tata McGraw Hill, seventh edition, 2011.

Reference:

Sarkar Kumar Swapan, *A Textbook of Discrete Mathematics*, S Chand & Company, 2005.

Practical: Mathematical Foundation of Computer Science I

Credit: 1

Marks: 25

Programs to be written using C Language:

1. Generate all permutations of n symbols, where $2 \le n \le 5$ is user defined.

2. Read a number and convert to other number formats.
    1. Convert an integer into binary number.
    2. Convert a binary number to decimal number.
    3. Convert a binary number to octal number.
    4. Convert a number into normalized form.

3. String Manipulation
    1. Read a string of decimal digits. Find the frequency distribution of digits.
    2. Read a binary string. Check the occurrence of the pattern 1001 in the string.
    3. Read two binary numbers. Add them using 1's complement and 2's complement method.

4. Read two integer numbers. Find their GCD using recursion.

5. Read the value of p. Find the p-th Fibonacci number from the following recurrence relation.

6. $f(0) = 0$, $f(1) = 1$, $f(n) = f(n-1) + f(n-2)$, $n \geq 2$. Given two functions $f(x) = x^3 + 2x + 3$, and $g(x) = 3x^2/4 + 10$, find $f \circ g\ (x)$.

7. Read an expression containing parentheses and check whether it is properly parenthesized.

    1. Equal number of '(' and ')' brackets
    2. Equal number of '{' and '}' brackets
    3. Equal number of '[' and ']' brackets s

8. Applications of set theory
    1. Read a set and check whether a given number is a member of the set.
    2. Read two sets. Find their union.
    3. Read two sets. Find their intersection.

9. Applications of finite state machines, matrices, Boolean algebra, gates.

10. Bit-wise operations using C

Programs using C language that covers the following concepts:

1. Conditions
    - if..else
    - nested if
2. Iterative Control Statements
    - for
    - while
    - do…while
3. Functions.
    - Standard Library functions
    - Call by Value
    - Call by reference
    - Recursive functions
4. Arrays.
    - One Dimensional Arrays
    - Two Dimensional Arrays
5. Sorting
    - Bubble sort
    - Insertion sort
6. Searching.
    - Sequential search
    - Binary search
7. Pointers.
    - Arrays and Pointers
    - Function returning pointers
    - Dynamic memory allocation
8. Strings.
    - Standard Library string functions
    - Strings and Pointers
    - Array of Strings
9. Structure and Union
    - Array of structures
    - Passing Structure to functions
    - Nested structure
    - Structure and Pointer
    - Union

10. File Handling.

- Text file
- Binary file
- Random Access to a file
- Command Line arguments

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Course Title: Introduction to Programming

Course Code: COM-I.C-2

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisite Courses: Nil

Course Objectives:

- To make the student understand the concept of basic computer algorithm and use the algorithm for various problem solving.
- To implement algorithms using high level programming language.
- To understand basic principles of structured programming – example C

Course Outcomes:

At the end of the course students will be able to:

CO1: Develop solutions to problems that are new to them, and implement these solutions efficiently.

CO2: Apply mathematics and logic to solve computing problems.

CO3: Develop Computer based Problem Solving Skills.

CO4: Recognize and incorporate programming elements such as loops, decision making, functions, arrays, string, structures, pointers and files into applications that solve real world problems. Develop programming skills.

Syllabus

1. Introduction to Computer Problem Solving: [5Hrs]

Algorithm, Flowchart, The Problem Solving Aspect, General problem solving strategies, Top-Down Design, Implementation of Algorithms, Efficiency of Algorithms, Recursive algorithms.

2. Basic Algorithms: **[3Hrs]**

Exchanging the values, Summation of a set of numbers, factorial computation, generation of the Fibonacci series, reversing the digits of an integer, base conversion.

3. Factoring Methods: **[2Hrs]**

Finding divisors of an integer, finding the Greatest Common Divisor of two integers, generating prime numbers, computing prime factors of an integers.

4. Sorting and Searching algorithms **[2Hrs]**

Bubble sort, Insertion Sort, Sequential Search and Binary Search.

5. Introduction to 'C': **[3Hrs]**

History, Structure of a C program, Keywords, Identifiers, variables, constants, data types, Arithmetic Operators & Expressions, Logical operators and Relational Operators, Precedence and Associativity rules.

6. Conditions and Iterations: **[3Hrs]**

Conditions and Actions, Condition statement, Simple control statement (*if*, *if-else*, *switch*), Iterative control statements (*for, while*, *do-while*).

7. Functions: **[5Hrs]**

What is a function, Advantages of functions, Standard library functions; User define functions – declaration, definition, function call, parameter passing, return keyword. Scope of variables, Storage classes, Recursion.

8. Arrays: **[4Hrs]**

One and Two dimensional arrays: Array declaration, initialization, accessing the values, passing arrays to functions.

9. Pointers: **[4Hrs]**

Pointer declaration, initialization, Pointer arithmetic, Pointer to Pointer, Arrays and Pointers, Functions and Pointers – passing pointers to functions, function returning pointer, dynamic memory allocation.

10. Strings: **[4Hrs]**

Declaration and initialization, standard library string functions, strings and pointers, array of strings.

11. Structure and Union: **[4Hrs]**

Creating structures, accessing structure members, array of structures, passing structure to functions, nested structure, pointers and structures, union, difference between structures and unions.

12. File Handling: **[4Hrs]**

FILE variable, file access modes, operations on files, random access to files, command line arguments.

13. Preprocessing: **[2Hrs]**

Format of Preprocessor directive, File Inclusion directive, Macro substitution, conditional compilation.

Text Books:

1. Dromey R.G., *How to solve it by computer*, Prentice Hall of India, 2nd Edition, 2004.
2. Kanetkar Yeshwant, *Let us C*, BPB Publications, 13th Edition, 2012.
3. Behrouz Forouzan, Richard Gilberg, *Computer Science: A Structure Programming Approach using C*, Cengage Learning 3rd Edition, 2013.

Reference books:

1. Horowith Ellis, Sahni Satraj, Sanguthevar Rajasekaran, *Fundamentals of Computer algorithm*, Orient Longman, 2nd Edition, 2008.
2. Gottfried Byron, *Programming with C*, Tata McGraw Hill, 3rd Edition, 2010.
3. Brain W. Kernighan and Dennis M Ritchie, *The C Programming Language*, Prentice Hall India, 2nd Edition, 1988.

Practical: Introduction to Programming
Credit: 1
Marks: 25

Programs using C language that covers the following concepts:

1. Conditions
    - if..else
    - nested if
2. Iterative Control Statements
    - for
    - while
    - do…while
3. Functions.

- Standard Library functions
- Call by Value
- Call by reference
- Recursive functions

4. Arrays.
    - One Dimensional Arrays
    - Two Dimensional Arrays
5. Sorting
    - Bubble sort
    - Insertion sort
6. Searching.
    - Sequential search
    - Binary search
7. Pointers.
    - Arrays and Pointers
    - Function returning pointers
    - Dynamic memory allocation
8. Strings.
    - Standard Library string functions
    - Strings and Pointers
    - Array of Strings
9. Structure and Union
    - Array of structures
    - Passing Structure to functions
    - Nested structure
    - Structure and Pointer
    - Union

10. File Handling.
- Text file
- Binary file
- Random Access to a file
- Command Line arguments

****

Semester II

Course Title: Data Base Management Systems -I

Course Code: COM-II.C-3A

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisites: Nil

Course Objectives:

It provides basic knowledge of a database management system. It helps to understand importance of ER diagram. It introduces SQL to query a database.

Course outcome:

At the end of the course students will be able to :

CO1: Gain a broad understanding of database concepts and the need for the same.

CO2: Identify different entities and relationship between them.

CO4: Represent the given system diagrammatically using ER diagram.

CO5: Convert an ER diagram to a schema and effectively represent it using appropriate RDBMS.

CO6: Formulate queries in Relational Algebra, SQL to manipulate the database.

CO7: Analyze the schema to see if they fulfill Normalization criterion.

Syllabus

1. Overview of database management [7Hrs]

Data, information, database, database management system; Managing data; File systems versus a DBMS, advantages of a DBMS; Data abstraction, instances and schemas, data models; Data manipulation language, data definition language; Architecture of a DBMS; Users of a DBMS, database administrator.

2. Database design and the ER model [10Hrs]

Design phases – conceptual design, logical design, physical design; ER model – entities, attributes, and relationships, mapping cardinalities, keys; ER diagrams – strong entities, weak entities, generalization, specialization, aggregation; Converting ER diagram to relational schemes.

3. Relational model [9Hrs]

Relation, properties of relational model; Entities, integrity constraints, referential integrity constraints; Relational algebra – select, project, cross product, set operations, rename operation; Other relational operations – natural join, outer join.

4. SQL [10Hrs]

Basic structure of SQL query – Create, select, where, from, rename operation; Set operations; Aggregate functions; Group by, having clauses; Nested queries; Views; Insert, delete, update.

5. Functional dependency and normalization [6Hrs]

Atomic domain, nested relation; Key, super key, primary key, candidate key; Functional dependency, axioms, closure of a set of attributes, closure of a set of functional dependencies; Purpose of normalization; 1NF; 2NF; 3NF; BCNF.

6. Introduction to Transactions [3Hrs]

Transaction concept, Transaction state, ACID properties, Concurrent Transactions, Serializability.

Text Book:

1. A Silberschatz, H F Korth, S Sudarshan, *Database system concepts*, McGraw-Hill ,sixth Edition

Reference Books:

Ramakrishan, J Gehrke, "*Database management systems"*, McGraw-Hill , 3rd edition
R Elmasri, S B Navathe, "*Fundamentals of database Systems"*, Pearson Education, 5th Edition

Lab : Database Management Systems I

Credit : 1

Marks : 25

1. ER diagram (1P)
2. ER diagram with specialization/generalization and aggregation.(1P)
3. Converting ERD into Database.(1P)
4. Mini project covering concepts ERD, Creating tables, SQL, .NET Framework, Loops, Control Statements, controls, Database Connectivity, Design UI (10)
5. Normalization (1P)
6. Report Writing (1P)

****

Course Title: Data Structures

Course Code: COM-II.C-4

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses: Introduction to Programming (COM-I.C-2)

Course Objectives:

To understand different methods of organizing data and efficiently implement different data structures.

Course outcome:

At the end of the course students will be able to :

CO1 : Define relevant standard algorithms for various data structures. Learn various applications of data structures.

CO2 : Implementation of data structures.

CO3 : Use various data structures for sorting and searching.

CO4 : Analyze and compare algorithms for efficiency using Big-O notation.

CO5 : Formulate new solutions for programming problems.

Syllabus

1. Introduction to data structures: **[2Hrs]**

Concept, Data type, Data object, ADT, Need of Data Structure, Types of Data Structure.

2. Algorithm analysis: **[2Hrs]**

Algorithm – definition, characteristics, Space complexity, time complexity, Asymptotic notation (Big O).

3. Linked List: **[7Hrs]**

Introduction to List, Implementation of List – static & dynamic representation, Types of Linked List, Operations on List, Applications of Linked List, polynomial manipulation, Generalized linked list – concept & representation.

4. Stacks: **[7Hrs]**

Introduction, Representation-static & dynamic, Operations, Application - infix to postfix& prefix, postfix evaluation, Simulating recursion using stack.

5. Queues: **[5Hrs]**

Introduction, Representation -static & dynamic, Operations, Circular queue, priority queue (with implementation), Concept of doubly ended queue.

6. **Trees:** **[10Hrs]**

Concept & Terminologies, Binary tree, binary search tree, Representation – static & dynamic, Operations on BST – create, Insert, delete, traversals (preorder, inorder, postorder), counting leaf, non-leaf & total nodes, non recursive in order traversal, Expression Tree. Introduction to AVL Trees, Multiway Search Trees, B Tree, B+ Tree.

7. Searching and Sorting : **[6Hrs]**

Use of various data structures for searching and sorting, selection sort, merge sort, quick sort, heap sort and hashing.

8. **Graph:** **[6Hrs]**

Concept & terminologies, Graph Representation – Adjacency matrix, adjacency list, Traversals – BFS & DFS, Application of BFS, DFS – Shortest path, Backtracking.

Text Book:

Horowitz Ellis, SahniSartaj, 2008, *Fundamentals of Data Structures in C*, University Press, 2nd Edition.

Reference:

1. LangsamYedidyah, Augenstein J. Moshe, Tenenbaum M. Aaron ,2009, *Data Structuresusing C*, Pearson Education, 2nd Edition.
2. Gilbeg Richard, ForouzanBehrouz, Data Structures: A PseudocodeApproch with C, Cengage Learning, 2nd Edition.
3. Michael Goodrich, Tamassia Roberto,2001, *Algorithm Design Foundations, Analysis andInternet Examples.* John Wiley and sons.

Practical: Data Structures

Credit: 1

Marks: 25

Programs using C language that covers the following concepts:

1. Stack: Static/Dynamic stack implementation.
2. Stack: infix to postfix.
   Stack: Evaluation of Postfix expression.
3. Queues: Static and Dynamic Queue Implementation
   Queues: Circular queue
4. List: Singly Linked List,
5. List: Doubly Linked List
6. List: Circular Linked List
7. Linked List: Polynomial addition
8. Trees: Binary Search Tree: create, add, delete, display nodes.
9. Trees: BST traversal.
10. Graph: Representation of Graphs, Graph Traversals.
    Graph: DFS, BFS.

****

SEMESTER III

Course Title: Object Oriented Programming

Course Code: COM-III.C-5A

Marks : 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses : Nil

Course Objectives:

- To teach the basic concepts and techniques which form the object oriented programming paradigm.
- To introduce object oriented programming (OOP) using Java.

Course Outcomes:

At the end of the course students will be able to :

CO1 : Apply fundamental object-oriented concepts in problem solving.

CO2: Analyze problem scenario and identify classes/objects, their properties/functionalities and associations.

CO3 : Analyze the problem scenario and model the system using UML diagrams.

CO4 : Implement the object oriented model in any object oriented language.

Syllabus

Principles of OOP **[3 Hrs]**

Programming paradigms. Basic concepts in OOP. OOP: major principles - encapsulation, abstraction, inheritance, polymorphism. Benefits of OOP. Applications of OOP.

Introduction to Java **[8 Hrs]**

Basics of Java programming, Data types, Variables, Operators, Control structures including selection, Looping, Java methods, Overloading, java.Math class, Arrays in java.

Objects and Classes **[9 Hrs]**

Basics of objects and classes in java, Constructors, Finalizer, Visibility modifiers, Methods and objects, object serialization, Inbuilt classes like String, Character, StringBuffer, File, this reference.

Inheritance and Polymorphism **[9 Hrs]**

Inheritance in java, Super and sub class, Overriding, java.lang.Object class, Polymorphism, Dynamic binding, Generic programming, Casting objects, Instance of operator, Abstract class, Interface in java, Package in java, java.util package.

Event and GUI programming **[6 Hrs]**

Design patterns – what and why? It's classification. Introduce the Observer design pattern. Event handling in java, Event types, Mouse and key events, GUI Basics, Panels, Frames, Layout Managers: Flow Layout, Border Layout, Grid Layout, GUI components like Buttons, Check Boxes, Radio Buttons, Labels, Text Fields, Text Areas, Combo Boxes, Lists, Scroll Bars, Sliders, Windows, Menus, Dialog Box, Applet and its life cycle.

Multithreading in java **[4 Hrs]**

Multithreading in java, Thread life cycle and methods, Runnable interface, Thread synchronization.

Exception handling **[3 Hrs]**

Exception handling – what and why? Try and catch block. Multiple catch blocks. Nested try, finally block, throw keyword, throws keyword. Custom Exception.

Introduction to the Collections Framework **[3 Hrs]**

Text Book

Paul Deitel& H. Deitel, , Java - How to Program, Prentice Hall Publications 9th Edition,

Suggested Reference material

1. Patrick Naughton, Herbert Schildt, 2000, Java 2 – The Complete ReferenceTMH publications 9th Edition
2. Patrick Naughton, 1997, The Java Handbook –TMH publications
3. E. Balaguruswamy 2009,Programming with Java – A Primer, TMH Publications , 4th Edition
4. D. Flanagan, 2004, "Java Examples in a Nutshell", O'Reilly. 4th Edition
5. Arnold, Gosling & Holmes, 2005 "The Java Programming Language", Addison-Wesley Professional,4th Edition.

Practical: Object Oriented Programming

Credit: 1

Marks: 25

Programs using Java language that covers the following concepts:

1) Classes and instances
2) Working with the java.Math class
3) Inheritance
4) Composition v/s inheritance
5) Polymorphism, abstract classes and interfaces
6) Algorithm and Data Structures
7) Utilising the java.util package
8) Event handling and GUI
9) Applets
10) I/O programming
11) Exception handling
12) Multithreading
13) Collections framework

****

Course Title: Software Engineering

Course Code: COM-III.E-I

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses: Nil

Course Objectives:

On completion of the course the students will develop specific skills and competencies to use various software engineering tools and methods to develop software for medical, industrial, military, communications, aerospace, business, scientific, and general computing applications.

Course Outcomes:

At the end of the course students will be able to :

CO1 : Have an ability to understand and identify various software testing problems and solve them.

CO2: Appreciate the role of Software Engineering in the Software development industry.

CO3: Demonstrate analytical design and implementation skills required in the process of Software project management.

CO4: Apply UML tools and strategies in Software development. Identify risks and suggest ways for risk mitigation. Evaluate the quality of design and code.

Syllabus

SOFTWARE PROCESS: [5Hrs]

Characteristics of software process.

Software Development Processes and Methodologies: waterfall, prototyping, iterative, spiral, unified process.

Benefits of iterative and incremental approach with emphasis on Unified process, CASE Tools, Agile methodologies.

PROJECT MANAGEMENT: [7Hrs]

Planning a Software Project – Cost estimation, Project Scheduling, Software configuration management plans, Quality Assurance plans, Project Monitoring plans and Risk Management. Techniques such as Interviewing , Requirement Workshop, brainstorming, prototyping. Characteristics of SRS

OOAD and UML: [10Hrs]

OOAD: Definition; object oriented analysis; object oriented design and modeling; Assigning responsibilities.

UML: Main UML diagrams – Class diagram , sequence diagram, activity diagram, use case diagram. Use case model – use case diagram , use case descriptions, use case realization using sequence and activity diagrams. Supplementary requirements. Advanced use case model features.

Requirements: Functional and non-functional.

System Design: Class diagram, sequence diagram, activity diagram, state chart diagram, deployment diagram. Brief introduction to other UML diagrams.

SOFTWARE ARCHITECTURE PATTERNS: [5Hrs]

Major Architectural Styles (patterns) like Layered Architecture, Pipe and Filter, Shared (Central) Data Store, Event Driven, Model-View-Controller (MVC), "Distributed & Emerging" Service Oriented Architecture (SOA) and Elementary GRASP Patterns.

HUMAN COMPUTER INTERACTION: [4Hrs]

HCI Definition; User categories, Interface Design-Internal & External Interface design, user interface design, Interface design guidelines.

CODING: [2Hrs]

Coding styles, standards, peer reviews, checklist.

TESTING: [4Hrs]

Testing Fundamental, Functional Testing, Structural Testing, Testing Object-Oriented Programs, Testing Process and Metrics.

DOCUMENTATION and MAINTENANCE: [4Hrs]

Need for Software Documentation. Types of documentation

Need for Maintenance; Types of Maintenance

REENGINEERING: **[4Hrs]**

Business Process Reengineering, Software Reengineering, Reverse Engineering, Restructuring, Forward Engineering, The Economics of Reengineering

Text Books:

- Roger Pressman, Software Engineering: A Practitioners Approach, McGraw Hill, (6th Edition), 1997.
- Craig Larman, Applying UML and patterns, Addison Wesley, 2nd Edition, 2003

References :

- Pankaj Jalote, An Integrated Approach to Software Engineering, Narosa Publishing House, 2nd Edition
- GlenfordJ. Myers, “ The Art of Software Testing “, John Wiley & Sons, 1979.
- Sommerville, Software Engineering, Adison Wesley, 7th edition, 1996.
- Martin Fowler, UML Distilled, Addison Wesley, 2nd Edition, 2003
- Thomas T. Barker , "Writing s/w documentation - a task oriented approach", Allyn& Bacon Series of Technical Communication , 1998.
- Steve Mc Connell, Code Complete, Microsoft Press, ISBN 978-0-7356-1967-8 Second Edition (June 2004)

Lab : Software Engineering

Credit : 1

Marks : 25

1) Requirements Gathering Techniques
2) SRS using IEEE format
3) Cost and Effort Estimation
4) I/O design
5) Test Case Design
6) Draw a Gantt Chart for a project

7) Develop a mini project/ Case Study

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Course Title: Digital Logic Design

Course Code: COM-III. E-2

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisite Courses: Nil

Course objectives:

To understand the basics of Boolean algebra and the operation of logic components, combinational, sequential circuits and design of digital systems.

Course Outcome:

After completing this course, students will be able to:

CO1: Convert values between decimal, binary, hexadecimal, and octal number systems.

CO2: Develop the minimized logic expression for a digital system using Boolean algebra.

CO3: Implement combinational circuits using simple gates, complex gates, or universal gates.

CO4: Simplify the logic function and create the digital logic circuit.

CO5: Design the sequential logic circuit.

CO6: Design efficient digital logic circuit for a particular application.

Syllabus

1. Introduction to Number Systems and codes: **[3Hrs]**

Decimal, Binary, Hexadecimal, and Octal number systems; BCD Code, Gray Code, Excess-3 Code, ASCII code, Unicode.

2. Boolean Algebra: [8Hrs]

Basic Boolean functions, Postulates and theorems of Boolean Algebra, logicgates, Sum-of-Products and Product-of-Sums forms of Boolean functions;Canonical and Standard forms. Simplification of Boolean Functions, Plotting of K-Maps, POS and SOP Simplification, NAND and NOR implementation.

3. Combinational Logic: [8Hrs]

Design procedure for combinational logic circuits; design and analysis of Half Adder, Full Adder; their use in designing other combinational logic circuits;Analysis & Design of Encoders and Decoders; Multiplexer and demultiplexers;their use in designing combinational circuits.

4. Sequential Circuits: [17Hrs]

SR, JK, T, D Flip-flops and Latches, their schematic symbols, Truth tables. Shift Registers - SISO, SIPO, PISO, PIPO, Bi-directional Shift Registers, Loading methods for Shift Registers. Design and analysis of Counters: Synchronous Counters, Modulo Counters, Asynchronous, Ripple and Ring Counters; Application of Counters.

5. D/A & A/D Converters: [4Hrs]

Digital to Analog converter – Introduction, Weighted-Resistor & R-2R Ladder,Analog to Digital Converter – Introduction, Successive Approximation method.

6. Semiconductor memories: [5Hrs]

Memory organization and operation, expanding memory size, Classification and characteristics of memories, RAM, ROM, Synchronous DRAM (SDRAM),Double Data Rate SDRAM, Synchronous SRAM, DDR and QDR SRAM, Content Addressable Memory.

Text Book:

1. R.P. Jain , ―Modern digital electronics‖ , 3rd edition , 12th reprint TMH Publication, 2007.

Reference Books:

1. D.P. Leach, A.P. Malvino, G.Saha, Digital Principles and Applications, 7th Edition, Mc. Graw Hill (SiE)

2. M. Morris Mano, Digital Logic and Computer Design.
3. Herbert Taub and Donald Schilling, Digital Integrated Electronics, McGraw-Hill.

Lab : Digital Logic Design

Credits :1

Marks :25

1. Introduction to digital ICs, specifications, verification of the truth tables of logic gates1.
2. Introduction to digital ICs, specifications, verification of the truth tables of logic gates2.
3. Implementation of the given Boolean function using logic gates in SOP form.
4. Implementation and verification of Decoder using logic gates.
5. Implementation of Multiplexer using logic gates.
6. Implementation and verification of De-multiplexer and Encoder using logic gates.

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Course Title: Mathematical Foundation of Computer Science - II

Course Code: COM-III.E-3

Credits: 3

Marks: 75

Duration:45 Hrs.

Prerequisite Courses: Nil

Course Objectives:

The objectives of this Course are to build mathematical foundations in the areas namely graph theory and numerical analysis being closely related to topics of computer science.

Course Outcomes:

On completion of the course students should be able to

CO1: Describe the following concepts: Graph theory and Numerical analysis.

CO2: Apply the Interpolation methods for solving the problems numerically.

CO3: Demonstrate the process of curve fitting of data.

CO4: Determine the roots of polynomial equations.

CO5: Construct and solve real-world problems using graphs and trees.

Syllabus

Graph Theory

1. Graphs, Subgraphs and Components **[3Hrs]**

Graphs, subgraphs, and some special graphs; Graph properties; Paths, cycles, and components

2. Trees and Cycles **[4Hrs]**

Trees; Spanning trees; Algorithms to find MST; Cycles; Generation of Trees and Cycles

3. Connectivity **[3Hrs]**

Cut vertices, Cut edges and Blocks; Eccentricity sequences and Sets; Connectivity parameters

4. Planarity **[4Hrs]**

Planar embeddings; Bridges; two characterization theorems

5. Eulerian graphs **[3Hrs]**

Introduction; Eulearian and traversable graphs; Non-Eulearian graphs

6. Digraphs **[4Hrs]**

Basic definitions; types of connectedness; Covers and bases; Connectivity; Acyclic digraphs

Numerical Analysis

1. Interpolation with Equal Intervals **[6Hrs]**

Introduction; Various methods of interpolation; Various methods of curve fitting; Newton's method of forward interpolation formula; Newton's method of backward interpolation formula

2. Interpolation with Unequal Intervals **[2Hrs]**

Introduction; Lagrange's formula

3. Numerical Integration **[5Hrs]**

Introduction; General quadrature formula; Trapezoidal rule; Simpson's one-third rule; Simpson's three-eighth rule; Weddle's rule

4. Solutions to algebraic and transcendental equations **[5Hrs]**

Introductions; Graphical method; Bisection method; Method of false position; Secant method; Newton-Raphson method

Linear Algebra **[6Hrs]**

Adjoint, inverse of a matrix; Rank; Linear equations; Characteristics roots and vectors

Text Books:

1. K R Parthasarathy, Basic Graph Theory, Tata McGraw-Hill Publishing, 1994

2. B S Goel, S K Mittal, Numerical Analysis, PragatiPrakashan, 13th Edition, 1998

3. S.N. Iyengar, Matrices, Anmol Publications, 2010

Reference Books:

1. J Clark, D A Holton, A First Look at Graph Theory, World Scientific, 1991

2. P N Chatterjee, Numerical Analysis, RajhansPrakashanMandir, 3rd Edition, 1996

3. V. Krishnamurthy, Introduction to Linear Algenra, Affiliated East-West Press, First Edition, New Delhi, 1976

Lab : Mathematical Foundation of Computer Science - II

Credit: 1

Marks: 25

Graph Theory

1) Read a graph, check if it is connected and find the components of a graph.

2) Check the existence of cycle in a graph.

3) Find the minimum spanning tree of a given weighted graph.

4) Implementation of Dijkstra's algorithm.

5) Find the strongly connected components of a digraph.

Numerical Analysis

6) Find the value of dependent variable using Newton's forward formula for a given value of independent variable.

7) Use Newton's backward formula to estimate a value

8) Estimate a value using Lagrange's formula

9) Apply Simpson's three-eighth rule to find the value of integration

10) Apply Newton-Raphson method OR secant method to estimate the root of a equation

Linear Algebra

11) Find the rank of a matrix.

12) Find solutions of a system of equations

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Course Title: Web Designing

Course Code: COM-III.E-4

Credits: 3

Marks: 75

Duration:45 Hrs.

Prerequisite Courses: Nil

Course objectives:

How to design good user interfaces covering important design principles such as learnability, visibility, error prevention, efficiency and graphic design

Course Outcomes:

At the end of the course students will be able to :

CO1: Identify the UI design principles.

CO2: Classify GUI design patterns.

CO3: Design a website structure using HTML (including HTML5).

CO4: Apply the style sheets to the website, using CSS (including CSS3).

CO5: Implement the dynamic features to the website and validate the forms using Javascript.

CO6: Apply JQuery methods to realize feature rich interactive website.

CO7: Design a full-fledged website using all the above technologies.

Syllabus

Unit I : User Interface – Introduction, its importance, design principles – learnability, visibility, error prevention, efficiency, graphic design. Design Patterns for GUI – View tree, Listener, Widget, Model-View-Controller. Approaches to GUI programming – Procedural, Declarative, Direct Manipulation. Web UI – HTML, Javascript, Jquery. **[6Hrs]**

Unit II : Structure and Style with HTML and CSS

HTML **[6Hrs]**

Introduction. The development process, basic HTML, formatting and fonts, commenting code, color, hyperlink, lists, tables, images, simple HTML forms, web site structure, Meta tags, Character entities, frames and frame sets.

HTML5 **[6Hrs]**

Introduction, New Elements, Canvas, SVG, Drag/Drop, Geolocation, Video, Audio, Input types, form elements, form attributes, semantic, web storage, app cache, web workers, SSE

CSS [**5Hrs]**

Introduction – Syntax, Id & Class, Backgrounds, Text, Fonts, Links, Lists, Tables. CSS Box Model – Border, Outline, Margin, Padding. Advanced - Grouping/Nesting, Dimension, Display, Positioning, Floating, Align, Pseudo-class, Pseudo-element, Navigation Bar, Image Gallery, Image Opacity, Image Sprites, Media Types, Attribute Selectors.

CSS3 **[5Hrs]**

Introduction, Borders, Backgrounds, Gradients, Text Effects, Fonts, 2D Transforms, 3D Transforms, Transitions, Animations, Multiple Columns.

Unit 3 :Javascript [10Hrs]

Introduction - What is JavaScript, Understanding Events, JavaScript Example, External JavaScript. Basic Elements – Comment, Variable, Global Variable, Data Types, Operators, If Statement, Switch, Loop: for and while, Function. JavaScript Objects – objects, Array. Browser Object Model - Browser Objects, Window Object, Document Object – getElementById, getElementsByName, getElementsByTagName, innerHTML property, inner Text property. Validation- form validation, email validation.

Unit 4 : Introducing jQuery [7Hrs]

JQuery : Introduction - Syntax, Selectors, Events. Effects- Hide/Show, Fade, Slide, Animate, stop(), Callback, Chaining. HTML/CSS- Add, Remove, CSS Classes, css(), Dimensions, slider. Traversing – ancestors, descendants, siblings, filtering.

Reference books:

Elisabeth Robson, Eric Freeman, “Head First HTML and CSS”, O'Reilly

Ivan Bayross, “HTML 5 and CSS 3 Made Simple”, BPB publication

Kogent Learning Solutions Inc., “HTML5 Black Book: Covers CSS3, Javascript, XML, XHTML, Ajax, PHP and Jquery”, Pearson Education.

Steven M. Jacobs, Ben Shneiderman, “Designing the User Interface : Strategies for effective human-computer interaction”, 5th Edition, Pearson Education

Lab : Web Designing

Marks: 25

Credits: 1

1) Case studies to review UI designs

2) Create a HTML page with the following:

a) Title heading paragraph emphasis strong and image elements

b) Complex HTML table

c) Simple HTML Form covering major form elements

d) Embed Video in an HTML page

3) Using CSS do the following:

a) Create a Navigation bar (with dropdown) with CSS

b) Create a CSS Grid

c) Create a CSS3 based button

d) Make an image rounded shape

e) Create a CSS based sticky footer

f) Create CSS3 Corner Ribbon

g) Create CSS3 blurry text effect

h) Create CSS3 speech bubble shape

i) Create image cross fade with CSS3 transition

j) Set style for link hover active and visited states of hyperlink

4) Write JavaScript functions to :

a) accept a string as a parameter and converts the first letter of each word of the string in upper case

b) check whether a given credit card number is valid or not.

c) check whether a given value is an valid url or not.

d) check whether a given email address is valid or not.

e) print an integer with commas as thousands separators

f) remove items from a dropdown list.

5) Use JQueryto :

a) Disable buttons

b) Make textbox read only

c) Uncheck check boxes

d) Confirm again

e) Sort

f) Switch rows and columns

A mini project combining all the technologies learnt using a front-end development framework such as bootstrap is recommended.

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SEMESTER IV

Course Title: Computer Architecture and Organization

Course Code: Com-IV. C-6

Marks:75

Credits :3

Duration:45 Hrs.

Prerequisite Courses: Nil

Course Objectives:

To have a thorough understanding of the basic structure and operation of a digital computer.

Course Outcome:

At the end of the course students will be able to :

CO1: Identify various components of the Computer System.

CO2: Explain the detailed function of a typical microprocessor and its control unit.

CO3: Develop 8086 processor's Assembly Language Program for simple mathematical problems.

CO4: Differentiate the function and role of semiconductor memories and map the cache memory for the given scenario.

CO5: Appraise the importance of input/output modules and Interrupts and their functions.

CO6: Distinguish the characteristics and function of I/O interfaces to computer system.

CO7: Illustrate the function of pipelined architecture and classify the Multiprocessor systems.

Syllabus

1. **Computer System:** **[3Hrs]**

   Function and structure of a computer, Interconnection of components, Performance of a computer. Computer Architecture – Princeton (Von Neumann) and Harvard architecture.

2. **Processing Unit:** **[6Hrs]**

   Architecture of 8086 processor - Registers, ALU and Control unit, Data path in a CPU. Instruction cycle, Organization of a control unit – Block Diagram of Hardwired and Micro programmed control unit.

3. **Representation of Instructions:** **[10Hrs]**

Machine instructions characteristics, Types of operations-data transfer, arithmetic, logical, conversion, I/O, system control, transfer of control; 8086 Instruction Set and Assembly language: Addressing modes-immediate, direct, indirect, register, register indirect, displacement, stack. Instruction formats - instruction length, allocation of bits, variable length instructions, Instruction set architectures - CISC and RISC architectures.

4. **Memory Subsystem:** **[10Hrs]**

Characteristics of memory system, the memory hierarchy, Semiconductor memories, Types of ROM & RAM, Cache memory unit - Concept of cache memory, Organization of a cache memory unit, Mapping methods, replacement algorithms, write policy, block size.

5. **Input/Output Subsystem:** **[8Hrs]**

General block diagram of External device & I/O module, Programmed I/O, Interrupt driven I/O, DMA, I/O channels and I/O processors. I/O interfaces – Serial port, Parallel port, PCI bus, SCSI bus, USB bus, Firewire and Infini band.

6. **Parallel Processing:** **[8Hrs]**

Classifications, Introduction to pipeline processing: Instruction pipeline & Arithmetic pipeline, Introduction to Array & Vector processors, Introduction to Multiprocessors.

Text Book:

1. William Stallings, “Computer Organization and Architecture - Designing for performance”, EEE, PHI, 9th Edition.

Reference Books:

1. M. Morris Mano, “Computer System Architecture”, Pearson Education, 3rd Edition, 2008

2. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design – The Hardware/Software Interface", Morgan Kaufmann, 4th Edition.

3. Douglas V. Hall, "**Microprocessors and its Interfacing”,** McGraw Hill Education

(India) Private Limited, 3rd Edition.

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**Lab : ** Computer Architecture and Organization

Credits :1

**Marks : ** 25

1. Study of Motherboard, Peripherals and the Computer System. O.S. Installation (Dual Boot):BIOS; Manage disk partitions: understand MBR-style partitions, (primary, extended, logical); list/create/delete partitions; Manage logical volumes: create/remove physical volumes, create/delete logical volumes, Boot loader Installation of drivers; updating software packages.

2. DOS Commands, Tools for Computer Management (Disk Management, Disk Cleanup, Defragmentation, Performance Monitor, System Restore etc).

Assembly language programs for 8086 using MASM / compatible assembler or Simulator, either in Windows or Linux.

3. Study of addressing modes.
4. Programs for arithmetic operations
5. Programs for data transfer operations
6. Programs for logical operations
7. Programs code conversion
8. Programs on sorting
9. Programs on searching
10. DOS/BIOS – Programming

****

Course Title: Design and Analysis of Algorithms

Course Code : COM-IV.E-5

Marks :75

Credits :3

Duration:45 Hrs.

Prerequisite Courses: Nil

Course Objectives:

- To study paradigms and approaches used to analyze and design algorithms and to appreciate the impact of algorithm design in practice.
- To ensure that students understand how the worst-case time complexity of an algorithm is defined, how asymptotic notation is used to provide a rough classification of algorithms and compare with one another, and how there are still some problems for which it is unknown whether there exist an efficient algorithm, and how to design efficient algorithms.

Course Outcomes:

At the end of the course students will be able to :

CO1: Explain basic concepts related to the design and analysis of algorithms.

CO2: Describe classical algorithms and their complexity.
CO3: Design and analyze selected algorithms.

Syllabus

1. Introduction **[8Hrs]**

What is an Algorithm?, Rules for writing Algorithms, Properties of Algorithms, Framework for design and analysis of algorithms(RAM model of computation),Recursive Algorithms, Space and Time Complexity by Tabular method(Performance Analysis).

2. Divide and Conquer **[7Hrs]**

Elements of Divide and Conquer Algorithms, QuickSort algorithm, Merge sort analysis, Strassen's algorithm for matrix multiplication, Analysis of Binary Search,The Maximum subarray Problem.

3. Dynamic programming **[8Hrs]**

General Method, caching v/s computation, Fibonacci numbers by recursion, Fibonacci numbers by cashing, Fibonacci numbers by dynamic programming,Optimal Binary Search Tree,Rod Cutting Problem.

4. Greedy algorithms **[5Hrs]**

Elements of greedy strategy, Activity-selection problem, Job sequencing with deadlines. Knapsack problem.

5. Basic Traversal and Search Technique **[7Hrs]**

Techniques for Binary Trees, Techniques for Graphs(Breadth First search and Traversal, Depth First Search and Traversal).

6. Graph Algorithms **[6Hrs]**

Elementary graph algorithms- Minimum spanning tree, growing a spanning tree, Kruskal and Prim algorithms.

7. Complexity Classes [**2Hrs]**

Introduction to polynomial time algorithms, NP, NP Complete, NP Hard.

8. Introduction to Randomisation and approximation. **[2Hrs]**

Text books

Thomas H. Cormen, charles E. Leiserson, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, “Introduction to Algorithms”, EEE, PHI, Third Edition

Ellis Horowitz, SartajSahni, SanguthevarRajasekaran, “Fundamentals of Computer Algorithms”, Galgotia, 2nd Edition

Reference Books

A. Aho, J. Hopcroft, J. Ullman, “The Design and Analysis of Computer Algorithms”, Pearson Education, Eighth Edition

Lab : Design and Analysis of Algorithms

Credit : 1

Marks : 25

1 Program to find GCD of 2 numbers using Iterative approach and Recursive approach
2 Program for quickSort
3 Program to perform Binary Search using Recursive approach
4 Program to generate Fibonacci numbers using Dynamic Programming approach.
5 Program to implement Activity Selection Problem.
6 Program to implement job sequencing with Deadlines.
7 Program to implement Knapsack Problem
8 Program to implement Rod Cutting Problem.
9 Program to implement Binary Tree.
10 Program to implement Optimal Binary Search Tree.
11 Program to represent graph using matrix.
12 Program to represent graph using Linked List.
13 Program to implement BFS/DFS Traversal on graph.
14 Program to implement Kruskal's Algorithm
15 Program to implement Prim's Algorithm

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Course Title: Mobile Application Development

Course Code: COM-IV.E-10

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses:

- Object Oriented Programming(COM-III.C-5A)
- Web Designing(COM-III.E-4)

Course Objective:

Students learn how to develop applications for mobile devices, including smart phones and tablets. Students are also introduced to the current mobile platforms, mobile application development environments and mobile device input methods. Students will design and build a variety of apps on a popular platform throughout the course to reinforce learning and to develop real competency.

Course Outcome :

At the end of the course students will be able to :

CO1: Explain mobile devices, including their capabilities and limitations.

CO2: Review current mobile platforms and their architectures.

CO3: Develop mobile applications on a popular mobile platform.

CO4: Evaluate development with another mobile platform.

Syllabus

Introduction to mobile devices **[3 Hrs]**

Mobile devices vs. desktop devices, Why we Need Mobile App, Different Kinds of Mobile Apps, ARM and intel architectures, Power Management, Screen resolution, Touch interfaces, Application deployment - App Store, Google Play, Windows Store, Development environments – Android Studio, PhoneGAP, Native vs. web applications.

Review of HTML5/JS/CSS3 **[2 Hrs]**

Quick recap of technologies, Mobile-specific enhancements, Browser-detection, Touch interfaces, Geolocation, Screen orientation, Mobile browser “interpretations” (Chrome/IE).

Mobile OS Architectures **[3 Hrs]**

Comparing and Contrasting architectures of Android, iOS and Windows, Underlying OS(Darwin vs. Linux vs. Windows), Kernel structure and native level programming, Runtime (Objective-C vs. Dalvik vs. WinRT), Approaches to power management, Security.

Android overview **[2Hrs]**

Introduction to Android.Overview of android stack, Introduction to OS layers, Android features. Linux Kernel, Libraries, Android Runtime, Application Framework, Dalvik VM

Android Components – Introduction **[3 Hrs]**

Activities, Services, Broadcast Receivers, Content Providers.

Building UI with Activities **[4Hrs]**

Activities, Views, layouts and Common UI components, Creating UI through code and XML, Activity life cycle, Intents, Communicating data among Activities.

Advanced UI **[5Hrs]**

Selection components (GridView, ListView, Spinner), Adapters, Custom Adapters, Menus, Toast, Custom Toast,Dialogs, Status bar Notifications.

Multithreading **[4Hrs]**

Using Java Mutithreading classes, AsyncTask, Handler, Post.

Intent, Intent Filters and Broadcast Receivers **[4 Hrs]**

Role of filters, Intent-matching rules, Filters in your manifest, Filters in dynamic Broadcast Receivers, Creating Broadcast receiver, Receiving System Broadcast, Understanding Broadcast action, category and data, Sending Broadcast.

Data Storage **[5Hrs]**

Shared Preferences, Android File System, Internal storage, External storage. SQLite Introducing SQLite, SQLiteOpenHelper and creating a database, Opening and closing a database, Working with cursors, inserts, updates, and deletes.

Content Providers **[5Hrs]**

Accessing built in content providers, Content provider MIME types, Searching for content, Adding, changing, and removing content, Creating content provider, Working with content files.

Services **[5Hrs]**

Overview of services in Android, Implementing a Service, Service lifecycle, Inter Process Communication (AIDL Services).
Web Services and WebView - Consuming web services, Receiving HTTP Response (XML, JSON), Parsing JSON and XML, Using WebView.

Reference books:

1. Beginning Android 4 Development, Wei-Ming Lee(John Wiley & Sons)
2. Pro Android 4 ; SatyaKomateneni, Dave MacLean (Apress)
3. Hello Android - Introducing Google's Mobile Development platform - Ed Brunette (The Pragmetic Bookshelf)
4. Android Apps with Eclipse 1st Edition, OnurCinar(Apress)
5. Android- A Programmer'S Guide, Dimarzio, J.F.(Tata McGraw Hill)

Web References:

1. http://developer.android.com/index.html
2. http://www.appinventor.org/

Lab : Mobile Application Development

Credit: 1

Marks: 25

1. Getting Started with Android – Installing the Development Environment, Configuring Android Stack
2. Creating the First Android Application - Creating a Simple Android Project, Debugging Application through DDMS. setting up environment. AVD Creation, Executing Project on Android Screen.
3. Android application development - Use of GUI components to implement a simple application such as a Calculator.
4. Review the earlier application making use of the advanced UI components.
5. Implementing Data storage application - an application to make Insert , update , Delete and retrieve operation on the database.

6. Understanding content providers and permissions: Read phonebook contacts using content providers and display them suitably.
7. Optimizing your app performance with Services/Multithreading/Multiprocessing
8. Course Project

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Course Title: Server Side Programming

Course Code: COM-IV.E-7

Marks: 75

Credits :3

Duration:45 Hrs.

Prerequisite Courses:

- Object Oriented Programming (COM-III.C-5A)
- Software Engineering (COM-III.E-1)

Course Objectives:

Provide an in depth understanding of object oriented approaches to software development, in particular to the analysis and design phases of the software life cycle.

- Design and implement basic server-side scripts.
- Create data documents using XML.
- Create and manipulate databases using SQL and server side technologies.
- Understand how rich internet applications are implemented using AJAX and XML/JSON.

Course Outcomes:

At the end of the course students will be able to :

CO1 : Get hands-on programming experience using open -source software, PHP and MySQL to build professional-quality, database-driven websites.

CO2 : Develop the skills to build interactive web sites with authentication and security by integrating PHP with HTML and CSS.

CO3 : Learn how to apply basic and advanced object-oriented programming techniques, use libraries, frameworks and advanced database connectivity techniques, and integrate PHP with other web technologies to build secure e-commerce applications.

CO4 : Customize an application to meet the specific needs of a client use case as would be done in a real-world application.

Syllabus

Review of OOAD: **[6 Hrs]**

Object Oriented Concepts - Class, Object, member variable, member function, Inheritance, Polymorphism, overloading, Data Abstraction, Encapsulation. Review of object oriented design and modeling

Server-side technologies: **[15 Hrs]**

Static vs. Dynamic web pages, Need for Server Side technologies, Multitier Web Architecture. Common Gateway Interface standard, server-side includes, server APIs, server-side scripting – working principles, and implicit objects. Database and file access. Comparison of Web servers.

Ajax-Enabled Rich Internet Applications with XML and JSON **[15 Hrs]**

AJAX – introduction, purpose, advantages and disadvantages. Key elements of AJAX – introduction to XML.XML processing with server sidescript.XSL, transforms andtemplates.The XMLHttpRequest object–methods and properties. Creating and usingXMLHttpRequest objects. Using XSLT with AJAX.

JSON – Syntax, mixing literals, Array, object, encoding/decoding, JSON versus XML, server-side JSON tools.

Web Services: **[9 Hrs]**

Introduction, its role. Basics – Creating, Publishing, Testing and Describing a Web services (WSDL)-Consuming a web service. SOAP - introduction, requests and responses. Role of UDDI

– accessing registries. REST based web services – building, deploying and consuming

Reference Books:

1.AndreaSteelman and Joel Murach, Murach's Java Servlets and JSP, 2nd Edition

2.Bryan Basham and Kathy Sierra, Head First Servlets and JSP

3.Dana Moore, Edward Benson, Professional Rich Internet Applications: Ajax And Beyond (English), Wiley India

4. Schmelzer, XML and Web Services Unleashed, Pearson India

Lab : Server Side programming

Credit : 1

Marks : 25

1) Perform OOAD of a given system using the following diagrams:
    a) use case
    b) class
    c) sequence
    d) activity

2) Using server side programming and following OOAD principles develop a dynamic web application.

3) Add AJAX and Web service(s) to the application.

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Course Title: Human Computer Interface

Course Code: COM-IV.E-8

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisites: Nil

Course Objectives:

To study the different aspects of human computer interaction and the computer interface design concepts.

Course Outcomes:

At the end of the course students will be able to :

CO1 : Understand the intricacies of human interaction with a computer System.

CO2 : Appreciate the principles of good screen design and layouts.

CO3 : Understand the different navigation schemes on windows based interface; learn the different types of selection devices and components of a window based interface.

CO4: Analyze Requirements of system. Classify human users based on their abilities, personalities.

CO5: Design prototypes. Evaluate the design of user interfaces. Compare the interfaces different products.

Syllabus

1. Introduction: Human-Computer Interaction, Evaluating Designs, The Birth of HCI. Importance of user Interface, Importance of good design, Benefits of good design, principles & heuristics of good design **[4Hrs]**

2. Human interaction with computers, Importance of : Human characteristics, Human consideration, Human interaction speeds, Understanding business functions. User centred design- Need-finding: Participant Observation, Interviewing, Additional Need finding, contextual inquiry & persona. **[6Hrs]**

3. Rapid Prototyping: story boarding. Paper Prototyping and Mockup, Video Prototyping, Creating and Comparing Alternatives **[5Hrs]**

4. Direct Manipulation and Representations: various user interaction models- command, menu, Direct Manipulation. Mental Models. Heuristics (guidelines) for design. **[7Hrs]**

5. Graphical Interface Design: Graphical user interface, standards such as Microsoft windows HCI guidelines, Windows: Navigation schemes selection of window; Selection of devices based and screen based controls, Components, Text and messages, Icons, Multimedia, Colors., controls, Help & error messages design.
[8Hrs]
6. Web user interface design – jessy James Garette five layers of user experience. **[4Hrs]**

7. Heuristic Evaluation: Heuristic Evaluation — Why and How? **[4Hrs]**

8. Visualization, Amount of information, Focus and emphasis, Presentation information simply and meaningfully, Information retrieval on web, Statistical graphics
[7Hrs]

Text books:

1. Alan Cooper & Robert Reimann, About Face 2.0: The Essentials of Interaction Design, Wiley
2. Alan Dix, Janet Finlay, Gregory D. Abowd, and Russell Beale, Human-Computer Interaction (3rd Edition), Pearson, 2004.
3. Ben Shneiderman and Catherine Plaisant, Designing the User Interface: Strategies for Effective Human-Computer Interaction (5th Edition), 5th ed., Pearson Addison-Wesley, 2009
4. Donald A. Norman, The Design of Everyday Things, Basic Books, 2002

Lab : Human Computer Interface

Credit : 1

Marks : 25

1. Paper Prototyping using templates
2. Conducting survey interview and summarizing the result
3. Persona- conducting contextual interview and developing persona

4. GUI design- form design, menu design, help, error messages
5. Web UI design- pages, navigation, controls, (Ajax)
6. Report designs
7. Visualization and info graphics
8. Heuristic evaluation
9. Story boarding

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Semester V

Course Title: Operating Systems

Course Code: COM-V.C-7

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses :

- Introduction to Programming(COM-I.C-2)
- Data structures(COM-II.C-4)

Course Objectives:

This course aims at understanding functions of operating system. As part of the course students will study different aspects of operating system such as Memory management, CPU scheduling, Concurrency, Storage management etc.

Course Outcomes:

At the end of the course students will be able to :

C01: Understand the fundamental functions of an operating system.

C02: Gain knowledge of Process, process coordination, Process synchronization.

C03: Understand the concept of memory management and virtual memory.

C04: Implement CPU scheduling, memory allocation algorithms.

C05: Gain knowledge of storage devices.

Syllabus

1. **Introduction to Operating System:** **[4Hrs]**

   Basic elements of a computer system: Processor, Main Memory, I/O Modules, System Bus, Instruction Execution; Operating Systems: Definition, Operating system Structure, operating system operations, Relationship between Kernel, OS, and Hardware, Operating system services, System calls, Types of system calls, System programs.

2. **Process Management:** **[10Hrs]**

   Process Definition, Process Control Block, Process States, Operations on Process; Interprocess communication, Threads and Microkernels: Definition, Multi-threading Model Process Scheduling, Scheduling Criteria, Scheduling Algorithms, Multi-Processor Scheduling;

3. **Process Coordination** **[10Hrs]**

   Process Synchronization, Principles, Mutual Exclusion, The Critical-Section Problem, Petersons Solution, Semaphores, Monitors, Readers/Writers Problem; Classic Problems of Synchronization, Dining Philosopher's problem.Deadlocks- system models, Deadlock characterization , Deadlock Handling Methods, Prevention, Avoidance, Detection, Recovery From Deadlock

4. **Memory Management:** [**13Hrs]**

   Introduction, Swapping, Contiguous Memory Allocation, Paging, Page Table, Segmentation Virtual Memory: Introduction, Demand Paging, Page Replacement, Allocation of Frames, Thrashing

5. **Storage Management** **[5Hrs]**

   File System, Concepts, File Organization and Access Methods, Directory and Disk Structure.Secondary Storage Structure - Overview, disk structure, Disk attachment, Disk scheduling

6. **Protection and Security** **[3Hrs]**

System Protection :Goals of protection, Principles, domain of protection, Access Matrix, Implementation of Access Matrix.

Text Book:

1. A. Silberchatz, Galvin, Gagne, 2008, Operating System Concepts, Wiley publication8th Edition.

Reference Book:

William Stallings, Operating Systems: Internals and Design Principles,Prentice Hall, 6th Edition

Lab : Operating Systems

Credit : 1

Marks : 25

Any 8 from the following can be done.

1. Demo/Review of Installing Linux / Windows Operating System, Partitioning and formatting disk, Installing applications device drivers, working with files, mounting file systems, checking system space, creating, modifying and deleting user accounts
2. Study of Basic commands of Linux.
3. Shell Programming in Unix/Linux, arithmetic operations, loops
4. Shell Programming – advanced
5. Menu Driven Shell scripting
6. Filters and Pipes in LINUX
7. Implementation of Inbuilt Linux/UNIX commands like cp, rename etc.

8. Implementation of CPU scheduling policies.
9. Implementation of Memory allocation techniques:
10. Implementation of Banker's algorithm. (Resource Allocation Graph)

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Course Title: Embedded Systems

Course Code: COM-V.E-9

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses:

- Digital Logic Design(COM-III.E-2)
- Knowledge of Programming

Course Objectives:

- To have a thorough understanding of Embedded Systems and their applications.

Course Outcome:

At the end of the course students will be able to :

CO1: Describe Embedded Systems and its characteristics.

CO2: Classify the Embedded processors and their design metrics.

CO3: Summarize the performance of ARM processors and various components of Embedded Systems.

CO4: Classify Sensors and Actuators, identify their functions and applications.

CO5: Categorize I/O devices, I/O Interfacing and Communication protocols along with their functions.

CO6: Generalize the functionality of IoT and RTOS.

CO7: Design and develop Embedded / IoT Applications using Arduino/Raspberry Pi boards.

Syllabus

1. Introduction: [6Hrs]

Introduction to Embedded Systems, Microprocessors and Micro-controllers. Components of Embedded System & its Classification, Characteristic of embedded system. Introduction to embedded processor, Digital Signal Processor, Application Specific System Processor, Design Process in Embedded System, Design metrics, Steps in design process. Challenges in Embedded System design, Design Examples. Advances in Embedded Systems.

2. System hardware: [10Hrs]

System hardware, Interrupt structure and Applications, ARM Processor - Architecture, Programmer's model, Modes of operation, Interrupt**,** Handling Interrupts, Comparison of ARM7 & ARM9. Components of Embedded Systems-Management of Power Supply, Clocking Unit, Real Time Clock and Timers, Reset Circuitry and Watchdog Timer. Processor and Memory Selection, Memory Map of Embedded System, Interfacing Processors, Memories and I/O – Analog vs Digital. Overview of Arduino, Intel Edison and Raspberry Pi boards.

3. Sensors and Actuators (Overview): [12Hrs]

Sensors / Transducers: Principles – Classification – Parameters – Characteristics – Environmental Parameters (EP) – Characterization.

Thermal Sensors: Introduction – Gas thermometric Sensors – Thermal Expansion Type Thermometric Sensors.

Magnetic sensors: Introduction – Sensors and the Principles Behind – Magneto-resistive Sensors, Semiconductor Magneto resistors.

Smart Sensors: Introduction – Primary Sensors – Excitation – Amplification – Filters – Converters – Compensation – Information Coding/Processing - Data Communication – Standards for Smart Sensor Interface – The Automation.

Sensors Applications: Introduction – On-board Automobile Sensors (Automotive Sensors) – Home Appliance Sensors – Aerospace Sensors — Sensors for Manufacturing – Sensors for environmental Monitoring.

Actuators: Overview of Pneumatic and Hydraulic Actuation Systems, Mechanical Actuation Systems, Electrical Actuation Systems.

4. I/O Interfacing and Communication: [10Hrs]

I/O interfacing and Communication Buses, Serial vs Parallel Communication, Serial Data Communication RS-232/UART.I/O devices, ADC / DAC, Optical Devices such as LED / LCD Display devices, Opto-Isolator, Relays, DC motor, Stepper motor, Timers/Counters, Parallel ports - Device interfacing. Serial communication Protocols - UART Protocols, I^2C, CAN, USB &ZigBee – Protocol Architecture, Topology, Packets, Communication Cycle, Arbitration, Applications and comparison.

5. Internet of Things (IoT): [3Hrs]

Introduction to IoT, **M2M to IoT**-The Vision-Introduction, M2M towards IoT- the global context, IoT **Architectural Overview, Potential and Challenges.**

6. Real Time Operating System: [4Hrs]

Introduction to RTOS, architecture of kernel, task and task scheduler, interrupt service routines in RTOS Environment.

Text Books

2. Rajkamal, “Embedded Systems – Architecture, Programming and Design”, Tata McGraw Hill, Second Edition, 2008.
3. D. Patranabis, “Sensors and Actuators”, 2nd Ed., PHI, 2013.

Reference Book:

1. Dr. K. V. K. K. Prasad, "Embedded / Real Time System : Concepts, Design, & Programming – Black Book‖", Dreamtech Press Publication.
2. David E Simon, "An Embedded Software Primer", Pearson India, 1st Edition.
3. Tammy Noergaard, "Embedded Systems Architecture", Elsevier
4. D. Patranabis, "Sensors and Transducers", PHI Learning Private Limited.
5. Dr. K. V. K. K. Prasad, Gupta Dass, Verma, "Programming for Embedded system", Wiley – Dreamtech India Pvt. Ltd.
6. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.

Lab : Embedded Systems

Credit: 1

Marks: 25

Programs to be executed on some of the embedded boards like Arduino, Intel Edison, Raspberry Pi, Bolt, etc., that covers the following tasks:

1) Interfacing sensors
2) Interfacing output devices
3) Interfacing input devices
4) Interfacing actuators
5) Building obstacle avoiding Robot
6) Line Following Robot
7) Programming with Raspberry Pi
8) Monitoring Data over Cloud
9) Building Web app to control devices.
10) Mini Project

Course Title: Data Base Management System - II

Course Code: COM-V.E-6

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisites: Data Base Management Systems –(COM II.C-3A)

Course Objectives:

- To provide advance database solutions.

Course outcome:

At the end of the course students will be able to :

CO1: Formulate complex queries for database updation.

CO2: Implement stored procedures and Functions.

CO3: Understand concurrent transactions and Recovery mechanisms.

CO4: Develop a full database application.

CO5: Differentiate between SQL and NOSQL databases.

C06 : Use given NOSQL database . (As covered in the Practical)

Syllabus

1.Advanced SQL **[15Hrs]**

SQL data types and schemas, Integrity constraints, Authorization, Embedded SQL, Dynamic SQL, Triggers, Stored Procedures, views.

2.Indexing and Hashing **[7Hrs]**

Basic concepts**,** Ordered Indices, Dense and Sparse Indices. B and B+ trees Hashing – Static hashing, Dynamic Hashing, Extendable hashing, Comparison of Ordered Indexing and Hashing.

3. Transaction, Concurrency Control, Recovery System. **[10Hrs]**

Transaction: Transaction concept, Transaction state, Implementation of Atomicity and Durability, concurrency. Serializability, conflict serializability. Concurrency Control : Lock-Based Protocol.Recovery System: Failure Classification, Storage structure, Stable storage implementation, Recovery and Atomicity: Log-Based Recovery.

4. Introduction to Big data and NoSQL

[13Hrs]

Introduction to the Big Data problem. Current challenges, trends, and applications.

Comparison between SQL and NOSQL Databases. Types and examples of NoSQL databases- Column, Document, Key-value, Gtraph, Multi-model.Introduction to Document type NoSQL database such as MongoDb. - Introduce concepts of collection and documents, Advantages, Data types, Projections, indexing, Sharding .

Text Book:

A Silberschatz, H F Korth, S Sudarshan, *Database system concepts*, McGraw-Hill ,sixth Edition

Reference Books :

Ramakrishan, J Gehrke, "*Database management systems"*, McGraw-Hill , 3rd edition R Elmasri, S B Navathe, "*Fundamentals of database Systems"*, Pearson Education , 5th Edition

Kristina Chodorow*MongoDB : The Definitive Guide (English)* O'Reilly 2nd Edition

Lab : Database Management Systems II

Credits : 1

Marks : 25

1. SQL Revision

2. Advance SQL- Dynamic SQL, Triggers
   Advance SQL- Stored Procedures

3. Using ODBC API for insertion of record into database.
   Using ODBC API for deletion of record.
   Using ODBC API for modification of data.
   Using ODBC API for data retrieval.

4. Installing and Creating a docudocument using MongoDb concept
   Performing Indexing using MongoDb

5. Performing aggregation functions on MongoDb
Implementation of Master-Slave approach.

6. Connection of MongoDb using Java
Insertion, modification, deletion using MongoDb
Data retrieval using MongoDb
Shrading using Java and MongoDb

7. Mini Project

Course Title: Introduction to Data Science

Course Code: COM-V.E-11

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite courses:

Students are expected to have basic knowledge of algorithms and reasonable programming experience, and some familiarity with basic linear algebra and basic probability and statistics.

Course Objectives:

- Become familiar with methods of data science and their practical usefulness.

Course outcomes:

At the end of the course students will be able to do:

CO1: Describe what Data Science is and the skill sets needed to be a data scientist.

CO2:Explain in basic terms what Statistical Inference means. Identify probability distributions commonly used as foundations for statistical modeling. Fit a model to data.

CO3:Use R to carry out basic statistical modeling and analysis.

Syllabus

Introduction **[4Hrs]**

What is Data Science?,Big Data and Data Science hype -and getting past the hype,
Why now? –Datafication, Current landscape of perspectives, Skill sets needed

Statistical Inference **[6Hrs]**
Populations and samples,Statistical modeling, probability distributions, fitting a model,
Intro to R

Exploratory Data Analysis and the Data Science Process **[6Hrs]**
Basic tools (plots, graphs and summary statistics) of EDA,Philosophy of EDA,
The Data Science Process, Case Study: Real Direct (online real estate firm)

Three Basic Machine Learning Algorithms **[6Hrs]**
Linear Regression,k-Nearest Neighbors (k-NN),k-means

Feature Generation and Feature Selection (Extracting Meaning From Data) **[6Hrs]**
Motivating application: user (customer) retention,Feature Generation (brainstorming, role of domain expertise, and place for imagination) , Feature Selection algorithms ,Filters; Wrappers; Decision Trees; Random Forests

Mining Social-Network Graphs **[6Hrs]**
Social networks as graphs,Clustering of graphs,Direct discovery of communities in graphs,
Partitioning of graphs, Neighborhood properties in graphs

Data Visualization **[6Hrs]**
Basic principles, ideas and tools for data visualization,Examples of inspiring (industry) projects,
Exercise: create your own visualization of a complex dataset

Data Science and Ethical Issues **[5Hrs]**
Discussions on privacy, security, ethics, A look back at Data Science,Next-generation data scientists

Text Book:

Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline, O'Reilly, 2014.

References Books :

• Jure Leskovek, AnandRajaraman and Jeffrey Ullman, Mining of Massive Datasets v2.1, Cambridge University Press, 2014 (free online)
• Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, ISBN 0262018020, 2013.
• Foster Provost and Tom Fawcett, Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking, ISBN 1449361323, 2013.
• Trevor Hastie, Robert Tibshirani and Jerome Friedman. Elements of Statistical Learning, Second Edition, ISBN 0387952845, 2009 (free online)
• Avrim Blum, John Hopcroft and RavindranKannan. Foundations of Data Science.
(Note: this is a book currently being written by the three authors. The authors have made the first draft of their notes for the book available online. The material is intended for a modern theoretical course in computer science.)
• Mohammed J. Zaki and Wagner MieraJr, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, 2014.
• Jiawei Han,MichelineKamber and Jian Pei, Data Mining: Concepts and Techniques, Third Edition, ISBN 0123814790, 2011.

Lab : Introduction to Data Science

Credit: 1

Marks: 25

1: Implementation of probabilty distribution

2: Sampling and re-sampling.

3: Linear Models

4: K-Nearest neighbour

5: K-Means

6: Feature Selection Algorithm

7: Filters and Wrappers

8: Decision Trees

All the experiments will be implemented using Excel /R-Tool/ or equivalent.

****

Course Title: Software Testing

Course Code: COM-V.E-12

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite courses: Introduction to Programming (COM-I.C-2)

Course Objectives:

- To study fundamental concepts in software testing, including software testing objectives, process, criteria, strategies, and methods.
- To discuss various software testing issues and solutions in software unit test; integration, regression, and system testing.
- To learn how to plan a test project, design test cases and data, conduct testing operations, manage software problems and defects, generate a testing report.

Course Outcomes:

At the end of the course students will be able to :

CO1 : Understand testing of web applications and automated testing tools.

CO2 : Apply modern software testing processes in relation to software development and project management.

CO3 : Create test strategies and plans, design test cases, prioritize and execute them.

CO4 :Develop an ability to understand and identify various software testing problems and solve them.

Syllabus

Software testing principles - Software Testing- Need for testing, Psychology of testing**,** Testing economics**,** SDLC and Testing**,** Verification & Validation**.** Quality Assurance, Quality Control **[3Hrs]**

Testing strategies and types - White box testing techniques - Statement coverage, Branch Coverage , Condition coverage, Decision/Condition coverage , Multiple condition coverage, Dataflow coverage, Automated code coverage analysis, Inspections, Walkthroughs Code Review **[5Hrs]**

Black box testing techniques - Boundary value analysis**,** Robustness testing **,**Equivalence partitioning**,** Syntax testing**,** Finite state testing**,** Levels of testing**,** Unit, Integration and System Testing**,** Compatibility Testing**,** Domain Testing**,** Adhoc Testing **,**Use of Requirement, Traceability Matrix **[6Hrs]**

Integration Testing Waterfall - Top-down ,Bottom up ,Big bang, Sandwich **[3Hrs]**

System and Performance Testing - Types of system testing ,Functional and non-functional testing Acceptance Testing ,Setting entry and exit criteria for phases and typical product release scenarios ,Basic factors governing performance testing, Methodology for performance testing ,Tools for performance testing **[4Hrs]**

Regression Testing - Purpose **,**Timing, Choice of tests **,**Smoke tests **,**Best practices **[3Hrs]**

Internationalization and Localization testing - Preliminary concepts,Adhoctesting,Pair testing, Extreme testing, Agile testing, Exploratory testing,Defect seeding **[3Hrs]**

Usability Testing - Factors in usability testing ,Aesthetics testing ,Accessibility testing ,Tools for usability testing **[3Hrs]**

Testing object oriented software - Definitions and Challenge differences from testing non-OO Software, Class testing strategies Class Modality, State-based Testing, Message Sequence Specification. **[4Hrs]**

People and organizational issues in testing - Common people issues and myths in testing, Providing career paths in testing, Organizational structures for testing teams, Geographically distributed testing teams and success factors **[6Hrs]**

Test Management and Automation- Test Planning,TestManagement,TestProcess,TestReporting,TestAutomation,Factors to consider in automation, Challenges in test automation, Test Metrics, Product Metrics, Process Metrics, Progress Metrics. Use of metrics in ascertaining product release **[5Hrs]**

References:

1. 1.Software Testing- Principles and Practices ,SrinivasanDesikan and Gopalaswamy Ramesh , Pearson Publication
2. Integrated Approach to Software Engineering , PankajJalote, Narosa Publishing House
3. Software Engineering – A Practitioners Approach, Roger Pressman, McGraw Hill Publication

Lab: Software Testing

Credit: 01

Marks: 25

1. Planning Test Cases
2. Generating Test Cases/Test Suite
3. Enhancing Tests
4. Debugging Tests
5. Running Tests
6. Analyzing Results
   Reporting Defects

****

Semester VI

Course Title: Computer Networks

Course Code: COM-VI. C-8

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses :

- Introduction to Programming (COM-I.C-2)
- Object Oriented Programming (COM-III.C-5A)

Course Objectives:

- To understand the basic concepts of Computer Networking
- Be familiar with the components required to build and design different types of networks.

Course outcome:

At the end of the course students will be able to do:

CO1: Know the working of reference model of communication to provide end to end services for the various applications.

CO 2: Analyze the various behavior of network protocols using the networking tools

CO3. Use IP addressing and apply routing algorithms to find the routes for packet delivery

CO4.Design the basic computer network and maintain the network

CO5. Describe the working of Data link layer , transport layer

Syllabus

1. Introduction **[8Hrs]**

Basics of Computer Networks, Classification: transmission technology, scale; Applications; Data Communications: data, signal, bandwidth, bit interval and bit rate, Modes of Communication. Layered network architecture, Networks models: OSI model, TCP / IP protocol suite; Guided and Unguided Transmission media, Multiplexing: FDM, TDM. Switching: Circuit switching, message switching, Packet Switching.

2. Data link layer **[12Hrs]**

Data link control: Framing:Character Count, Character Stuffing, Bit Stuffing; , Error Detection and correction, Flow and error control, HDLC; Multiple access: Random access – Controlled access , ALHOA, CSMA, CSMA/CD and CSMA/CA; Ethernet : IEEE standards, standard

Ethernet, Fast Ethernet, Gigabit Ethernet; Connecting devices: repeater/hub, bridge, router and gateway, Backbone networks - Virtual LANS

3. Network layer

[14Hrs]

Functions of Network layer; Network Service types: Virtual Circuits, Datagrams; Logical addressing: IPv4, private and public IP addressing, special IP addresses, subnetting, IPV6 addressing Internet Protocol: Internetworking:IPv4, Fragmentation and reassembly , Address mapping : ARP, RARP, BOOTP, DHCP, ICMP . Routing: classification of routing, Shortest path routing, Distance Vector routing, Link State routing;

4. Transport layer and Application layer **[9Hrs]**

Process-to-Process delivery: User Datagram Protocol (UDP), Transmission Control Protocol (TCP), Quality of services (QoS); Application Layer: Domain Name System (DNS) , E-mail, FTP, HTTP.

5. Wireless Networks **[2Hrs]**

Basics of wireless networking.

TEXT BOOK:

1. Andrew S. Tanenbaum, David J. Wetherall"Computer Networks", Prentice-Hall, 5th Edition.

REFERENCES:

1. Behrouz A. Forouzan, "Data communication and Networking", Tata McGraw – Hill, 2011, 4th Edition.
2. James F. Kurose, Keith W. Ross, "Computer Networking – A Top-Down Approach Featuring the Internet", Pearson Education, 2009, 5th Edition,
3. Nader. F. Mir, "Computer and Communication Networks", Pearson Prentice Hall Publishers, 2010.
4. Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, "Computer Networks: An Open Source Approach", McGraw Hill Publisher, 2011.
5. Larry L. Peterson, Bruce S. Davie, "Computer Networks: A Systems Approach", Morgan Kaufmann Publishers, 2011, 5th Edition

Lab : Computer Networks

Credits : 1

Marks : 25

practical (Any 6 Practical):

1. Setting up of LAN Network (2P)
2. IP address manipulation -Extract network id and Host id given netmask (2P)/Mini Project
3. Configuring routing tables
4. TCP Socket programming (2P)
5. UDP Socket programming (2P)
6. Mini Project / Simulation of IP fragmentation
7. Mini Project/Configuring E-Mail/DNS
8. Installing virtual machines, Ethernet cabling

****

Course Title: Network Security

Course Code: COM-VI. E-13

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses:

- Introduction to Programming(COM-I.C-2)/Object Oriented Programming(COM-III.C-5A)

Course Objectives:

To understand the theory and concepts of Network Security

Course outcome:

At the end of the course students will be able to :

CO1: Gain Knowledge of the threats, vulnerabilities and system risks

CO2: Understand cryptography, ciphers and encryption algorithms

CO3 : Compare and contrast symmetric and asymmetric encryption systems

CO4: Know about viruses, Trojan horses, worms, program flaws and the defenses against them

Syllabus

1. Concepts of Security & Classical Encryption Techniques **[6Hrs]**

Introduction, The need for security, Security Approaches, Security Attacks, Security Services, Security Mechanisms, A Model for Network Security, Classical Encryption Techniques : Substitution techniques, Transposition techniques, Steganography.

2. Design Principle of Block Cipher **[6Hrs]**

Block Cipher Operation: Electronic Code Book, Cipher Block Chaining, Cipher Feedback, Output Feedback, Counter, Feistel Cipher, The Data Encryption Standard.

3. Cryptography

i. Mathematical Tools **[3Hrs]**

Introduction to Number Theory, Modular Arithmetic, Prime Numbers, Euler's Totient Function.

ii. Public Key Cryptography **[3Hrs]**

Principles of Public Key Cryptosystems, The RSA Algorithm, Other Public key cryptosystems, Diffie Hellman Key Exchange.

iii. Cryptographic Hash Functions **[7Hrs]**

Applications of Cryptographic Hash Functions, Two Simple Hash Functions, Hash Functions Based on Cipher Block Chaining, MD5 Message Digest Algorithm, Secure Hash Algorithm SHA 512.

4. Message Authentication Codes and Digital Signatures [8Hrs]

Message Authentication Requirements – Message Authentication Functions –Requirements for Security of MACs,MACs Based on Hash Functions, HMAC, MACs Based on Block Ciphers, Data Authentication Algorithm. Digital Signatures, Digital Signature Standard.

5. Key Management & Distribution And User Authentication [6Hrs]

Introduction, Digital Certificate, Private key Management, The PKIX Model, Public key cryptographic standards ,XML, PKI and security

6. Program Security [3Hrs]

Flaws, Malicious code: viruses, Trojan horses, worms, Program flaws: buffer overflows, time-of-check to time-of-use flaws, incomplete mediation.

7. Firewall and Virtual Private Network [3Hrs]

Introduction to network security techniques: IP Security, firewalls, virtual private networks.

TEXT BOOKS:

1. William Stallings, ―Cryptography and Network Security – Principles and Practices‖,

Prentice Hall of India, Fifth Edition

2. KahateAtul, “Cryptography and Network Security” Tata McGraw-Hill.

3. Charles P. Pfleeger and Shari L. Fleeger, ―Security in Computing‖. Prentice-Hall.2003, (3rd edition)

4. Menezes A. J., P.C. Van Oorschot and S.A. Vanstone, “Handbook of Applied Cryptrography”

Lab : Network Security

Credits :1

Marks :25

1. Implementation of Caesar Cipher
2. Implementation of One-Time Pad
3. Implementation of Playfair Cipher
4. Implementation of Hill Cipher
5. Implementation of Data Encryption Standard Algorithm
6. Implementation of Image Steganography
7. Implementation of RSA Algorithm
8. Implementation of Digital Signatures using RSA Algorithm
9. Design Network protocol analyzer tool to analyse network traffic.
10. Mini Project/ Case Study

****

Course Title: Cloud Computing

Course Code: COM-VI. E-14

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses:

- Operating Systems(COM-V.C-7)

Course Objectives:

- To make students understand the key elements of cloud computing.
- To understand the difference between deploying applications on the cloud and the local infrastructure.
- To understand various cloud service models.

Course Outcomes:

At the end of the course students will be able to :

CO1: Explain the core concepts of the cloud computing paradigm.
CO2: Characterize the different cloud services ie. Infrastructure, Platform and Software as a Service (IaaS, PaaS, SaaS).

Syllabus

1. Overview of Computing Paradigm [**7Hrs**]

Recent trends in Computing: Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing.

2. Introduction to cloud computing: **[7Hrs]**

Cloud Computing definition, History of Cloud Computing, How Cloud Computing Works, Benefits and challenges of cloud computing, Issues for Cloud Computing.

3. Cloud Computing Architecture **[10Hrs]**

Comparison with traditional computing architecture (client/server), Cloud Computing Service Models, Deployment Models- Public cloud, Private cloud, Hybrid cloud and Community cloud, Key drivers to adopting cloud, Impact of cloud on users, Governance in the cloud.

4. **Infrastructure as a Service(IaaS)** [**7Hrs**]

Introduction to IaaS: IaaS definition, Introduction to virtualization, Different approaches to virtualization, Hypervisors, Machine Image, Virtual Machine(VM). Resource Virtualization: Server, Storage, Network. Examples: Amazon EC2.

5. **Platform as a Service(PaaS)** **[7Hrs]**

Introduction to PaaS: What is PaaS, Service Oriented Architecture (SOA).Cloud Platform and Management: Computation, Storage, Examples: Google App Engine, Microsoft Azure, SalesForce.com.

6. **Software as a Service(PaaS)** **[7Hrs]**

Introduction to SaaS, Web services,Web 2.0, Web OS, Introduction to MapReduce, Case Study on SaaS.

Text Books:

1. Tim mather, subra kumarswamry and sharhed Latif, "Cloud Computing Security and Privacy", O'Reilly publication.
2. Richard Hill, Laurie Hirsch, Peter Lake, SiavashMoshiri, "Guide to Cloud Computing Principles and Practices", Springer, 2013.
3. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, "Cloud Computing: Principles and Paradigms", Wile,2011.
4. Nikos Antonopoulos, Lee Gillam"Cloud Computing: Principles, Systems and Applications", Springer, 2012.
5. Ronald L. Krutz, Russell Dean Vines,"Cloud Security: A Comprehensive Guide to Secure Cloud Computing", Wiley-India, 2010

Lab : Cloud Computing

Credit : 1

Marks : 25

1. Create virtual machines that access different programs on same platform.
2. Create virtual machines that access different programs on different platforms.
3. Install a C compiler in the virtual machine and execute a sample program.
4.Working on tools used in cloud computing online-
a) Storage

b) Sharing of data

c) Manage your calendar, to-do lists,

d) A document editing tool

5. Working with any cloud service to make spreadsheet and notes and collaborate online in real time and chat with other collaborators.
6. Exploring Public Cloud.
7. Exploring Cloud IDE's.
8. Installation and Working of Google App Engine
9. Web Service deployment and usage over cloud.

****

Course Title: Multimedia Techniques

Course Code: COM-VI. E-15

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses: Nil

Course Objectives:

On completion of the course the students will develop specific skills and competencies by making them proficient in Designing Graphical Images, Audio and Video Capture and Editing using Software tools

Course Outcomes:

At the end of the course students will be able to :

CO1 :Understand the concept of Multimedia – Team members and their roles.

CO2 :Identify and describe the function of the general skill sets in the multimedia industry.

CO3 : Classify and realize the types of Authoring tools and their functions.

CO4 : Identify basic components of a multimedia project.

CO5 : Analyze the requirements of Multimedia product.

CO6: Assemble and deliver multimedia projects

Syllabus

1. Introduction to Multimedia: [8Hrs]

Commonly used terms associated with multimedia like CDROM, Storyboard, Script and Authoring tools.

Stages of a Multimedia Project-Planning and Costing, Designing and Producing, Testing and Delivering.

The Multimedia team and their roles- Project Manager, Writer, Video specialist, Audio specialist and Multimedia programmer.

Multimedia Software.Multimedia Hardware.

Social & Ethical considerations, Digital Representations & Standards.

2. Introduction to Computer Graphics: [8Hrs]
Vector graphics fundamentals, shapes, transforms and filters,
Bitmapped graphics: resolution, image compression, manipulation, Geometrical transformations

3. Text and Layout: [5Hrs]

Text in graphics, character set, fonts, layout

4. Sound: [8Hrs]

Basic Sound Concepts, Digitizing and processing sound, Music, Speech, Compression, formats, MIDI and Digital Audio

5. Color Science and Color Models: [8Hrs]
Human vision, Camera systems, Gamma correction, Color matching, different Color models – RGB, CYMK, Transformations among color model

6. Video: [8Hrs]
Digitizing video, streamed video, video standards, compression: mpeg, dv, codec comparison, introduction to Animation: captured, sprite, key frame, web, 3-D. Virtual reality: VRML

Text Book:

1. Nigel Chapman, Jenny Chapman; Digital Multimedia; Wiley India Edition, 2nd Edition
2. Ze-Nian Li & Mark S Drew; Fundamentals of Multimedia; Pearson Education International Edition
3. Vaughan, Tay; Multimedia: Making it Work; Tata McGraw-Hill, 3rd edition
4. Jeffcoate, Judith; Multimedia in Practice, Technology and Applications, PHI

Lab: Multimedia Techniques

Credit: 01

Marks: 25

Practical can be done using Proprietary or FOSS for Text, Image, Audio and Video Editing. For example Scribus, GIMP, Audacity, Movie maker, Openshot, etc.

1. Design a Brochure for a given product, give details. Learn about different Image file Formats
2. Design a Poster with given information and learn about Image compression
3. Learn to prepare Images for Print, Web and Video.
4. Edit the Sound file and Learn about Effects and Filters of sound
5. Record Your voice and learn about Audio Compression.
6. Record an Audio Program and Learn about streaming an audio content.
7. Learn about Video editing – Prepare video with rough cut
8. Prepare Video content with title and special effects.
9. Record Video content and learn about video compressions.

Prepare Video content for streaming.

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Course Title: Digital Marketing

Course Code: COM-VI.E-16

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses: Web Designing (COM-III.E-4)

Course Objectives:

- To study various online Marketing Strategies.
- Analyze and research Internet to improve the quality and marketability of the Websites.

Course Outcomes:

At the end of the course students will be able to :

CO1:Optimize the website for various search engines.

CO2:Market the company/product using Search Engine and Social Media.

CO3: Analyze the Web for improving the marketing strategy.

Syllabus

I. Search Engine Optimisation (SEO): [10Hrs]

Introduction to Online Search; Function of Search Engines Google Page Rank; Introduction to Search Engine Optimisation; Building Accessible Site; Keyword Research and Optimisation; Link Building Strategies; Useful Tools for SEO; The Past, Present and Future of SEO.

II. Search Engine Marketing (SEM): [9Hrs]

Introduction to Internet and Search Engine Marketing; Google Adwords; Adwords Account Structure; Navigating in Google Adwords; Working with Keywords; Creating Ads in Google Adwords; Creating and Managing your First Ad Campaign; Adwords Reporting and Account Performance Reports.

III. Social Media Marketing (SMM): [9Hrs]

Introduction to the World of SMM; Why Social Media?; Getting Started with Social Media; Building Relationships via Facebook, Twitter, LinkedIn, YouTube; Handling Positive and Negative Comments; Social Media Content Base Creation.

IV. Email Marketing: [5Hrs]

Importance of Email marketing; Email Marketing Software's; Subscriber List; Email Marketing Campaign; Newsletters; Measuring the results.

V. WEB Analytics: [9Hrs]

Web Analytics and Intelligence Tools; Basic Metrics Demystified; Introduction to Google Analytics; Goals and Actionable Insights; Data Management; Social Media Analytics; Social Media Goals and KPI's; Tools for Social Media Analytics.

VI. Marketing Automation: **[3Hrs]**
Introduction to Marketing Automation; Advantages of using Marketing Automation Software; Issues with Marketing Automation.

Text Books:

- Damian Ryan, 2014 "Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation", Kogan Page Publisher, 3rd Edition.

Reference Books:

- Calvin Jones and Damian Ryan, 2012 "The Best Digital Marketing Campaigns in the World**:**
- Nick Smith, 2013 , "Successful SEO and Search Marketing in a Week", Teach Yourself Publisher,.
- Lee Odden,2012,"Optimize: How to Attract and Engage More Customers by Integrating SEO, Social Media, and Content Marketing", Wiley Publishing, 1st Edition.
- AvinashKaushik, 2013, "Web Analytics 2.0: The Art of Online Accountability & Science of Customer Centricity (Sybex)", Wiley Publishing, 2nd edition .

Practical: Digital Marketing

Credit: 1

Marks: 25

1. Using Search Engine Optimization tools (like google&bing search console, hubspot, webceo, google page speed)
2. Using Search Engine Marketing tools (like googleadwords, googleadwords certifications, search, display, remarketing formats, facebook marketing, linkedin advertising)
3. Using Social Media Marketing tools (like hootsuite, buffer, sproutsocial, klear, twitonomy, socialmention, google alerts, mention)

4. Using Email Marketing tools (like mailchimp, campaign monitor, mailgun, mandrill, phplist, amazon ses

5. Using Web Analytics tools (likegoogle analytics, compete.com, crazyegg, facebook insights, twitter insights)

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ANENXURE IV A

Parvatibai Chowgule College of Arts and Science

(Autonomous)

DEPARTMENT OF COMPUTER SCIENCE

COURSE STRUCTURE

THREE YEAR B.Sc. DEGREE COURSE IN COMPUTER SCIENCE

COMPONENT A:

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	**COM-I.C-1** Mathematical foundation of Computer Science – I	**COM-I.C-2 *** Introduction to Programming	---	---	---	---
II	**COM-II. C-3 **** Object Oriented	**COM-II.C-4 *** Data Structures	---	---	---	---

	Programming					
III	**COM-III.C-5 *** Data Base Management Systems -I	---	**COM-III.E-1** Software Engineering	**COM-III. E-2** Digital Logic Design	**COM-III. E-3** Mathematical Foundation of Computer Science – II	**COM-III. E-4** Web Designing
IV	**COM-IV.C-6** Computer Architecture and Organization	---	**COM-IV.E-5** Design & Analysis of Algorithms	**COM-IV.E-6** Data Base Management System II	**COM-IV. E-7** Server Side Programming	**COM-IV. E-8** HCI
V	**COM-V.C-7 *** Operating Systems	---	**COM-V. E-9** Embedded Systems	**COM-V. E-10** Mobile Application Development	**COM-V. E-11** Introduction to Data Science	**COM-V. E-12** Software Testing

VI	**COM-VI.C-8 *** Computer Networks	---	**COM-VI.E-13** Network Security	**COM-VI. E-14** Cloud Computing	**COM-VI. E-15** Multimedia Techniques	**COM-VI. E-16** Digital Marketing

Note: * Core Compulsory Courses also offered for minor subject combination.

** Core Compulsory Courses also offered for minor subject combination in 4th Semester.

Programme Specific Outcome (PSO) for B.Sc. Computer Science

At the end of the programme the students will be able to:

PSO1 : Analyze a Software problem, design, implement a solution and evaluate the proposed solution to ensure that it meets customer needs and Software standard.

PSO2 : Use and Apply appropriate current technologies, techniques and modern tools necessary for computing practice.

PSO3: Embark on an Entrepreneurial venture or be eligible for employment in IT industry or pursue higher education.

PSO4: Apply the concept of networking and security features in designing the systems.

Parvatibai Chowgule College of Arts and Science (Autonomous)
Margao, Goa

B.Sc. Computer Science – Syllabus

(From Academic Year 2019-20)

Semester I

Course Title: Mathematical Foundation of Computer Science I

Course Code: COM-I.C-1

Marks: 75

Credits: 3

Duration: 45 Hrs

Prerequisite Courses: Nil

Course Objectives:

- To build mathematical foundations that are essential requirement in understanding various concepts related to computer science.

Course Outcome:

At the end of the course students will be able to:

CO1 : Apply counting principles to determine probabilities.

CO2 : Demonstrate an understanding of relations and functions and determine their properties.

CO3 : Evaluate Boolean functions and simplify expressions using the properties of Boolean algebra.

CO4 : Write an argument using logical notation and determine if the argument is valid or not.

CO5 : Construct and analyze finite state automata.

Syllabus

1. **Combinatory:** **[8Hrs]**

Permutations, Combinations, Counting, Summation, generating functions, recurrence relations.

2**. Binary Number System:** **[7Hrs]**

Decimal to binary conversion and vice versa, binary number representation (signed, 1's Complement and 2's complement) binary addition, subtraction, binary to octal, hexadecimal conversion and vice versa. Floating point representation.

3. **Boolean Algebra:** **[7Hrs]**

Boolean functions, truth table, De Morgan's theorem, logic gates, Realization of Boolean Function using logic gates, Simplification using Karnaugh map.

4. **Set, Relations and Functions:** **[9Hrs]**

Venn diagram, set operations, relations and properties, closures, equivalence relations, Partial ordering, functions, function types, inverse of functions, composition of functions, recursive functions, growth of functions.

5. **Logic:** **[6Hrs]**

Propositional logic, first order logic, mathematical induction, deduction, proof by Contradiction, program correctness.

6. **Grammars, Languages and Automation:** **[8Hrs]**

Grammars and languages, finite automation of finite state machines, regular languages, regular expressions.

Text Book:

Rosen H. Kenneth, *Discrete Mathematics and its Applications*, Tata McGraw Hill, seventh edition, 2011.

Reference:

Sarkar Kumar Swapan, *A Textbook of Discrete Mathematics*, S Chand & Company, 2005.

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Practical: Mathematical Foundation of Computer Science I

Credit: 1

Marks: 25

Programs to be written using C Language:

1. Generate all permutations of *n* symbols, where $2 \leq n \leq 5$ is user defined.

2. Read a number and convert to other number formats.
    1. Convert an integer into binary number.
    2. Convert a binary number to decimal number.
    3. Convert a binary number to octal number.
    4. Convert a number into normalized form.

3. String Manipulation
    1. Read a string of decimal digits. Find the frequency distribution of digits.
    2. Read a binary string. Check the occurrence of the pattern 1001 in the string.
    3. Read two binary numbers. Add them using 1's complement and 2's complement method.

4. Read two integer numbers. Find their GCD using recursion.

5. Read the value of *p*. Find the *p*-th Fibonacci number from the following recurrence relation.
   $f(0) = 0, f(1) = 1, f(n) = f(n-1) + f(n-2), n \geq 2$.

6. Given two functions $f(x) = x^3 + 2x + 3$, and $g(x) = 3x^2/4 + 10$, find $f \circ g\ (x)$.

7. Readan expression containing parentheses and check whether it is properly parenthesized.

    1. Equal number of '(' and ')' brackets
    2. Equal number of '{' and '}' brackets
    3. Equal number of '[' and ']' brackets

8. Applications of set theory
    1. Read a set and check whether a given number is a member of the set.
    2. Read two sets. Find their union.
    3. Read two sets. Find their intersection.

9. Applications of finite state machines, matrices, Boolean algebra, gates.

10. Bit-wise operations using C

Programs using C language that covers the following concepts:

1. Conditions
   - if..else
   - nested if

2. Iterative Control Statements
   - for
   - while
   - do…while

3. Functions.
   - Standard Library functions
   - Call by Value
   - Call by reference
   - Recursive functions

4. Arrays.
   - One Dimensional Arrays
   - Two Dimensional Arrays

5. Sorting
   - Bubble sort
   - Insertion sort

6. Searching.
   - Sequential search
   - Binary search

7. Pointers.
   - Arrays and Pointers
   - Function returning pointers
   - Dynamic memory allocation

8. Strings.
   - Standard Library string functions
   - Strings and Pointers
   - Array of Strings

9. Structure and Union
   - Array of structures
   - Passing Structure to functions
   - Nested structure
   - Structure and Pointer
   - Union

10. File Handling.
   - Text file
   - Binary file
   - Random Access to a file
   - Command Line arguments

****

Course Title: Introduction to Programming

Course Code: COM-I.C-2

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses: Nil

Course Objectives:

- To make the student understand the concept of basic computer algorithm and use the algorithm for various problem solving.
- To implement algorithms using high level programming language.
- To understand basic principles of structured programming – example C

Course Outcomes:

At the end of the course students will be able to :

CO1: Develop solutions to problems that are new to them, and implement these solutions efficiently.

CO2: Apply mathematics and logic to solve computing problems.

CO3: Develop Computer based Problem Solving Skills.

CO4: Recognize and incorporate programming elements such as loops, decision making, functions, arrays, string, structures, pointers and files into applications that solve real world problems. Develop programming skills.

1. **Introduction to Computer Problem Solving:** **[5Hrs]**

Algorithm, Flowchart, The Problem Solving Aspect, General problem solving strategies, Top-Down Design, Implementation of Algorithms, Efficiency of Algorithms, Recursive algorithms.

2. **Basic Algorithms:** **[3Hrs]**

Exchanging the values, Summation of a set of numbers, factorial computation, generation of the Fibonacci series, reversing the digits of an integer, base conversion.

3. **Factoring Methods:** **[2Hrs]**

Finding divisors of an integer, finding the Greatest Common Divisor of two integers, generating prime numbers, computing prime factors of an integers.

4. Sorting and Searching algorithms **[2Hrs]**

Bubble sort, Insertion Sort, Sequential Search and Binary Search.

5. Introduction to 'C': **[3Hrs]**

History, Structure of a C program, Keywords, Identifiers, variables, constants, data types, Arithmetic Operators & Expressions, Logical operators and Relational Operators, Precedence and Associativity rules.

6. **Conditions and Iterations:** **[3Hrs]**

Conditions and Actions, Condition statement, Simple control statement (*if*, *if-else, switch*), Iterative control statements (*for*, *while*, *do-while*).

7. Functions: **[5Hrs]**

What is a function, Advantages of functions, Standard library functions; User defined functions – declaration, definition, function call, parameter passing, return keyword. Scope of variables, Storage classes, Recursion.

8. **Arrays:** **[4Hrs]**

One and Two dimensional arrays: Array declaration, initialization, accessing the values, passing arrays to functions.

9. **Pointers:** **[4Hrs]**

Pointer declaration, initialization, Pointer arithmetic, Pointer to Pointer, Arrays and Pointers, Functions and Pointers – passing pointers to functions, function returning pointer, dynamic memory allocation.

10. **Strings:** **[4Hrs]**

Declaration and initialization, standard library string functions, strings and pointers, array of strings.

11. **Structure and Union:** **[4Hrs]**

Creating structures, accessing structure members, array of structures, passing structure to functions, nested structure, pointers and structures, union, difference between structures and unions.

12. **File Handling:** **[4Hrs]**

FILE variable, file access modes, operations on files, random access to files, command line arguments.

13. **Preprocessing:** **[2Hrs]**

Format of Preprocessor directive, File Inclusion directive, Macro substitution, conditional compilation.

Text Books:

1. Dromey R.G., *How to solve it by computer*, Prentice Hall of India, 2^{nd} Edition, 2004.
2. Kanetkar Yeshwant, *Let us C*, BPB Publications, 13^{th} Edition, 2012.
3. Behrouz Forouzan, Richard Gilberg, *Computer Science: A Structure ProgrammingApproach using C*, Cengage Learning 3^{rd} Edition, 2013.

Reference books:

1. Horowith Ellis, Sahni Satraj, Sanguthevar Rajasekaran, *Fundamentals of Computer algorithm*, Orient Longman, 2^{nd} Edition, 2008.
2. Gottfried Byron, *Programming with C*, Tata McGraw Hill, 3^{rd} Edition, 2010.
3. Brain W. Kernighan and Dennis M Ritchie, *The C Programming Language*, Prentice Hall India, 2^{nd} Edition, 1988.

Practical: Introduction to Programming
Credit: 1
Marks: 25

Programs using C language that covers the following concepts:

1. Conditions
    - if..else

- nested if

2. Iterative Control Statements
    - for
    - while
    - do…while
3. Functions.
    - Standard Library functions
    - Call by Value
    - Call by reference
    - Recursive functions
4. Arrays.
    - One Dimensional Arrays
    - Two Dimensional Arrays
5. Sorting
    - Bubble sort
    - Insertion sort
6. Searching.
    - Sequential search
    - Binary search
7. Pointers.
    - Arrays and Pointers
    - Function returning pointers
    - Dynamic memory allocation
8. Strings.
    - Standard Library string functions
    - Strings and Pointers
    - Array of Strings
9. Structure and Union
    - Array of structures
    - Passing Structure to functions
    - Nested structure
    - Structure and Pointer
    - Union

10. File Handling.
- Text file
- Binary file
- Random Access to a file
- Command Line arguments

****

Semester II

Course Title: Object Oriented Programming

Course Code: COM-II.C-3

Marks : 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses: Nil

Course Objectives:

- To teach the basic concepts and techniques which form the object oriented programming paradigm
- To introduce object oriented programming (OOP) using Java.

Course Outcomes:

At the end of the course students will be able to :

CO1 : Apply fundamental object-oriented concepts in problem solving.

CO2: Analyze problem scenario and identify classes/objects, their properties/functionalities and associations.

CO3 : Analyze the problem scenario and model the system using UML diagrams.

CO4 : Implement the object oriented model in any object oriented language.

Syllabus

Principles of OOP **[3 Hrs**]

Programming paradigms. Basic concepts in OOP. OOP: major principles - encapsulation, abstraction, inheritance, polymorphism. Benefits of OOP. Applications of OOP.

Introduction to Java **[8 Hrs]**

Basics of Java programming, Data types, Variables, Operators, Control structures including selection, Looping, Java methods, Overloading, java.Math class, Arrays in java.

Objects and Classes **[9 Hrs]**

Basics of objects and classes in java, Constructors, Finalizer, Visibility modifiers, Methods and objects, object serialization, Inbuilt classes like String, Character, StringBuffer, File, this reference.

Inheritance and Polymorphism **[9 Hrs]**

Inheritance in java, Super and sub class, Overriding, java.lang. Object class, Polymorphism, Dynamic binding, Generic programming, Casting objects, Instance of operator, Abstract class, Interface in java, Package in java, java.util package.

Event and GUI programming **[6 Hrs]**

Design patterns – what and why? It's classification. Introduce the Observer design pattern. Event handling in java, Event types, Mouse and key events, GUI Basics, Panels, Frames, Layout Managers: Flow Layout, Border Layout, Grid Layout, GUI components like Buttons, Check Boxes, Radio Buttons, Labels, Text Fields, Text Areas, Combo Boxes, Lists, Scroll Bars, Sliders, Windows, Menus, Dialog Box, Applet and its life cycle.

Multithreading in java **[4 Hrs]**

Multithreading in java, Thread life cycle and methods, Runnable interface, Thread synchronization.

Exception handling **[3 Hrs]**

Exception handling – what and why? Try and catch block. Multiple catch blocks. Nested try, finally block, throw keyword, throws keyword. Custom Exception.

Introduction to the Collections Framework. **[3 Hrs]**

Text Book

Paul Deitel& H. Deitel, , Java - How to Program, Prentice Hall Publications 9th Edition,

Suggested Reference material

1. Patrick Naughton, Herbert Schildt, 2000, Java 2 – The Complete ReferenceTMH publications 9th Edition
2. Patrick Naughton, 1997, The Java Handbook –TMH publications
3. E. Balaguruswamy 2009,Programming with Java – A Primer, TMH Publications , 4th Edition
4. D. Flanagan, 2004, "Java Examples in a Nutshell", O'Reilly. 4th Edition
5. Arnold, Gosling & Holmes, 2005 "The Java Programming Language", Addison-Wesley Professional,4th Edition.

Practical: Object Oriented Programming

Credit: 1

Marks: 25

Programs using Java language that covers the following concepts:

1) Classes and instances
2) Working with the java.Math class
3) Inheritance
4) Composition v/s inheritance
5) Polymorphism, abstract classes and interfaces
6) Algorithm and Data Structures
7) Utilizing the java.util package
8) Event handling and GUI
9) Applets
10) I/O programming
11) Exception handling
12) Multithreading
13) Collections framework

****

Course Title: Data Structures

Course Code: COM-II.C-4

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses: Introduction to Programming (COM-I.C-2)

Course Objectives:

To understand different methods of organizing data and efficiently implement different data structures.

Course outcome:

At the end of the course students will be able to :

CO1: Define relevant standard algorithms for various data structures. Learn various applications of data structures

CO2: Implementation of data structures.

CO3: Use various data structures for sorting and searching.

CO4: Analyze and compare algorithms for efficiency using Big-O notation.

CO5: Formulate new solutions for programing problems.

Syllabus:

1. **Introduction to data structures:** **[2Hrs]**

Concept, Data type, Data object, ADT, Need of Data Structure, Types of Data Structure

2. **Algorithm analysis:** **[2Hrs]**

Algorithm – definition, characteristics, Space complexity, time complexity, Asymptotic notation (Big O).

3. **Linked List:** **[7Hrs]**

Introduction to List, Implementation of List – static & dynamic representation, Types Linked List, Operations on List, Applications of Linked List, polynomial of manipulation, Generalized linked list – concept & representation.

4. **Stacks:** **[7Hrs]**

Introduction, Representation-static & dynamic, Operations, Application - infix to postfix& prefix, postfix evaluation, Simulating recursion using stack.

5. **Queues:** **[5Hrs]**

Introduction, Representation -static & dynamic, Operations, Circular queue, priority queue (with implementation), Concept of doubly ended queue.

6. Trees: **[10Hrs]**

Concept & Terminologies, Binary tree, binary search tree, Representation – static & dynamic, Operations on BST – create, Insert, delete, traversals (preorder, inorder, postorder), counting leaf, non-leaf & total nodes, non recursiveinorder traversal, Expression Tree. Introduction to AVL Trees, Multiway Search Trees, B Tree, B+ Tree.

7. Searching and Sorting : **[6Hrs]**

Use of various data structures for searching and sorting, selection sort, merge sort, quick sort, heap sort and hashing.

8. **Graph:** **[6Hrs]**

Concept & terminologies, Graph Representation – Adjacency matrix, adjacency list, Traversals – BFS & DFS, Application of BFS, DFS – Shortest path, Backtracking.

Text Book:

Horowitz Ellis, Sahni Sartaj, 2008, *Fundamentals of Data Structures in C*, University Press, 2nd Edition.

Reference:

1. Langsam Yedidyah, Augenstein J. Moshe, Tenenbaum M. Aaron ,2009, *Data Structuresusing C*, Pearson Education, 2nd Edition.
2. Gilbeg Richard, ForouzanBehrouz, Data Structures: A Pseudocode Approch with C, Cengage Learning, 2nd Edition.
3. Michael Goodrich, Tamassia Roberto,2001, *Algorithm Design Foundations, Analysis and Internet Examples.* John Wiley and sons.

Practical: Data Structures

Credit: 1

Marks: 25

Programs using C language that covers the following concepts:

1. Stack: Static/Dynamic stack implementation.
2. Stack: infix to postfix.
   Stack: Evaluation of Postfix expression.
3. Queues: Static and Dynamic Queue Implementation
   Queues: Circular queue
4. List: Singly Linked List,
5. List: Doubly Linked List
6. List: Circular Linked List
7. Linked List: Polynomial addition
8. Trees: Binary Search Tree: create, add, delete, display nodes.

9. Trees: BST traversal.
10. Graph: Representation of Graphs, Graph Traversals.
    Graph: DFS, BFS.

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Semester III

Course Title: Data Base Management Systems -I

Course Code: COM-III.C-5

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisites: Nil

Course Objectives:

It provides basic knowledge of a database management system. It helps to understand importance of ER diagram. It introduces SQL to query a database.

Course outcome:

At the end of the course students will be able to :

CO1 :Gain a broad understanding of database concepts and the need for the same.

CO2: Identify different entities and relationship between them.

CO4: Represent the given system diagrammatically using ER diagram.

CO5: Convert an ER diagram to a schema and effectively represent it using appropriate RDBMS

CO6: Formulate queries in Relational Algebra, SQL to manipulate the database.

CO7: Analyze the schema to see if they fulfill Normalization criterion

Syllabus

1**. Overview of database management** **[7Hrs]**

Data, information, database, database management system; Managing data; File systems versus a DBMS, advantages of a DBMS; Data abstraction, instances and schemas, data models; Data manipulation language, data definition language; Architecture of a DBMS; Users of a DBMS, database administrator

2**. Database design and the ER model** [**10Hrs]**

Design phases – conceptual design, logical design, physical design; ER model – entities, attributes, and relationships, mapping cardinalities, keys; ER diagrams – strong entities, weak entities, generalization, specialization, aggregation; Converting ER diagram to relational schemas

3. **Relational model** **[9Hrs]**

Relation, properties of relational model; Entities, integrity constraints, referential integrity constraints; Relational algebra – select, project, cross product, set operations, rename operation; Other relational operations – natural join, outer join.

4. **SQL** **[10Hrs]**

Basic structure of SQL query – Create, select, where, from, rename operation; Set operations; Aggregate functions; Group by, having clauses; Nested queries; Views; Insert, delete, update.

5**. Functional dependency and normalization** **[6Hrs]**

Atomic domain, nested relation; Key, super key, primary key, candidate key; Functional dependency, axioms, closure of a set of attributes, closure of a set of functional dependencies; Purpose of normalization; 1NF; 2NF; 3NF; BCNF.

6**. Introduction to Transactions** [**3Hrs]**

Transaction concept, Transaction state, ACID properties, Concurrent Transactions, Serializability.

Text Book:

1. A Silberschatz, H F Korth, S Sudarshan, *Database system concepts*, McGraw-Hill ,sixth Edition

Reference Books:

Ramakrishan, J Gehrke, "*Database management systems"*, McGraw-Hill , 3^{rd} edition
R Elmasri, S B Navathe, "*Fundamentals of database Systems"*, Pearson Education , 5^{th} Edition

Lab : Database Management Systems

Credit : 1

Marks : 25

1. ER diagram(1P)
2. ER diagram with specialization/generalization and aggregation.(1P)
3. Converting ERD into Database.(1P)
4. Mini project covering concepts ERD, Creating tables, SQL, .NET Framework, Loops, Control Statements, controls, Database Connectivity, Design UI (10)
5. Normalization(1P)
6. Report Writing(1P)

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Course Title: Software Engineering

Course Code: COM-III.E-I

Marks: 75

Credits: 3

Duration: 45 Hrs

Prerequisite Courses: Nil

Course Objectives:

On completion of the course the students will develop specific skills and competencies to use various software engineering tools and methods to develop software for medical, industrial, military, communications, aerospace, business, scientific, and general computing applications.

Course Outcomes:

At the end of the course students will be able to :

CO1 : Have an ability to understand and identify various software testing problems and solve them.

CO2: Appreciate the role of Software Engineering in the Software development industry.

CO3: Demonstrate analytical design and implementation skills required in the process of Software project management.

CO4: Apply UML tools and strategies in Software development. Identify risks and suggest ways for risk mitigation. Evaluate the quality of design and code.

SOFTWARE PROCESS: [5Hrs]

Characteristics of software process.

Software Development Processes and Methodologies: waterfall, prototyping, iterative, spiral, unified process.
Benefits of iterative and incremental approach with emphasis on Unified process, CASE Tools, Agile methodologies.

PROJECT MANAGEMENT: [7Hrs]

Planning a Software Project – Cost estimation, Project Scheduling, Software configuration management plans, Quality Assurance plans, Project Monitoring plans and Risk Management. Techniques such as Interviewing , Requirement Workshop, brainstorming, prototyping. Characteristics of SRS

OOAD and UML: [10Hrs]

OOAD: Definition; object oriented analysis; object oriented design and modeling; Assigning responsibilities.

UML:Main UML diagrams – Class diagram , sequence diagram, activity diagram, use case diagram. Use case model – use case diagram , use case descriptions, use case realization using sequence and activity diagrams. Supplementary requirements. Advanced use case model features.

Requirements: Functional and non-functional
System Design: Class diagram, sequence diagram, activity diagram, state chart diagram, deployment diagram. Brief introduction to other UML diagrams.

SOFTWARE ARCHITECTURE PATTERNS: [5Hrs]

Major Architectural Styles (patterns) like Layered Architecture, Pipe and Filter, Shared (Central) Data Store, Event Driven, Model-View-Controller (MVC), "Distributed & Emerging" Service Oriented Architecture (SOA) and Elementary GRASP Patterns.

HUMAN COMPUTER INTERACTION: [4Hrs]

HCI Definition; User categories, Interface Design-Internal & External Interface design, user interface design, Interface design guidelines.

CODING: [2Hrs]

Coding styles, standards, peer reviews, checklist.

TESTING: **[4Hrs]**

Testing Fundamental, Functional Testing, Structural Testing, Testing Object-Oriented Programs, Testing Process and Metrics.

DOCUMENTATION and MAINTENANCE: [4Hrs]

Need for Software Documentation. Types of documentation

Need for Maintenance; Types of Maintenance

REENGINEERING: [4Hrs]

Business Process Reengineering, Software Reengineering, Reverse Engineering, Restructuring, Forward Engineering, The Economics of Reengineering

Text Books:

- Roger Pressman, Software Engineering: A Practitioners Approach, McGraw Hill, (6th Edition), 1997.
- Craig Larman, Applying UML and patterns, Addison Wesley, 2nd Edition, 2003

References :

- Pankaj Jalote, An Integrated Approach to Software Engineering, Narosa Publishing House, 2nd Edition
- Glenford J.Myers, " The Art of Software Testing ", John Wiley & Sons, 1979.
- Sommerville, Software Engineering, Adison Wesley, 7th edition, 1996.
- Martin Fowler, UML Distilled, Addison Wesley, 2nd Edition, 2003
- Thomas T. Barker , "Writing s/w documentation - a task oriented approach", Allyn& Bacon Series of Technical Communication , 1998.
- Steve Mc Connell, Code Complete, Microsoft Press, ISBN 978-0-7356-1967-8 Second Edition (June 2004)

Lab : Software Engineering

Credit : 1

Marks : 25

1) Requirements Gathering Techniques
2) SRS using IEEE format
3) Cost and Effort Estimation
4) I/O design
5) Test Case Design
6) Draw a Gantt Chart for a project
7) Develop a mini project/ Case Study

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Course Title: Digital Logic Design

Course Code: COM-III. E-2

Marks: 75

Credits: 3

Duration: 45 Hrs.

Prerequisite Courses: Nil

Course objectives:

To understand the basics of Boolean algebra and the operation of logic components, combinational, sequential circuits and design of digital systems.

Course Outcome:

After completing this course, students will be able to:

CO1: Convert values between decimal, binary, hexadecimal, andoctal number systems.

CO2: Develop the minimized logic expression for a digital system using Boolean algebra.

CO3: Implement combinational circuits using simple gates, complex gates, or universal gates.

CO4: Simplify the logic function and create the digital logic circuit.

CO5: Design the sequential logic circuit.

CO6: Design efficient digital logic circuit for a particular application.

Syllabus

1. **Introduction to Number Systems and codes:** **[3Hrs]**
Decimal, Binary, Hexadecimal, and Octal number systems; BCD Code, Gray Code, Excess-3 Code, ASCII code, Unicode.

2. **Boolean Algebra:** **[8Hrs]**
Basic Boolean functions, Postulates and theorems of Boolean Algebra, logic gates, Sum-of-Products and Product-of-Sums forms of Boolean functions; Canonical and Standard forms. Simplification of Boolean Functions, Plotting of K-Maps, POS and SOP Simplification, NAND and NOR implementation.

3. **Combinational Logic:** **[8Hrs]**

Design procedure for combinational logic circuits; design and analysis of Half Adder, Full Adder; their use in designing other combinational logic circuits; Analysis & Design of Encoders and Decoders; Multiplexer and demultiplexers; their use in designing combinational circuits.

4. **Sequential Circuits:** **[17Hrs]**

SR, JK, T, D Flip-flops and Latches, their schematic symbols, Truth tables. Shift Registers - SISO, SIPO, PISO, PIPO, Bi-directional Shift Registers, Loading methods for Shift, Registers. Design and analysis of Counters: Synchronous Counters, Modulo Counters, Asynchronous, Ripple and Ring Counters; Application of Counters.

5. D/A & A/D Converters: **[4Hrs]**

Digital to Analog converter – Introduction, Weighted-Resistor & R-2R Ladder,Analog to Digital Converter – Introduction, Successive Approximation method.

6. **Semiconductor memories:** **[5Hrs]**

Memory organization and operation, expanding memory size, Classification and characteristics of memories, RAM, ROM, Synchronous DRAM (SDRAM),Double Data Rate SDRAM, Synchronous SRAM, DDR and QDR SRAM,Content Addressable Memory.

Text Book:

1. R.P. Jain , ―Modern digital electronics‖ , 3rd edition , 12th reprint TMH Publication, 2007.

Reference Books:

1. D.P. Leach, A.P. Malvino, G.Saha, Digital Principles and Applications, 7th Edition, Mc. Graw Hill (SiE)
2. M. Morris Mano, Digital Logic and Computer Design.
3. Herbert Taub and Donald Schilling, Digital Integrated Electronics, McGraw-Hill.

Lab : Digital Logic Design

Credits :1

Marks :25

1. Introduction to digital ICs, specifications, verification of the truth tables of logic gates1.
2. Introduction to digital ICs, specifications, verification of the truth tables of logic gates2.

3. Implementation of the given Boolean function using logic gates in SOP form.
4. Implementation and verification of Decoder using logic gates.
5. Implementation of Multiplexer using logic gates.
6. Implementation and verification of De-multiplexer and Encoder using logic gates.

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Course Title: Mathematical Foundation of Computer Science - II

Course Code: COM-III.E-3

Credits: 3

Marks: 75

Duration:45 Hrs

Prerequisite Courses: Nil

Course Objectives:

The objectives of this Course are to build mathematical foundations in the areas namely graph theory and numerical analysis being closely related to topics of computer science.

Course Outcomes:

On completion of the course students should be able to

CO1: Describe the following concepts: Graph theory and Numerical analysis.

CO2: Apply the Interpolation methods for solving the problems numerically.

CO3: Demonstrate the process of curve fitting of data.

CO4: Determine the roots of polynomial equations.

CO5: Construct and solve real-world problems using graphs and trees.

Syllabus

Graph Theory

1. Graphs, Subgraphs and Components **[3Hrs]**

Graphs, subgraphs, and some special graphs; Graph properties; Paths, cycles, and components.

2. Trees and Cycles **[4Hrs]**

Trees; Spanning trees; Algorithms to find MST; Cycles; Generation of Trees and Cycles.

3. Connectivity **[3Hrs]**

Cut vertices, Cut edges and Blocks; Eccentricity sequences and Sets; Connectivity parameters.

4. Planarity **[4Hrs]**

Planar embeddings; Bridges; two characterization theorems.

5. Eulerian graphs **[3Hrs]**

Introduction; Eulearian and traversable graphs; Non-Eulearian graphs.

6. Digraphs **[4Hrs]**

Basic definitions; types of connectedness; Covers and bases; Connectivity; Acyclic digraphs.

Numerical Analysis

1. Interpolation with Equal Intervals **[6Hrs]**

Introduction; Various methods of interpolation; Various methods of curve fitting; Newton's method of forward interpolation formula; Newton's method of backward interpolation formula.

2. Interpolation with Unequal Intervals **[2Hrs]**

Introduction; Lagrange's formula.

3. Numerical Integration **[5Hrs]**

Introduction; General quadrature formula; Trapezoidal rule; Simpson's one-third rule; Simpson's three-eighth rule; Weddle's rule.

4. Solutions to algebraic and transcendental equations **[5Hrs]**

Introductions; Graphical method; Bisection method; Method of false position; Secant method; Newton-Raphson method

Linear Algebra **[6Hrs]**

Adjoint, inverse of a matrix; Rank; Linear equations; Characteristics roots and vectors

Text Books:

1. K R Parthasarathy, Basic Graph Theory, Tata McGraw-Hill Publishing, 1994

2. B S Goel, S K Mittal, Numerical Analysis, PragatiPrakashan, 13th Edition, 1998

3. S.N. Iyengar, Matrices, Anmol Publications, 2010

Reference Books:

1. J Clark, D A Holton, A First Look at Graph Theory, World Scientific, 1991

2. P N Chatterjee, Numerical Analysis, RajhansPrakashanMandir, 3rd Edition, 1996

3. V. Krishnamurthy, Introduction to Linear Algenra, Affiliated East-West Press, First Edition, New Delhi, 1976

**Lab : ** Mathematical Foundation of Computer Science - II

Credit: 1

Marks: 25

Graph Theory

1) Read a graph, check if it is connected and find the components of a graph.

2) Check the existence of cycle in a graph.

3) Find the minimum spanning tree of a given weighted graph.

4)Implementation of Dijkstra's algorithm.

5) Find the strongly connected components of a digraph.

Numerical Analysis

6) Find the value of dependent variable using Newton's forward formula for a given value of independent variable.

7) Use Newton's backward formula to estimate a value

8) Estimate a value using Lagrange's formula

9) Apply Simpson's three-eighth rule to find the value of integration

10) Apply Newton-Raphson method OR secant method to estimate the root of a equation

Linear Algebra

11) Find the rank of a matrix.

12) Find solutions of a system of equations

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Course Title: Web Designing

Course Code: COM-III.E-4

Credits: 3

Marks: 75

Duration:45 Hrs.

Prerequisite Courses: Nil

Course objectives:

How to design good user interfaces covering importatant design principles such as learnability, visibility, error prevention, efficiency and graphic design

Course Outcomes:

At the end of the course students will be able to :

CO1: Identify the UI design principles.

CO2: Classify GUI design patterns.

CO3: Design a website structure using HTML (including HTML5).

CO4: Apply the style sheets to the website, using CSS (including CSS3).

CO5: Implement the dynamic features to the website and validate the forms using Javascript.

CO6: Apply JQuery methods to realize feature rich interactive website.

CO7: Design a full-fledged website using all the above technologies.

Syllabus

Unit I : User Interface – Introduction, its importance, design principles – learnability, visibility, error prevention, efficiency, graphic design. Design Patterns for GUI – View tree, Listener, Widget, Model-View-Controller. Approaches to GUI programming – Procedural, Declarative, Direct Manipulation. Web UI – HTML, Javascript, Jquery. **[6Hrs]**

Unit II : Structure and Style with HTML and CSS

HTML **[6Hrs]**

Introduction. The development process, basic HTML, formatting and fonts, commenting code, color, hyperlink, lists, tables, images, simple HTML forms, web site structure, Meta tags, Character entities, frames and frame sets.

HTML5 **[6Hrs]**

Introduction, New Elements, Canvas, SVG, Drag/Drop, Geolocation, Video, Audio, Input types, form elements, form attributes, semantic, web storage, app cache, web workers, SSE

CSS **[5Hrs]**

Introduction – Syntax, Id & Class, Backgrounds, Text, Fonts, Links, Lists, Tables. CSS Box Model – Border, Outline, Margin, Padding. Advanced - Grouping/Nesting, Dimension, Display, Positioning, Floating, Align, Pseudo-class, Pseudo-element, Navigation Bar, Image Gallery, Image Opacity, Image Sprites, Media Types, Attribute Selectors.

CSS3 **[5Hrs]**

Introduction, Borders, Backgrounds, Gradients, Text Effects, Fonts, 2D Transforms, 3D Transforms, Transitions, Animations, Multiple Columns.

Unit 3 : Javascript **[10Hrs]**

Introduction - What is JavaScript, Understanding Events, JavaScript Example, External JavaScript. Basic Elements – Comment, Variable, Global Variable, Data Types, Operators, If Statement, Switch, Loop: for and while, Function. JavaScript Objects – objects, Array. Browser Object Model - Browser Objects, Window Object, Document Object – getElementById, getElementsByName, getElementsByTagName, innerHTML property, inner Text property. Validation- form validation, email validation.

Unit 4 : Introducing jQuery **[7Hrs]**

JQuery : Introduction - Syntax, Selectors, Events. Effects- Hide/Show, Fade, Slide, Animate, stop(), Callback, Chaining. HTML/CSS- Add, Remove, CSS Classes, css(), Dimensions, slider. Traversing – ancestors, descendants, siblings, filtering.

Reference books:

Elisabeth Robson, Eric Freeman, “Head First HTML and CSS”, O'Reilly

Ivan Bayross, “HTML 5 and CSS 3 Made Simple”, BPB publication

Kogent Learning Solutions Inc., “HTML5 Black Book: Covers CSS3, Javascript, XML, XHTML, Ajax, PHP and Jquery”, Pearson Education.

Steven M. Jacobs, Ben Shneiderman, “Designing the User Interface : Strategies for effective human-computer interaction”, 5th Edition, Pearson Education

Lab : Web Designing

Marks: 25

Credits: 1

1) Case studies to review UI designs

2) Create a HTML page with the following :

a) title heading paragraph emphasis strong and image elements

b) complex HTML table

c) simple HTML Form covering major form elements

d)Embed Video in an HTML page

3) Using CSS do the following :

a) Create a Navigation bar (with dropdown) with CSS

b) Create a CSS Grid

c) Create a CSS3 based button

d) make an image rounded shape

e) Create a CSS based sticky footer

f) Create CSS3 Corner Ribbon

g) Create CSS3 blurry text effect

h) Create CSS3 speech bubble shape

i) Create image cross fade with CSS3 transition

j) Set style for link hover active and visited states of hyperlink

4) Write JavaScript functions to :

a) accept a string as a parameter and converts the first letter of each word of the string in upper case
b) check whether a given credit card number is valid or not.
c) check whether a given value is an valid url or not.
d) check whether a given email address is valid or not.
e) print an integer with commas as thousands separators
f) remove items from a dropdown list.

5)Use JQuery to :

a) Disable buttons
b) Make textbox read only
c) Uncheck check boxes
d) Confirm again
e) Sort
f) Switch rows and columns

A mini project combining all the technologies learnt using a front-end development framework such as bootstrap is recommended.

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Semester IV

Course Title: Computer Architecture and Organization

Course Code: Com-IV. C-6

Marks:75

Credits : 3

Duration:45 Hrs.

Prerequisite Courses: Nil

Objectives:

To have a thorough understanding of the basic structure and operation of a digital computer.

Course Outcome:

At the end of the course students will be able to :

CO1: Identify various components of the Computer System.

CO2: Explain the detailed function of a typical microprocessor and its control unit.

CO3: Develop 8086 processor's Assembly Language Program for simple mathematical problems.

CO4: Differentiate the function and role of semiconductor memories and map the cache memory for the given scenario.

CO5: Appraise the importance of input/output modules and Interrupts and their functions.

CO6: Distinguish the characteristics and function of I/O interfaces to computer system.

CO7: Illustrate the function of pipelined architecture and classify the Multiprocessor systems.

Syllabus

1. Computer System: [3Hrs]

Function and structure of a computer, Interconnection of components, Performance of a computer. Computer Architecture – Princeton (Von Neumann) and Harvard architecture.

2. Processing Unit: [6Hrs]

Architecture of 8086 processor - Registers, ALU and Control unit, Data path in a CPU. Instruction cycle, Organization of a control unit – Block Diagram of Hardwired and Microprogrammed control unit.

3. Representation of Instructions: [10Hrs]

Machine instructions characteristics, Types of operations-data transfer, arithmetic, logical, conversion, I/O, system control, transfer of control; 8086 Instruction Set and Assembly language: Addressing modes-immediate, direct, indirect, register, register indirect, displacement, stack. Instruction formats - instruction length, allocation of bits, variable length instructions, Instruction set architectures - CISC and RISC architectures.

4. Memory Subsystem: [10Hrs]

Characteristics of memory system, the memory hierarchy, Semiconductor memories, Types of ROM & RAM, Cache memory unit - Concept of cache memory, Organization of a cache memory unit, Mapping methods, replacement algorithms, write policy, block size.

5. Input/Output Subsystem: [8Hrs]

General block diagram of External device & I/O module, Programmed I/O, Interrupt driven I/O, DMA, I/O channels and I/O processors. I/O interfaces –Serial port, Parallel port, PCI Bus, SCSI bus, USB bus, Firewire and Infiniband.

6. Parallel Processing: [8Hrs]

Classifications, Introduction to pipeline processing: Instruction pipeline & Arithmetic pipeline, Introduction to Array & Vector processors, Introduction to Multiprocessors.

Text Book:

1. William Stallings, “Computer Organization and Architecture - Designing for performance”, EEE, PHI, 9th Edition.

Reference Books:

1. M. Morris Mano, “Computer System Architecture”, Pearson Education, 3rd Edition, 2008
2. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design – The Hardware/Software Interface", Morgan Kaufmann, 4th Edition.
3. Douglas V. Hall, "Microprocessors and its Interfacing**”,** McGraw Hill Education (India) Private Limited, 3rd Edition.

Lab : Computer Architecture and Organization

Credits: 1

Marks: 25

1. Study of Motherboard, Peripherals and the Computer System. O.S.Installation (Dual Boot): BIOS; Manage disk partitions: understand MBR-style partitions, (primary, extended, logical); list/create/delete partitions; Manage logical volumes: create/remove physical volumes, create/delete logical volumes, Boot loader.

   Installation of drivers; updating software packages

2. DOS Commands, Tools for Computer Management (Disk Management, Disk Cleanup, Defragmentation, Performance Monitor, System Restore etc).

Assembly language programs for 8086 using MASM / compatible assembler or Simulator, either in Windows or Linux.

3. Study of addressing modes.
4. Programs for arithmetic operations
5. Programs for data transfer operations
6. Programs for logical operations
7. Programs code conversion
8. Programs on sorting
9. Programs on searching
10. DOS/BIOS – Programming

****

Course Title : Design and Analysis of Algorithms

Course Code : COM-IV.E-5

Marks : 75

Credits : 3

Duration:45 Hrs

Prerequisite Courses: Nil

Course Objectives:

- To study paradigms and approaches used to analyze and design algorithms and to appreciate the impact of algorithm design in practice.
- To ensure that students understand how the worst-case time complexity of an algorithm is defined, how asymptotic notation is used to provide a rough classification of algorithms and compare with one another, and how there are still some problems for which it is unknown whether there exist an efficient algorithm, and how to design efficient algorithms.

Course Outcomes:

At the end of the course students will be able to :

CO1: To explain basic concepts related to the design and analysis of algorithms
CO2: To describe classical algorithms and their complexity.
CO3: To design and analyze selected algorithms.

Syllabus

1. Introduction [8Hrs]

What is an Algorithm?, Rules for writing Algorithms, Properties of Algorithms, Framework for design and analysis of algorithms(RAM model of computation),Recursive Algorithms, Space and Time Complexity by Tabular method(Performance Analysis).

2. Divide and Conquer **[7Hrs]**

Elements of Divide and Conquer Algorithms, QuickSort algorithm, Merge sort analysis, Strassen's algorithm for matrix multiplication, Analysis of Binary Search,The Maximum subarray Problem.

3. Dynamic programming **[8Hrs]**

General Method, caching v/s computation, Fibonacci numbers by recursion, Fibonacci numbers by cashing, Fibonacci numbers by dynamic programming,Optimal Binary Search Tree,Rod Cutting Problem.

4. Greedy algorithms **[5Hrs]**

Elements of greedy strategy, Activity-selection problem, Job sequencing with deadlines.
Knapsack problem.

5. Basic Traversal and Search Technique **[7Hrs]**

Techniques for Binary Trees, Techniques for Graphs(Breadth First search and Traversal, Depth First Search and Traversal)

6. Graph Algorithms **[6Hrs]**

Elementary graph algorithms- Minimum spanning tree, growing a spanning tree, Kruskal and Prim algorithms.

7. Complexity Classes **[2Hrs]**

Introduction to polynomial time algorithms, NP, NP Complete, NP Hard

8. Introduction to Randomisation and approximation. **[2Hrs]**

Text books

Thomas H. Cormen, charles E. Leiserson, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, “Introduction to Algorithms”, EEE, PHI, Third Edition

Ellis Horowitz, SartajSahni, SanguthevarRajasekaran, “Fundamentals of Computer Algorithms”, Galgotia, 2nd Edition

Reference Books

A. Aho, J. Hopcroft, J. Ullman, “The Design and Analysis of Computer Algorithms”, Pearson Education, Eighth Edition

Lab : Design and Analysis of Algorithms

Credit : 1

Marks : 25

1. Program to find GCD of 2 numbers using Iterative approach and Recursive approach
2. Program for quickSort
3. Program to perform Binary Search using Recursive approach
4. Program to generate Fibonacci numbers using Dynamic Programming approach.
5. Program to implement Activity Selection Problem.
6. Program to implement job sequencing with Deadlines.
7. Program to implement Knapsack Problem
8. Program to implement Rod Cutting Problem.
9. Program to implement Binary Tree.
10. Program to implement Optimal Binary Search Tree.
11. Program to represent graph using matrix.
12. Program to represent graph using Linked List.
13. Program to implement BFS/DFS Traversal on graph.
14. Program to implement Kruskal’s Algorithm
15. Program to implement Prim’s Algorithm

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Course Title: Data Base Management System - II

Course Code: COM-IV.E-6

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisites: Data Base Management Systems –I (COM –III C-5)

Course Objectives:

To provide advance database solutions.

Course outcome:

At the end of the course students will be able to :

CO1: Formulate complex queries for database updation.
CO2: Implement stored procedures and Functions.
CO3: Understand concurrent transactions and Recovery mechanisms.
CO4: Develop a full database application.
CO5: Understand and appreciate the NoSQL databases.

Syllabus

1**. Advanced SQL** **[15Hrs]**

SQL data types and schemas, Integrity constraints, Authorization, Embedded SQL, Dynamic SQL, Triggers, Stored Procedures, views

2**. Indexing and Hashing** [**7Hrs]**

Basic concepts**,** Ordered Indices, Dense and Sparse Indices. B and B+ trees Hashing – Static hashing, Dynamic Hashing, Extendable hashing, Comparison of Ordered Indexing and Hashing.

3. Transaction, Concurrency Control, Recovery System. **[10Hrs]**

Transaction: Transaction concept, Transaction state, Implementation of Atomicity and Durability, concurrency. Serializability, conflict serializability. Concurrency Control : Lock-Based Protocol

Recovery System: Failure Classification, Storage structure, Stable storage implementation, Recovery and Atomicity: Log-Based Recovery.

4. Introduction to Big data and NoSQL [**13Hrs]**

Introduction to the Big Data problem. Current challenges, trends, and applications Comparison between SQL and NOSQL Databases Types and examples of NoSQL databases- Column, Document, Key-value, Graph, Multi-model. Introduction to Document type NoSQL database such as MongoDb. - Introduce concepts of collection and documents, Advantages, Data types, Projections, indexing, Sharding .

Text Book:

A Silberschatz, H F Korth, S Sudarshan, *Database system concepts*, McGraw-Hill ,sixth Edition

Reference Books :

Ramakrishan, J Gehrke, "*Database management systems"*, McGraw-Hill , 3rd edition R Elmasri, S B Navathe, "*Fundamentals of database Systems"*, Pearson Education , 5th Edition Kristina Chodorow *MongoDB : The Definitive Guide (English)* O'Reilly 2nd Edition

Lab : Database Management Systems II

Credits : 1

Marks : 25

1. SQL Revision

2. Advance SQL- Dynamic SQL, Triggers
   Advance SQL- Stored Procedures

3. Using ODBC API for insertion of record into database.
   Using ODBC API for deletion of record.
   Using ODBC API for modification of data.
   Using ODBC API for data retrieval.

4. Installing and Creating a document using MongoDb concept
   Performing Indexing using MongoDb

5. Performing aggregation functions on MongoDb
   Implementation of Master-Slave approach.

6. Connection of MongoDb using Java
Insertion, modification, deletion using MongoDb
Data retrieval using MongoDb
Shrading using Java and MongoDb

7. Mini Project

****

Course Title: Server Side Programming

Course Code: COM-IV.E-7

Marks: 75

Credits : 3

Duration:45 Hrs

Prerequisite Courses:

- Object Oriented Programming (COM-II.C-3)
- Software Engineering (COM-III.E-1)

Course Objectives:

- Provide an in depth understanding of object oriented approaches to software development, in particular to the analysis and design phases of the software life cycle.
- Design and implement basic server-side scripts
- Create data documents using XML
- Create and manipulate databases using SQL and server side technologies
- Understand how rich internet applications are implemented using AJAX and XML/JSON.

Course Outcomes:

At the end of the course students will be able to :

CO1 : Get hands-on programming experience using open -source software, PHP and MySQL to build professional-quality, database-driven websites.

CO2 : Develop the skills to build interactive web sites with authentication and security by integrating PHP with HTML and CSS.

CO3 : Learn how to apply basic and advanced object-oriented programming techniques, use libraries, frameworks and advanced database connectivity techniques, and integrate PHP with other web technologies to build secure e-commerce applications.

CO4 : Customize an application to meet the specific needs of a client use case as would be done in a real-world application.

Syllabus

Review of OOAD: **[6 Hrs]**

Object Oriented Concepts - Class, Object, member variable, member function, Inheritance, Polymorphism, overloading, Data Abstraction, Encapsulation. Review of object oriented design and modeling.

Server-side technologies: **[15 Hrs]**

Static vs. Dynamic web pages, Need for Server Side technologies, Multitier Web Architecture. Common Gateway Interface standard, server-side includes, server APIs, server-side scripting – working principles, and implicit objects. Database and file access. Comparison of Web servers.

Ajax-Enabled Rich Internet Applications with XML and JSON **[15 Hrs]**

AJAX – introduction, purpose, advantages and disadvantages. Key elements of AJAX – introduction to XML. XML processing with server sidescript. XSL, transforms andtemplates. The XMLHttpRequest object–methods and properties. Creating and usingXMLHttpRequest objects. Using XSLT with AJAX. JSON – Syntax, mixing literals, Array, object, encoding/decoding, JSON versus XML, server-side JSON tools.

Web Services: **[9 Hrs]**

Introduction, its role. Basics – Creating, Publishing, Testing and Describing a Web services (WSDL)-Consuming a web service. SOAP - introduction, requests and responses. Role of UDDI – accessing registries. REST based web services – building, deploying and consuming

Reference Books:

1.Andrea Steelman and Joel Murach, Murach's Java Servlets and JSP, 2nd Edition

2.Bryan Basham and Kathy Sierra, Head First Servlets and JSP

3.Dana Moore, Edward Benson, Professional Rich Internet Applications: Ajax And Beyond (English), Wiley India

4.Schmelzer, XML and Web Services Unleashed, Pearson India

Lab : Server Side programming

Credit : 1

Marks : 25

1) Perform OOAD of a given system using the following diagrams:
   - a) use case
   - b) class
   - c) sequence
   - d) activity

2) Using server side programming and following OOAD principles develop a dynamic web application.

3) Add AJAX and Web service(s) to the application.

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Course Title: Human Computer Interface

Course Code: COM-IV.E-8

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisites: Nil

Course Objectives:

To study the different aspects of human computer interaction and the computer interface design concepts.

Course Outcomes

At the end of the course students will be able to :

CO1 : Understand the intricacies of human interaction with a computer System.

CO2 : Appreciate the principles of good screen design and layouts.

CO3 : Understand the different navigation schemes on windows based interface; learn the different types of selection devices and components of a window based interface.

CO4: Analyze Requirements of system. Classify human users based on their abilities, personalities.

CO5: Design prototypes. Evaluate the design of user interfaces.Compare the interfaces different products.

Syllabus

1. Introduction: Human-Computer Interaction, Evaluating Designs, The Birth of HCI. Importance of user Interface, Importance of good design, Benefits of good design, principles & heuristics of good design **[4Hrs]**

2. Human interaction with computers, Importance of : Human characteristics, Human consideration, Human interaction speeds, Understanding business functions. User centred design- Need-finding: Participant Observation, Interviewing, Additional Need finding, contextual inquiry & persona. **[6Hrs]**

3. Rapid Prototyping: story boarding. Paper Prototyping and Mockup, Video Prototyping, Creating and Comparing Alternatives **[5Hrs]**

4. Direct Manipulation and Representations: various user interaction models- command, menu, Direct Manipulation. Mental Models. Heuristics (guidelines) for design. **[7Hrs]**

5. Graphical Interface Design: Graphical user interface, standards such as Microsoft windows HCI guidelines, Windows: Navigation schemes selection of window; Selection of devices based and screen based controls, Components, Text and messages, Icons, Multimedia, Colors., controls, Help & error messages design. **[8Hrs]**

6. Web user interface design – jessy James Garette five layers of user experience. **[4Hrs]**

7. Heuristic Evaluation: Heuristic Evaluation — Why and How? **[4Hrs]**

8. visualization, Amount of information, Focus and emphasis, Presentation information simply and meaningfully, Information retrieval on web, Statistical graphics **[7Hrs]**

Text books:

1. Alan Cooper & Robert Reimann, About Face 2.0: The Essentials of Interaction Design, Wiley
2. Alan Dix, Janet Finlay, Gregory D. Abowd, and Russell Beale, Human-Computer Interaction (3rd Edition), Pearson, 2004.
3. Ben Shneiderman and Catherine Plaisant, Designing the User Interface: Strategies for Effective Human-Computer Interaction (5th Edition), 5th ed., Pearson Addison-Wesley, 2009
4. Donald A. Norman, The Design of Everyday Things, Basic Books, 2002

Lab : Human Computer Interface

Credit : 1

Marks : 25

1. Paper Prototyping using templates
2. Conducting survey interview and summarizing the result
3. Persona- conducting contextual interview and developing persona
4. GUI design- form design, menu design, help, error messages
5. Web UI design- pages, navigation, controls, (Ajax)
6. Report designs

7. Visualization and info graphics
8. Heuristic evaluation
9. Story boarding

****

Semester V

Course Title: Operating Systems

Course Code: COM-V.C-7

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses :

- Introduction to Programming(COM-I.C-2)
- Data structures(COM-II.C-4)

Course Objectives:

This course aims at understanding functions of operating system. As part of the course students will study different aspects of operating system such as Memory management, CPU scheduling, Concurrency, Storage management etc.

Course Outcomes:

At the end of the course students will be able to :

C01: Understand the fundamental functions of an operating system.

C02: Gain knowledge of Process, process coordination, Process synchronization.

C03: Understand the concept of memory management and virtual memory.

C04: Implement CPU scheduling, memory allocation algorithms.

C05: Gain knowledge of storage devices.

Syllabus :

1. Introduction to Operating System: [**4Hrs]**

Basic elements of a computer system: Processor, Main Memory, I/O Modules, System Bus, Instruction Execution; Operating Systems: Definition, Operating system Structure, operating system operations, Relationship between Kernel, OS, and Hardware, Operating system services, System calls, Types of system calls, System programs.

2. Process Management: **[10Hrs]**

Process Definition, Process Control Block, Process States, Operations on Process; Interprocess communication, Threads and Microkernels: Definition, Multi-threading Model Process Scheduling, Scheduling Criteria, Scheduling Algorithms, Multi-Processor Scheduling;

3. **Process Coordination** **[10Hrs]**

Process Synchronization, Principles, Mutual Exclusion, The Critical-Section Problem, Petersons Solution, Semaphores, Monitors, Readers/Writers Problem; Classic Problems of Synchronization, Dining Philosopher's problem

Deadlocks- system models, Deadlock characterization , Deadlock Handling Methods, Prevention, Avoidance, Detection, Recovery From Deadlock

4. **Memory Management:** **[13Hrs]**

Introduction, Swapping, Contiguous Memory Allocation, Paging, Page Table, Segmentation

Virtual Memory: Introduction, Demand Paging, Page Replacement, Allocation of Frames, Thrashing

5. Storage Management **[5Hrs]**

File System, Concepts, File Organization and Access Methods, Directory and Disk Structure.

Secondary Storage Structure - Overview, disk structure, Disk attachment, Disk scheduling

6. **Protection and Security** **[3Hrs]**

   System Protection :Goals of protection, Principles, domain of protection, Access Matrix, Implementation of Access Matrix.

Text Book:

1. A. Silberchatz, Galvin, Gagne, 2008, Operating System Concepts, Wiley publication8th Edition.

Reference Book:

William Stallings, Operating Systems: Internals and Design Principles,Prentice Hall, 6th Edition

Lab : Operating Systems

Credit : 1

Marks : 25

Any 8 from the following can be done.

1. Demo/Review of Installing Linux / Windows Operating System, Partitioning and formatting disk, Installing applications device drivers, working with files, mounting file systems, checking system space, creating, modifying and deleting user accounts
2. Study of Basic commands of Linux.
3. Shell Programming in Unix/Linux, arithmetic operations, loops
4. Shell Programming – advanced
5. Menu Driven Shell scripting
6. Filters and Pipes in LINUX
7. Implementation of Inbuilt Linux/UNIX commands like cp, rename etc.

8. Implementation of CPU scheduling policies.
9. Implementation of Memory allocation techniques:
10. Implementation of Banker's algorithm. (Resource Allocation Graph)

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Course Title: Embedded Systems

Course Code: COM-V.E-9

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses:

- Digital Logic Design(COM-III.E-2)
- Knowledge of Programming

Course Objectives:

- To have a thorough understanding of Embedded Systems and their applications.

Course Outcome:

At the end of the course students will be able to :

CO1: Describe Embedded Systems and its characteristics.

CO2: Classify the Embedded processors and their design metrics.

CO3: Summarize the performance of ARM processors and various components of Embedded Systems.

CO4: Classify Sensors and Actuators, identify their functions and applications.

CO5: Categorize I/O devices, I/O Interfacing and Communication protocols along with their functions.

CO6: Generalize the functionality of IoT and RTOS.

CO7: Design and develop Embedded / IoT Applications using Arduino/Raspberry Pi boards.

Syllabus :

1. **Introduction:** **[6Hrs]**
   Introduction to Embedded Systems, Microprocessors and Micro-controllers. Components of Embedded System & its Classification, Characteristic of embedded system. Introduction to embedded processor, Digital Signal Processor, Application Specific System Processor, Design Process in Embedded System, Design metrics, Steps in design process. Challenges in Embedded System design, Design Examples. Advances in Embedded Systems.

2. **System hardware:** **[10Hrs]**
   System hardware, Interrupt structure and Applications, ARM Processor - Architecture, Programmer's model, Modes of operation, Interrupt**,** Handling Interrupts,Comparison of ARM7 & ARM9. Components of Embedded Systems-Management of Power Supply, Clocking Unit, Real Time Clock and Timers, Reset Circuitry and Watchdog Timer. Processor and Memory Selection, Memory Map of Embedded System, Interfacing Processors, Memories and I/O – Analog vs Digital. Overview of Arduino, Intel Edison and Raspberry Pi boards.

3. **Sensors and Actuators (Overview):** **[12Hrs]**
   Sensors / Transducers: Principles – Classification – Parameters – Characteristics – Environmental Parameters (EP) – Characterization.

   Thermal Sensors: Introduction – Gas thermometric Sensors – Thermal Expansion Type Thermometric Sensors.

   Magnetic sensors: Introduction – Sensors and the Principles Behind – Magneto-resistive Sensors, Semiconductor Magnetoresistors.

   Smart Sensors: Introduction – Primary Sensors – Excitation – Amplification – Filters – Converters – Compensation – Information Coding/Processing - Data Communication – Standards for Smart Sensor Interface – The Automation.

Sensors Applications: Introduction – On-board Automobile Sensors (Automotive Sensors) – Home Appliance Sensors – Aerospace Sensors –– Sensors for Manufacturing – Sensors for environmental Monitoring.

Actuators: Overview of Pneumatic and Hydraulic Actuation Systems, Mechanical Actuation Systems, Electrical Actuation Systems

4. I/O Interfacing and Communication: [10Hrs]

I/O interfacing and Communication Buses, Serial vs Parallel Communication, Serial Data Communication RS-232/UART. I/O devices, ADC / DAC, Optical Devices such as LED / LCD Display devices, Opto-Isolator, Relays, DC motor, Stepper motor, Timers/Counters, Parallel ports - Device interfacing. Serial communication Protocols - UART Protocols, I^2C, CAN, USB &ZigBee – Protocol Architecture, Topology, Packets, Communication Cycle, Arbitration, Applications and comparison.

5. Internet of Things (IoT): [3Hrs]

Introduction to IoT, **M2M to IoT**-The Vision-Introduction, M2M towards IoT- the global context, IoT **Architectural Overview, Potential and Challenges.**

1. Real Time Operating System: [4Hrs]

Introduction to RTOS, architecture of kernel, task and task scheduler, interrupt service routines in RTOS Environment.

Text Books

2. Rajkamal, "Embedded Systems – Architecture, Programming and Design", Tata McGraw Hill, Second Edition, 2008.
3. D. Patranabis, "Sensors and Actuators", 2nd Ed., PHI, 2013.

Reference Book:

1. Dr. K. V. K. K. Prasad, "Embedded / Real Time System : Concepts, Design, & Programming – Black Book‖", Dreamtech Press Publication.
2. David E Simon, "An Embedded Software Primer", Pearson India, 1st Edition.
3. Tammy Noergaard, "Embedded Systems Architecture", Elsevier
4. D. Patranabis, "Sensors and Transducers", PHI Learning Private Limited.
5. Dr. K. V. K. K. Prasad, Gupta Dass, Verma, "Programming for Embedded system", Wiley – Dreamtech India Pvt. Ltd.

6. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.

Lab : Embedded Systems

Credit: 1

Marks: 25

Programs to be executed on some of the embedded boards like Arduino, Intel Edison, Raspberry Pi, Bolt, etc., that covers the following tasks:

1) Interfacing sensors
2) Interfacing output devices
3) Interfacing input devices
4) Interfacing actuators
5) Building obstacle avoiding Robot
6) Line Following Robot
7) Programming with Raspberry Pi
8) Monitoring Data over Cloud
9) Building Web app to control devices.
10) Mini Project

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Course Title: Mobile Application Development

Course Code: COM-V.E-10

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses :

- Object Oriented Programming(COM-II.C-3)
- Web Designing(COM-III.E-4)

Course Objective:

Students learn how to develop applications for mobile devices, including smart phones and tablets. Students are also introduced to the current mobile platforms, mobile application development environments and mobile device input methods. Students will design and build a variety of apps on a popular platform throughout the course to reinforce learning and to develop real competency.

Course Outcome :

At the end of the course students will be able to do:

CO1: Explain mobile devices, including their capabilities and limitations.

CO2: Review current mobile platforms and their architectures.

CO3: Develop mobile applications on a popular mobile platform.

CO4: Evaluate development with another mobile platform.

Syllabus:

Introduction to mobile devices **[3 Hrs]**

Mobile devices vs. desktop devices, Why we Need Mobile App, Different Kinds of Mobile Apps, ARM and intel architectures, Power Management, Screen resolution, Touch interfaces, Application deployment - App Store, Google Play, Windows Store, Development environments – Android Studio, Phone GAP, Native vs. web applications.

Review of HTML5/JS/CSS3 **[2 Hrs]**

Quick recap of technologies, Mobile-specific enhancements, Browser-detection, Touch interfaces, Geolocation, Screen orientation, Mobile browser “interpretations” (Chrome/IE).

Mobile OS Architectures **[3 Hrs]**

Comparing and Contrasting architectures of Android, iOS and Windows, Underlying OS(Darwin vs. Linux vs. Windows), Kernel structure and native level programming, Runtime (Objective-C vs. Dalvik vs. WinRT), Approaches to power management, Security.

Android overview **[2Hrs]**

Introduction to Android.Overview of android stack, Introduction to OS layers, Android features. Linux Kernel, Libraries, Android Runtime, Application Framework, Dalvik VM

Android Components – Introduction **[3 Hrs]**

Activities, Services, Broadcast Receivers, Content Providers.

Building UI with Activities **[4Hrs]**

Activities, Views, layouts and Common UI components, Creating UI through code and XML, Activity life cycle, Intents, Communicating data among Activities.

Advanced UI **[5Hrs]**

Selection components (GridView, ListView, Spinner), Adapters, Custom Adapters, Menus,

Toast, Custom Toast,Dialogs, Status bar Notifications.

Multithreading **[4Hrs]**

Using Java Mutithreading classes, AsyncTask, Handler, Post.

Intent, Intent Filters and Broadcast Receivers **[4 Hrs]**

Role of filters, Intent-matching rules, Filters in your manifest, Filters in dynamic Broadcast Receivers, Creating Broadcast receiver, Receiving System Broadcast, Understanding Broadcast action, category and data, Sending Broadcast.

Data Storage **[5Hrs]**

Shared Preferences, Android File System, Internal storage, External storage. SQLite Introducing SQLite, SQLiteOpenHelper and creating a database, Opening and closing a database, Working with cursors, inserts, updates, and deletes.

Content Providers **[5Hrs]**

Accessing built in content providers, Content provider MIME types, Searching for content, Adding, changing, and removing content, Creating content provider, Working with content files.

Services **[5Hrs]**

Overview of services in Android, Implementing a Service, Service lifecycle, Inter Process Communication (AIDL Services).Web Services and WebView - Consuming web services, Receiving HTTP Response (XML, JSON), Parsing JSON and XML, Using WebView.

Reference books:

1. Beginning Android 4 Development, Wei-Ming Lee(John Wiley & Sons)
2. Pro Android 4 ; SatyaKomateneni, Dave MacLean (Apress)
3. Hello Android - Introducing Google's Mobile Development platform - Ed Brunette (The Pragmetic Bookshelf)
4. Android Apps with Eclipse 1st Edition, OnurCinar(Apress)
5. Android- A Programmer'S Guide, Dimarzio, J.F.(Tata McGraw Hill)

Web References:

1. http://developer.android.com/index.html
2. http://www.appinventor.org/

Lab : Mobile Application Development

Credit: 1

Marks: 25

1. Getting Started with Android – Installing the Development Environment, Configuring Android Stack
2. Creating the First Android Application - Creating a Simple Android Project, Debugging Application through DDMS. setting up environment. AVD Creation, Executing Project on Android Screen.
3. Android application development - Use of GUI components to implement a simple application such as a Calculator.
4. Review the earlier application making use of the advanced UI components.
5. Implementing Data storage application - an application to make Insert , update , Delete and retrieve operation on the database.
6. Understanding content providers and permissions: Read phonebook contacts using content providers and display them suitably.
7. Optimizing your app performance with Services/Multithreading/Multiprocessing
8. Course Project

****

Course Title: Introduction to Data Science

Course Code: COM-V.E-11

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite courses:

Students are expected to have basic knowledge of algorithms and reasonable programming experience, and some familiarity with basic linear algebra and basic probability and statistics.

Course Objectives:

Become familiar with methods of data science and their practical usefulness.

Course outcomes:

At the end of the course students will be able to do:

CO1*:* Describe what Data Science is and the skill sets needed to be a data scientist.

CO2:Explain in basic terms what Statistical Inference means. Identify probability distributions commonly used as foundations for statistical modeling. Fit a model to data.

CO3:Use R to carry out basic statistical modeling and analysis.

Syllabus

Introduction **[4Hrs]**

What is Data Science? Big Data and Data Science hype -and getting past the hype,
Why now? –Datafication, Current landscape of perspectives, Skill sets needed.

Statistical Inference: **[6Hrs]**
Populations and samples,Statistical modeling, probability distributions, fitting a model,
Intro to R

Exploratory Data Analysis and the Data Science Process: [**6Hrs]**
Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA,The Data Science Process, Case Study: RealDirect (online real estate firm).

Three Basic Machine Learning Algorithms: **[6Hrs]**
Linear Regression,k-Nearest Neighbors (k-NN),k-means

Feature Generation and Feature Selection (Extracting Meaning From Data): **[6Hrs]**
Motivating application: user (customer) retention,Feature Generation (brainstorming, role of domain expertise, and place for imagination) , Feature Selection algorithms ,Filters; Wrappers; Decision Trees; Random Forests

Mining Social-Network Graphs: **[6Hrs]**
Social networks as graphs,Clustering of graphs,Direct discovery of communities in graphs, Partitioning of graphs, Neighborhood properties in graphs

Data Visualization: **[6Hrs]**
Basic principles, ideas and tools for data visualization, Examples of inspiring (industry) projects, Exercise: create your own visualization of a complex dataset

Data Science and Ethical Issues: **[5Hrs]**
Discussions on privacy, security, ethics, A look back at Data Science,Next-generation data scientists

Text Book:

Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline, O'Reilly, 2014.

References Books :

• Jure Leskovek, AnandRajaraman and Jeffrey Ullman, Mining of Massive Datasets v2.1,Cambridge University Press, 2014 (free online).
• Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, ISBN 0262018020, 2013.
• Foster Provost and Tom Fawcett, Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking, ISBN 1449361323, 2013.
• Trevor Hastie, Robert Tibshirani and Jerome Friedman. Elements of Statistical Learning, Second Edition, ISBN 0387952845, 2009 (free online).
• Avrim Blum, John Hopcroft and RavindranKannan. Foundations of Data Science.
(Note: this is a book currently being written by the three authors. The authors have made the first draft of their notes for the book available online. The material is intended for a modern theoretical course in computer science.)

• Mohammed J. Zaki and Wagner MieraJr, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, 2014.
• Jiawei Han,MichelineKamber and Jian Pei, Data Mining: Concepts and Techniques, Third Edition, ISBN 0123814790, 2011.

Lab : Introduction to Data Science

Credit: 1

Marks: 25

1: Implementation of probability distribution

2: Sampling and re-sampling.

3: Linear Models

4: K-Nearest neighbour

5: K-Means

6: Feature Selection Algorithm

7: Filters and Wrappers

8: Decision Trees

All the experiments will be implemented using Excel /R-Tool/ or equivalent.

****

Course Title: Software Testing

Course Code: COM-V.E-12

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite courses: Introduction to Programming(COM-I.C-2)

Course Objectives:

- To study fundamental concepts in software testing, including software testing objectives, process, criteria, strategies, and methods.
- To discuss various software testing issues and solutions in software unit test; integration, regression, and system testing.
- To learn how to plan a test project, design test cases and data, conduct testing operations, manage software problems and defects, generate a testing report.

Course Outcomes:

At the end of the course students will be able to :

CO1 : Understand testing of web applications and automated testing tools.

CO2 : Apply modern software testing processes in relation to software development and project management.

CO3 : Create test strategies and plans, design test cases, prioritize and execute them.

CO4 :Develop an ability to understand and identify various software testing problems and solve them.

Syllabus

Software testing principles - Software Testing- Need for testing, Psychology of testing**,**Testing economics**,** SDLC and Testing**,**Verification&Validation**.**Quality Assurance, Quality Control **[3Hrs]**

Testing strategies and types - White box testing techniques - Statement coverage, Branch Coverage , Condition coverage, Decision/Condition coverage , Multiple condition coverage, Dataflow coverage, Automated code coverage analysis, Inspections, Walkthroughs Code Review **[5Hrs]**

Black box testing techniques - Boundary value analysis**,** Robustness testing **,**Equivalence partitioning**,** Syntax testing**,** Finite state testing**,** Levels of testing**,** Unit, Integration and System Testing**,** Compatibility Testing**,** Domain Testing**,** Adhoc Testing **,**Use of Requirement, Traceability Matrix **[6Hrs]**

Integration Testing Waterfall - Top-down ,Bottom up ,Big bang, Sandwich **[3Hrs]**

System and Performance Testing - Types of system testing ,Functional and non-functional testing Acceptance Testing ,Setting entry and exit criteria for phases and typical product release scenarios ,Basic factors governing performance testing, Methodology for performance testing ,Tools for performance testing **[4Hrs]**

Regression Testing - Purpose **,**Timing, Choice of tests **,**Smoke tests **,**Best practices **[3Hrs]**

Internationalization and Localization testing - Preliminary concepts, Adhoctesting,Pair testing, Extreme testing, Agile testing, Exploratory testing, Defect seeding **[3Hrs]**

Usability Testing - Factors in usability testing ,Aesthetics testing ,Accessibility testing ,Tools for usability testing **[3Hrs]**

Testing object oriented software - Definitions and Challenge differences from testing non-OO Software, Class testing strategies Class Modality, State-based Testing, Message Sequence Specification

[4Hrs]

People and organizational issues in testing - Common people issues and myths in testing, Providing career paths in testing, Organizational structures for testing teams, Geographically distributed testing teams and success factors. **[6Hrs]**

Test Management and Automation - Test

Planning, Test Management, Test Process, Test Reporting, Test Automation, Factors to consider in automation, Challenges in test automation, Test Metrics, Product Metrics, Process Metrics, Progress Metrics Use of metrics in ascertaining product release

[5Hrs]

References:

1. 1.Software Testing- Principles and Practices ,Srinivasan Desikan and Gopalaswamy Ramesh , Pearson Publication
2. Integrated Approach to Software Engineering , Pankaj Jalote, Narosa Publishing House
3. Software Engineering – A Practitioners Approach, Roger Pressman, McGraw Hill Publication

Lab: Software Testing

Credit: 01

Marks: 25

1. Planning Test Cases
2. Generating Test Cases/Test Suite
3. Enhancing Tests
4. Debugging Tests
5. Running Tests
6. Analyzing Results
   Reporting Defects

****

Semester VI

Course Title: Computer Networks

Course Code: COM-VI. C-8

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses :

- Introduction to Programming (COM-I.C-2)
- Object Oriented Programming (COM-II.C-3)

Course Objectives:

- To understand the basic concepts of Computer Networking.
- Be familiar with the components required to build and design different types of networks.

Course outcome:

At the end of the course students will be able to do:

CO1: Know the working of reference model of communication to provide end to end services for the various applications.

CO 2:Analyze the various behavior of network protocols using the networking tools.

CO3. Use IP addressing and apply routing algorithms to find the routes for packet delivery.

CO4.Design the basic computer network and maintain the network.

CO5. Describe the working of Data link layer , transport layer.

Syllabus :

1. Introduction [8Hrs]

Basics of Computer Networks, Classification: transmission technology, scale; Applications; Data Communications: data, signal, bandwidth, bit interval and bit rate, Modes of Communication. Layered network architecture, Networks models: OSI model, TCP / IP protocol suite; Guided and Unguided Transmission media, Multiplexing: FDM, TDM. Switching: Circuit switching, message switching, Packet Switching.

2. Data link layer [12Hrs]

Data link control: Framing: Character Count, Character Stuffing, Bit Stuffing; , Error Detection and correction, Flow and error control, HDLC; Multiple access: Random access – Controlled access , ALHOA, CSMA, CSMA/CD and CSMA/CA; Ethernet : IEEE standards, standard Ethernet, Fast Ethernet, Gigabit Ethernet; Connecting devices: repeater/hub, bridge, router and gateway, Backbone networks - Virtual LANS

3. Network layer [14Hrs]

Functions of Network layer; Network Service types: Virtual Circuits, Datagrams; Logical addressing: IPv4, private and public IP addressing, special IP addresses, subnetting, IPV6 addressing Internet Protocol: Internetworking:IPv4, Fragmentation and reassembly , Address mapping : ARP, RARP, BOOTP, DHCP, ICMP . Routing: classification of routing, Shortest path routing, Distance Vector routing, Link State routing;

4. Transport layer and Application layer [9Hrs]

Process-to-Process delivery: User Datagram Protocol (UDP), Transmission ControlProtocol (TCP), Quality of services (QoS); Application Layer: Domain Name System (DNS) , E-mail, FTP, HTTP.

5. Wireless Networks [2Hrs]

Basics of wireless networking.

TEXT BOOK:

1. Andrew S. Tanenbaum, David J. Wetherall“Computer Networks”, Prentice-Hall, 5th Edition.

REFERENCES:

1. Behrouz A. Forouzan, “Data communication and Networking”, Tata McGraw – Hill, 2011, 4th Edition.
2. James F. Kurose, Keith W. Ross, “Computer Networking – A Top-Down Approach Featuring the Internet”, Pearson Education, 2009, 5th Edition,
3. Nader. F. Mir, “Computer and Communication Networks”, Pearson Prentice Hall Publishers, 2010.
4. Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, “Computer Networks: An Open Source Approach”, McGraw Hill Publisher, 2011.
5. Larry L. Peterson, Bruce S. Davie, “Computer Networks: A Systems Approach”, Morgan Kaufmann Publishers, 2011, 5th Edition

Lab : Computer Networks

Credits : 1

Marks : 25

Practical (Any 6 practical):

1. Setting up of LAN Network (2P)
2. IP address manipulation -Extract network id and Host id given netmask (2P)/Mini Project
3. Configuring routing tables
4. TCP Socket programming (2P)
5. UDP Socket programming (2P)
6. Mini Project / Simulation of IP fragmentation
7. Mini Project/Configuring E-Mail/DNS
8. Installing virtual machines, Ethernet cabling

****

Course Title: Network Security

Course Code: COM-VI. E-13

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses:

Introduction to Programming(COM-I.C-2)/Object Oriented Programming(COM-II.C-3)

Course Objectives:

- To understand the theory and concepts of Network Security

Course outcome:

At the end of the course students will be able to :

CO1: Gain Knowledge of the threats, vulnerabilities and system risks.

CO2: Understand cryptography, ciphers and encryption algorithms.

CO3 : Compare and contrast symmetric and asymmetric encryption systems.

CO4: Know about viruses, Trojan horses, worms, program flaws and the defenses against them.

1. Concepts of Security & Classical Encryption Techniques [6Hrs]

Introduction, The need for security, Security Approaches, Security Attacks, Security Services, Security Mechanisms, A Model for Network Security, Classical Encryption Techniques : Substitution techniques, Transposition techniques, Steganography.

2. Design Principle of Block Cipher [6Hrs]

Block Cipher Operation: Electronic Code Book, Cipher Block Chaining, Cipher Feedback, Output Feedback, Counter, Feistel Cipher, The Data Encryption Standard.

3. Cryptography

i. Mathematical Tools [3Hrs]

Introduction to Number Theory, Modular Arithmetic, Prime Numbers, Euler's Totient Function.

ii. Public Key Cryptography [3Hrs]

Principles of Public Key Cryptosystems, The RSA Algorithm, Other Public key cryptosystems, Diffie Hellman Key Exchange.

iii. Cryptographic Hash Functions [7Hrs]

Applications of Cryptographic Hash Functions, Two Simple Hash Functions, Hash Functions Based on Cipher Block Chaining, MD5 Message Digest Algorithm, Secure Hash Algorithm SHA 512.

4. Message Authentication Codes and Digital Signatures [8Hrs]

Message Authentication Requirements – Message Authentication Functions –Requirements for Security of MACs,MACs Based on Hash Functions, HMAC, MACs Based on Block Ciphers, Data Authentication Algorithm. Digital Signatures, Digital Signature Standard.

5. Key Management & Distribution And User Authentication [6Hrs]

Introduction, Digital Certificate, Private key Management, The PKIX Model, Public key cryptographic standards ,XML, PKI and security

6. Program Security [3Hrs]

Flaws, Malicious code: viruses, Trojan horses, worms, Program flaws: buffer overflows, time-of-check to time-of-use flaws, incomplete mediation.

7. Firewall and Virtual Private Network [3Hrs]

Introduction to network security techniques: IP Security, firewalls, virtual private networks.

TEXT BOOKS:

1.William Stallings, ―Cryptography and Network Security – Principles and Practices‖,

Prentice Hall of India, Fifth Edition

2. KahateAtul, "Cryptography and Network Security" Tata McGraw-Hill.

3.Charles P. Pfleeger and Shari L. Fleeger, ―Security in Computing‖. Prentice-Hall.2003, (3rd edition)

4. Menezes A. J., P.C. Van Oorschot and S.A. Vanstone, "Handbook of Applied Cryptrography"

Lab : Network Security

Credits : 1

Marks : 25

1. Implementation of Caesar Cipher
2. Implementation of One-Time Pad
3. Implementation of Playfair Cipher
4. Implementation of Hill Cipher
5. Implementation of Data Encryption Standard Algorithm
6. Implementation of Image Steganography
7. Implementation of RSA Algorithm
8. Implementation of Digital Signatures using RSA Algorithm
9. Design Network protocol analyzer tool to analyze network traffic.
10. Mini Project/ Case Study

****

Course Title: Cloud Computing

Course Code: COM-VI. E-14

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses: Operating Systems(COM-V.C-7)

Course Objectives:

- To make students understand the key elements of cloud computing.

- To understand the difference between deploying applications on the cloud and the local infrastructure.

- To understand various cloud service models.

Course Outcomes:

At the end of the course students will be able to :

CO1: Explain the core concepts of the cloud computing paradigm.
CO2: Characterize the different cloud services i.e. Infrastructure, Platform and Software as a Service (IaaS, PaaS, SaaS).

Syllabus

1. Overview of Computing Paradigm **[7Hrs]**

Recent trends in Computing: Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing.

2. Introduction to cloud computing: **[7Hrs]**

Cloud Computing definition, History of Cloud Computing, How Cloud Computing Works, Benefits and challenges of cloud computing, Issues for Cloud Computing.

3. Cloud Computing Architecture **[10Hrs]**

Comparison with traditional computing architecture (client/server), Cloud Computing Service Models, Deployment Models- Public cloud, Private cloud, Hybrid cloud and Community cloud, Key drivers to adopting cloud, Impact of cloud on users, Governance in the cloud.

4. Infrastructure as a Service(IaaS) **[7Hrs]**

Introduction to IaaS: IaaS definition, Introduction to virtualization, Different approaches to virtualization, Hypervisors, Machine Image, Virtual Machine(VM). Resource Virtualization: Server, Storage, Network. Examples: Amazon EC2.

5. Platform as a Service(PaaS) **[7Hrs]**

Introduction to PaaS: What is PaaS, Service Oriented Architecture (SOA).Cloud Platform and Management: Computation, Storage, Examples: Google App Engine, Microsoft Azure, SalesForce.com.

6. **Software as a Service(PaaS)** **[7Hrs]**
   Introduction to SaaS, Web services,Web 2.0, Web OS, Introduction to MapReduce, Case Study on SaaS.

Text Books:

1. Tim mather, subra kumarswamry and sharhedLatif, "Cloud Computing Security and Privacy", O'Reilly publication.
2. Richard Hill, Laurie Hirsch, Peter Lake, Siavash Moshiri, "Guide to Cloud Computing Principles and Practices", Springer, 2013.
3. RajkumarBuyya, James Broberg, Andrzej M. Goscinski, "Cloud Computing: Principles and Paradigms", Wile,2011.
4. Nikos Antonopoulos, Lee Gillam"Cloud Computing: Principles, Systems and Applications", Springer, 2012.
5. Ronald L. Krutz, Russell Dean Vines,"Cloud Security: A Comprehensive Guide to Secure Cloud Computing", Wiley-India, 2010

Lab : Cloud Computing

Credit : 1

Marks : 25

1. Create virtual machines that access different programs on same platform.
2. Create virtual machines that access different programs on different platforms.
3. Install a C compiler in the virtual machine and execute a sample program.
4.Working on tools used in cloud computing online -
a) Storage
b) Sharing of data
c) Manage your calendar, to-do lists,
d) A document editing tool

5. Working with any cloud service to make spreadsheet and notes and collaborate online in real time and chat with other collaborators.
6. Exploring Public Cloud.
7. Exploring Cloud IDE's.
8. Installation and Working of Google App Engine
9. Web Service deployment and usage over cloud.

****

Course Title: Multimedia Techniques

Course Code: COM-VI. E-15

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses: Nil

Course Objectives:

On completion of the course the students will develop specific skills and competencies by making them proficient in Designing Graphical Images, Audio and Video Capture and Editing using Software tools

Course Outcomes:

At the end of the course students will be able to :

CO1 :Understand the concept of Multimedia – Team members and their roles.

CO2 :Identify and describe the function of the general skill sets in the multimedia industry.

CO3 : Classify and realize the types of Authoring tools and their functions.

CO4 : Identify basic components of a multimedia project.

CO5 : Analyze the requirements of Multimedia product.

CO6: Assemble and deliver multimedia projects

Syllabus

1. Introduction to Multimedia: [8Hrs]

Commonly used terms associated with multimedia like CDROM, Storyboard, Script and Authoring tools. Stages of a Multimedia Project-Planning and Costing, Designing and Producing, Testing and Delivering.

The Multimedia team and their roles- Project Manager, Writer, Video specialist, Audio specialist and Multimedia programmer. Multimedia Software. Multimedia Hardware. Social & Ethical considerations, Digital Representations & Standards.

2. Introduction to Computer Graphics: [8Hrs]

Vector graphics fundamentals, shapes, transforms and filters,
Bitmapped graphics: resolution, image compression, manipulation, Geometrical transformations

3. Text and Layout: [5Hrs]

Text in graphics, character set, fonts, layout

4. Sound: [8Hrs]

Basic Sound Concepts, Digitising and processing sound, Music, Speech, Compression, formats, MIDI and Digital Audio

5. Color Science and Color Models: [8Hrs]

Human vision, Camera systems, Gamma correction, Color matching, different Color models – RGB, CYMK, Transformations among color model

6. Video: [8Hrs]

Digitising video, streamed video, video standards, compression: mpeg, dv, codec comparison, introduction to Animation: captured, sprite, key frame, web, 3-D. Virtual reality: VRML

Text Book:

1. Nigel Chapman, Jenny Chapman; Digital Multimedia; Wiley India Edition, 2nd Edition
2. Ze-Nian Li & Mark S Drew; Fundamentals of Multimedia; Pearson Education International Edition
3. Vaughan, Tay; Multimedia: Making it Work; Tata McGraw-Hill, 3rd edition
4. Jeffcoate, Judith; Multimedia in Practice, Technology and Applications, PHI

Lab: Multimedia Techniques

Credit: 01

Marks: 25

Practical can be done using Proprietary or FOSS for Text, Image, Audio and Video Editing. For example Scribus, GIMP, Audacity, Movie maker, Openshot, etc.

1. Design a Brochure for a given product, give details. Learn about different Image file Formats
2. Design a Poster with given information and learn about Image compression
3. Learn to prepare Images for Print, Web and Video.
4. Edit the Sound file and Learn about Effects and Filters of sound
5. Record Your voice and learn about Audio Compression.
6. Record an Audio Program and Learn about streaming an audio content.
7. Learn about Video editing – Prepare video with rough cut
8. Prepare Video content with title and special effects.
9. Record Video content and learn about video compressions.

Prepare Video content for streaming.

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Course Title: Digital Marketing

Course Code: COM-VI.E-16

Marks: 75

Credits: 3

Duration:45 Hrs.

Prerequisite Courses: Web Designing(COM-III.E-4)

Course Objectives:

- To study various online Marketing Strategies.
- Analyze and research Internet to improve the quality and marketability of the Websites.

Course Outcomes:

At the end of the course students will be able to :

CO1: Optimize the website for various search engines.

CO2: Market the company/product using Search Engine and Social Media.

CO3: Analyze the Web for improving the marketing strategy.

Syllabus

I. Search Engine Optimisation (SEO): [10Hrs]

Introduction to Online Search; Function of Search Engines Google Page Rank; Introduction to Search Engine Optimisation; Building Accessible Site; Keyword Research and Optimisation; Link Building Strategies; Useful Tools for SEO; The Past, Present and Future of SEO.

II. Search Engine Marketing (SEM): [9Hrs]

Introduction to Internet and Search Engine Marketing; Google Adwords; Adwords Account Structure; Navigating in Google Adwords; Working with Keywords; Creating Ads in Google Adwords; Creating and Managing your First Ad Campaign; Adwords Reporting and Account Performance Reports.

III. Social Media Marketing (SMM): [9Hrs]

Introduction to the World of SMM; Why Social Media?; Getting Started with Social Media; Building Relationships via Facebook, Twitter, LinkedIn, YouTube; Handling Positive and Negative Comments; Social Media Content Base Creation.

IV. Email Marketing: [5Hrs]

Importance of Email marketing; Email Marketing Software's; Subscriber List; Email Marketing Campaign; Newsletters; Measuring the results.

V. WEB Analytics: [9Hrs]

Web Analytics and Intelligence Tools; Basic Metrics Demystified; Introduction to Google Analytics; Goals and Actionable Insights; Data Management; Social Media Analytics; Social Media Goals and KPI's; Tools for Social Media Analytics.

VI. Marketing Automation: **[3Hrs]**

Introduction to Marketing Automation; Advantages of using Marketing Automation Software; Issues with Marketing Automation.

Text Books:

- Damian Ryan, 2014*"Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation",* Kogan Page Publisher, 3rd Edition.

Reference Books:

- Calvin Jones and Damian Ryan, 2012 "The Best Digital Marketing Campaigns in the World**:**
- Nick Smith, 2013 , *"Successful SEO and Search Marketing in a Week",*Teach Yourself Publisher,.
- Lee Odden,2012,"*Optimize: How to Attract and Engage More Customers by Integrating SEO, Social Media, and Content Marketing"*, Wiley Publishing, 1st Edition.
- AvinashKaushik, 2013, *"Web Analytics 2.0: The Art of Online Accountability & Science of Customer Centricity (Sybex)",*Wiley Publishing, 2nd edition .

Practical: Digital Marketing

Credit: 1

Marks: 25

1. Using Search Engine Optimization tools (like google&bing search console, hubspot, webceo, google page speed)
2. Using Search Engine Marketing tools (like googleadwords, googleadwords certifications, search, display, remarketing formats, facebook marketing, linkedin advertising)
3. Using Social Media Marketing tools (like hootsuite, buffer, sproutsocial, klear, twitonomy, socialmention, google alerts, mention)
4. Using Email Marketing tools (like mailchimp, campaign monitor, mailgun, mandrill, phplist, amazon ses
5. Using Web Analytics tools (like google analytics, compete.com, crazyegg, facebook insights, twitter insights)

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ANNEXURE VI

Parvatibai Chowgule College of Arts and Science (Autonomous)

DEPARTMENT OF COMPUTER SCIENCE

SKILL ENHANCEMENT COURSES

Course Title: Python Programming
Course Code: COM-SEC1
Marks: 100
Credits: 4
Duration: 60 HRS.

Prerequisite Courses: Nil

Course Objectives:
To provides skills of data analysis using Python programming language.

Course Outcome:
At the end of the course students should be able to :

CO1: Understand syntax of Python Programming
CO2: Write program using conditional statements, loops.
C03:Apply required List function.
C04: Write Python program specific to the domain of the given problem.

Syllabus

1. Introduction to Python **[4Hrs**]

Motivation, programming paradigms, What Python can do, Python's technical strength, Python interpreter, Program execution, Execution model variations, How to run programs.
.

2. Basic Syntax **[12Hrs]**

Variable and Data Types, Operator, Conditional Statements - if, if- else, Nested if-else. Looping – For, While, Nested loops. Control Statements – Break, Continue, Pass.

3. Input-Output **[4Hrs]**

Printing on screen, Reading data from keyboard, Opening and closing file, Reading and writing files, Functions.

4. String Manipulation **[8Hrs]**

Accessing Strings, Basic Operations, String slices, Function and Methods.

5. Tuple and Lists **[8Hrs]**

Introduction, Accessing list, Operations, Working with lists, Function and Methods.
Introduction Accessing tuples, Operations, Working, Functions and Methods.

6. Dictionaries **[8Hrs]**

Introduction, Accessing values in dictionaries, Working with dictionaries, Properties, Functions.

7.Functions **[8Hrs]**

Defining a function, Calling a function, Types of functions, Function Arguments, Anonymous functions, Global and local variables.

8.Modules **[8Hrs]**

Importing module. Math module. Random module.

Text Book:
1. Mark Lutz,Learning Python, O'Reilly Media, Fifth Edition

Web References:
1: https://docs.python.org/3/
2: https://www.tutorialspoint/python/
3: https://www.w3schools.com/python/

Reference Books:
1. Alex Martelli,Python – A Nutshell, O'Reilly Media, Second Edition, 2006
2. Wes McKinney, Python for Data Analysis, O'Reilly Media, 2012

Course Title: R Programming

Course Code: COM-SEC2

Marks: 100

Credits: 4

Duration:60 Hrs.

Prerequisite Courses : Nil

Course Objectives:

- To make the student understand the fundaments of R language.
- To implement algorithms using R.
- To connect R with other data sources and perform computation
- To use R for plotting charts and graphs

Course Outcomes:

At the end of the course students will be able to :

CO1 : Develop solutions to problems and implement these solutions in R.
CO2 : Use R with various data sources and perform computation.
CO3 : Solve mathematical problems using R.
CO4 : Plot charts and graphs using R.

1. **Introduction to R:** **[2 Hrs]**
   Install and configure R software and R Studio, Using R console to perform basic arithmetic operations, display strings and workspace variables, R Overview, Getting help.

2. **R Data Types:** **[8 Hrs]**
   Determining the data type of a variable, boolean, integer, numeric, character, complex and raw. Vectors, Lists, Matrices, Data Frames, Factors and Arrays

3. **R Operators:** **[4 Hrs]**
   Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators Miscellaneous Operators (Colon, %in% and %*%)

4. **Control Flow and Iterations** **[10 Hrs]**
   The if, if-else, if – else if-else and switch statements, while and for loops, loops for vectors, matrices, data frames and lists. Programs to test understanding of the same.

5. **Functions in R** **[14 Hrs]**
   Writing an R function, Nested Functions, Function Scoping, Recursion, Loading an R package, Mathematical Functions, Cumulative sums and products, Calculus, Input and Output operations, Selection and Bubble sort, Linear and Binary Search

6. **Apply Family in R** **[5 Hrs]**
   Using apply, lapply, sapply, tapply and mapply, Differences between lapply and sapply, Applications of mapply, Split Function

7. **R Data Interfaces:** **[14 Hrs]**

R and Database Connectivity , creating and dropping tables, inserting data and updating table rows, querying and querying with filters

R and CSV files – Inputting, Reading, Writing to and Analyzing a csv files.

R and Spreadsheets – Reading from, writing to and analyzing spreadsheets

R and XML files – Reading and processing XML files

8. **Charts and Graphs** **[3 Hrs]**

Generating Pie charts, Bar Charts and Line Graph

Text Book:

1. K. G. Srinivasa, G. M. Siddesh et al, Statistical Programming in R, Oxford University Press.

Web References

1. https://www.tutorialspoint.com/r/index.htm
2. https://www.guru99.com/r-tutorial.html
3. https://www.w3schools.in/r/

Reference Book:

1. Sandip Rakshit, R Programming for Beginners, McGraw Hill Education.

Course Title: Scilab Programming

Course Code: COM-SEC3

Marks: 100

Credits: 4

Duration:60 Hrs.

Prerequisite Courses : Nil

Course Objectives:

- To make the student understand the fundaments of Scilab.
- To implement algorithms using Scilab.
- To handle polynomials and implement numerical methods using Scilab
- To use Scilab for plotting charts and graphs

Course Outcomes:

At the end of the course students will be able to :

CO1 : Develop solutions to problems and implement these solutions in Scilab.
CO2 : Use Scilab to handle Polynomials.
CO3 : Use Scilab to implement Numerical Methods.
CO4 : Plot charts and graphs using Scilab.

1. **Introduction to Scilab:** **[2 Hrs]**
   Install and configure Scilab software, Starting and ending a Scilab session, Scilab environment, Getting help, Some useful Scilab commands.

2. **Fundamentals of Scilab:** **[5 Hrs]**
   Character sets, Data types, Constants and Variables, Operators, Scilab Expressions, Hierarchy of operations, Built-in functions

3. **Vectors and Matrices:** **[6 Hrs]**
   Vectors, Matrices and Scalars, Creating matrices from values, Creating empty matrix, , row vectors, column vectors, scalars, special matrices, sparse matrices, matrix size, accessing matrix elements, creating sub-matrices, creating multi-dimensional array, operations on matrices and arrays, matrix manipulation, useful matrix commands

4. **Polynomials** **[6 Hrs]**

   Polynomial creation and evaluation, roots of a polynomial, Polynomial arithmetic operations, differentiation and integration, Curve fitting.

5. **Scilab Graphics** **[11 Hrs]**
   Two-dimensional plots, Sub-plots, Creating commonly-used 2D plots, 3D Plots

6. **Programming in Scilab** **[15 Hrs]**

   Keywords, Predefined variables, input and output statements, Control structures, looping, File Handling, Scripts and Functions, Error-handling, Coding conventions

7. **Numerical Methods using Scilab** **[15 Hrs]**

Solutions of Algebraic and Transcendental equations, Interpolation, Numerical Differentiation and Integration, Solution of Linear Systems of Equations

Text Book:

2. Rachna Verma, Arvind Kumar Verma, Introduction to Scilab.

Web References:

1. https://www.scilab.org/tutorials
2. http://programming-with-scilab.blogspot.com/
3. https://www.tutorialspoint.com/matlab/

Reference Book:

2. Dr. M Affouf, Scilab by Example.

Annexure -VII

Parvatibai Chowgule College of Arts and Science (Autonomous)

Department of Computer Science

Panel of Examiners

Following is the list of examiners approved by Board Of studies Members in the meeting held on 16th February 2019.

Name	Designation	College/Institution	Phone No.
Ms. Olivia Soares	Associate Professor	Govt. College, Quepem	9673724803
Ms. Liana D'Costa	Associate Professor	Govt. College, Quepem	9657568426

Mr. Kissan Dessai	Assistant Professor	Govt. College, Quepem	9822169976
Mr. Omkar Ainapure	Associate Professor	Govt. College, Quepem	9422437693
Mr. Nilesh Natekar	Associate Professor	Govt. college, Sanquelim	9689131279
Mr. Milton Pires	Assistant Professor	Rosary College , Navelim	9823874436
Mr. Edwin D.Souza	Associate Professor	St. Xavier College, Mapusa Goa.	9890185533
Ms. Sandra Fernandes	Associate Professor	St. Xavier College, Mapusa Goa.	9822313843
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ANNEXURE I

Parvatibai Chowgule College of Arts and Science

(Autonomous)

DEPARTMENT OF COMPUTER SCIENCE

COURSE STRUCTURE

THREE YEAR B.Sc. DEGREE COURSE IN COMPUTER SCIENCE (2020 -2021)

COMPONENT A:

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	COM-I.C-1 Mathematical foundation of Computer Science – I	COM-I.C-2 * Introduction to Programming	---	---	---	---
II	COM-II. C-3 ** Object Oriented Programming	COM-II.C-4 * Data Structures	---	---	---	---
III	COM-III.C-5 * Data Base Management Systems -I	---	COM-III.E-1 Software Engineering	COM-III. E-2 Digital Logic Design	COM-III. E-3 Mathematical Foundation of Computer Science – II	COM-III. E-4 Web Designing
	COM-IV.C-6		COM-IV.E-5	COM-IV.E-17	COM-IV.E-7 Server Side Programming	COM-IV.E-8

IV	Computer Architecture and Organization	---	Design & Analysis of Algorithms	Data Base Management System II		HCI
V	COM-V.C-7 * Operating Systems	---	COM-V. E-9 Embedded Systems	COM-V. E-10 Mobile Application Development	COM-V. E-11 Introduction to Data Science	COM-V. E-12 Software Testing
VI	COM-VI.C-8 * Computer Networks	---	COM-VI.E-13 Network Security	COM-VI. E-14 Cloud Computing	COM-VI. E-15 Multimedia Techniques	COM-VI. E-16 Digital Marketing

Note: * Core Compulsory Courses also offered for minor subject combination.
** Core Compulsory Courses also offered for minor subject combination in 4th Semester.

(2020 -2021)
SEMESTER V

Course Title: Operating Systems
Course Code: COM-V.C-7
Marks: 75
Credits: 3
Duration:45 Hrs

Prerequisite Courses :
- Introduction to Programming(COM-I.C-2)

Course Objectives:
- To understand different functions of an operating system.
- To study various aspects of operating system like Process Management, Memory Management, Storage management etc.
- To understand different algorithms used for CPU scheduling, Memory allocation.

Course Outcomes:
At the end of the course students will be able to :
CO1: Explain the role of operating system.
CO2: Differentiate between different types of operating system.
CO3: Describe process management and process coordination.
CO4: Implement various CPU scheduling algorithms and compare their performance.
CO5: Explain deadlock handling.
CO6: Describe features of Virtual memory.
CO7: Implement various Memory Allocation algorithms.
CO8: Implement various page replacement algorithms.
CO9: Describe different file organization and access methods.

SYLLABUS:

UNIT I : Introduction to Operating System and Process Management [15HRS]

Introduction to Operating System: Basic elements of a computer system: Processor, Main Memory, I/O Modules, System Bus, Instruction Execution; Operating Systems: Definition, Operating system Structure, operating system operations, Relationship between Kernel, OS, and Hardware, Operating system services, System calls, Types of system calls, System programs.
Process Management: Process Definition, Process Control Block, Process States, Operations on Process; Interprocess communication, Threads and Microkernels: Definition, Multi-threading Model Process Scheduling, Scheduling Criteria, Scheduling Algorithms, Multi-Processor Scheduling.

UNIT II : Process Coordination [15HRS]

Process Coordination

Process Synchronization, Principles, Mutual Exclusion, The Critical-Section Problem, Petersons Solution, Semaphores, Monitors, Readers/Writers Problem; Classic Problems of Synchronization, Dining Philosopher's problem
Deadlocks- system models, Deadlock characterization , Deadlock Handling Methods, Prevention, Avoidance, Detection, Recovery From Deadlock

UNIT III: Memory Management and Storage Management [15HRS]

Memory Management: Introduction, Swapping, Contiguous Memory Allocation, Paging, Page Table, Segmentation, Virtual Memory: Introduction, Demand Paging, Page Replacement, Allocation of Frames, Thrashing
Storage Management : File System, Concepts, File Organization and Access Methods, Directory and Disk Structure.
Secondary Storage Structure : Overview, disk structure, Disk attachment, Disk scheduling Reading.

MANDATORY:

1. Silberchatz, A., Galvin, , & Gagne. (2008). Operating System Concepts (8th ed.). Wiley publication.

SUPPLEMENTARY:
1. Stallings, W. (2001). Operating systems: Internals and design principles.(6th ed.). Upper Saddle River, N.J: Prentice Hall.

WEB BASED:
1. https://www.geeksforgeeks.org/operating-systems/
2. Video Links and Animations
3. https://www.youtube.com/watch?v=WP3uDglbPiI
4.http://williamstallings.com/OS-Animation/Animations.html
5.Linux Tutorials for Practical
6.https://www.tutorialspoint.com/unix/index.htm

Practical : Operating Systems
Credit : 1
Marks : 25
Duration:30 Hrs

Any 8 from the following can be done.

1. Demo/Review of Installing Linux / Windows Operating System, Partitioning and formatting disk, Installing applications device drivers, working with files, mounting file systems, checking system space, creating, modifying and deleting user accounts
2. Study of Basic commands of Linux.
3. Shell Programming in Unix/Linux, arithmetic operations, loops
4. Shell Programming – advanced
5. Menu Driven Shell scripting
6. Filters and Pipes in LINUX

7. Implementation of Inbuilt Linux/UNIX commands like cp, rename etc.
8. Implementation of CPU scheduling policies.
9. Implementation of Memory allocation techniques:
10. Implementation of Banker’s algorithm. (Resource Allocation Graph)

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Course Title: Embedded Systems
Course Code: COM-V.E-9
Marks: 75
Credits: 3
Duration: 45Hours

Prerequisite Courses :

- Introduction to Programming COM-I.C-2

Course Objectives:

- To have a thorough understanding of major components of Embedded Systems.
- Implement small modules of programs to solve well defined problems in an Embedded Systems.
- To familiarize with the tools to develop applications in an Embedded Environment.

Course Outcomes:

At the end of the course students should be able to:

CO1: Describe Embedded Systems and its characteristics.
CO2: Classify the Embedded processors and their design metrics.
CO3: Summarize the performance of ARM processors and various components of Embedded Systems.
CO4: Classify Sensors and Actuators and identify their functions and applications.
CO5: Categorize I/O devices, I/O Interfacing and Communication protocols along with their functions.
CO6: Generalize the functionality of IoT and RTOS.
CO7: Design and develop Embedded / IoT Applications using Arduino/Raspberry-Pi boards.

SYLLABUS
UNIT I: Introduction to Embedded Systems and System Hardware [15 HRS]
Introduction to Embedded Systems, Microprocessors and Micro-controllers. Components of Embedded System & its Classification, Characteristic of embedded system. Introduction to embedded processor, Digital Signal Processor, Application Specific System Processor, Design Process in Embedded System, Design metrics, Steps in design process. Challenges in Embedded System design, Design Examples. Advances in Embedded Systems.

System hardware, Interrupt structure and Applications, ARM Processor - Architecture, Programmer's model, Modes of operation, Interrupt, Handling Interrupts, Comparison of ARM7 & ARM9.
Components of Embedded Systems-Management of Power Supply, Clocking Unit, Real Time Clock and Timers, Reset Circuitry and Watchdog Timer. Processor and Memory Selection, Memory Map of Embedded System, Interfacing Processors, Memories and I/O – Analog vs Digital. Overview of Arduino, Intel Edison and Raspberry Pi boards.

UNIT II: Input/Output Devices and Internet of Things [15 HRS]
I/O interfacing and Communication Buses, Serial vs Parallel Communication, Serial Data Communication RS-232/UART.

I/O devices, ADC / DAC, Optical Devices such as LED / LCD Display devices, Opto-Isolator, Relays, DC motor, Stepper motor, Timers/Counters, Parallel ports - Device interfacing. Serial communication Protocols - UART Protocols, I2C, CAN, USB & ZigBee – Protocol Architecture, Topology, Packets, Communication Cycle, Arbitration, Applications and comparison.
Introduction to IoT, M2M to IoT-The Vision-Introduction, M2M towards IoT- the global context, IoT Architectural Overview, Potential and Challenges.

UNIT III: Sensors, Actuators and RTOS [15 HRS]
Sensors / Transducers: Principles – Classification – Parameters – Characteristics –Environmental Parameters (EP) – Characterization.
Thermal Sensors: Introduction – Gas thermometric Sensors – Thermal Expansion Type Thermometric Sensors.
Magnetic sensors: Introduction – Sensors and the Principles Behind – Magneto-resistive Sensors, Semiconductor Magnetoresistors.
Smart Sensors: Introduction – Primary Sensors – Excitation – Amplification – Filters – Converters – Compensation – Information Coding/Processing - Data Communication – Standards for Smart Sensor Interface – The Automation.
Sensors Applications: Introduction – On-board Automobile Sensors (Automotive Sensors) – Home Appliance Sensors – Aerospace Sensors –– Sensors for Manufacturing – Sensors for environmental Monitoring.
Actuators: Overview of Pneumatic and Hydraulic Actuation Systems, Mechanical Actuation Systems, Electrical Actuation Systems.
RTOS: Introduction to RTOS, architecture of kernel, task and task scheduler, interrupt service routines in RTOS Environment.

REFERENCES:

MANDATORY:
1.Rajkamal, (2010), Embedded Systems – Architecture, Programming and Design, (2nd ed.), Tata McGraw Hill.
2.D. Patranabis, (2013), Sensors and Actuators, (2nd ed), PHI.

SUPPLEMENTARY:
1. David E Simon, (2004), An Embedded Software Primer, (1st ed.), Pearson India.
2. Tammy Noergaard, (2012), Embedded Systems Architecture, (2nd ed.), Elsevier
3. D. Patranabis, (2010), Sensors and Transducer, (2nd ed.), PHI Learning Private Limited.
4. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, (2014), From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, (1st ed), Academic Press,.

WEB BASED:
1.https://www.tutorialspoint.com/internet_of_things/index.htm
2.https://www.arduino.cc/
3.http://www.zdnet.com/article/m2m-and-the-internet-of-things-a-guide
4.https://www.raspberrypi.org/
5.www.thingspeak.com
6.https://blynk.io/

Practicals: Embedded Systems
Credit: 1
Marks: 25
Duration:30 Hrs

Programs to be executed on some of the embedded boards like Arduino, Intel Edison, Raspberry
Pi, Bolt, etc that covers the following tasks (Any 10 experiments):

1) Interfacing sensors (3P)
2) Interfacing output devices (1P)
3) Interfacing input devices (1P)
4) Interfacing actuators (1P)
5) Building obstacle avoiding Robot (1P)
6) Line Following Robot (1P)
7) Programming with Raspberry Pi (2P)
8) Monitoring Data over Cloud (1P)
9) Building Web app to control devices (1P)
10) Mini Project.

****

Course Title: Mobile Application Development
Course Code: COM-IV.E-10
Marks: 75
Credits: 3
Duration:45 Hrs

Prerequisite Courses:

- Object Oriented Programming(COM-III.C-5A)

Course Objective:

- To develop applications for mobile devices, including smart phones and tablets.
- To familiarize with current mobile platforms, mobile application development environments and mobile device input methods.
- To design and build a variety of apps on a popular platform throughout the course to reinforce learning and to develop real competency.

Course Outcomes :
At the end of the course students will be able to :
CO1: Explain mobile devices, including their capabilities and limitations.
CO2: Review current mobile platforms and their architectures.
CO3: Develop mobile applications on a popular mobile platform.
CO4: Evaluate development with another mobile platform.

SYLLABUS:

Unit I :Introduction to mobile devices, mobile operating systems [15 HRS]
Mobile devices vs. desktop devices, Why we Need Mobile App, Different Kinds of Mobile Apps, ARM and intel architectures, Power Management, Screen resolution, Touch interfaces, Application deployment - App Store, Google Play, Windows Store.
Development environments – Android Studio, PhoneGAP.
Native vs. web app, Browser-detection, Touch interfaces, Geolocation, Screen orientation, Mobile browser ―interpretations‖ (Chrome/IE).
Comparing and Contrasting architectures of Android, iOS and Windows, Underlying OS(Darwin vs. Linux vs. Windows), Kernel structure and native level programming, Runtime (Objective-C vs. Dalvik vs. WinRT), Security.
Introduction to Android Operating System, Overview of android stack, Android features. Linux Kernel, Libraries, Android Runtime, Application Framework, Dalvik VM ,Multithreading in Android-Async Task,Handler Post.

Unit II :Android Components [15 HRS]
Activities, Services, Broadcast Receivers, Creating Broadcast receiver, Receiving System Broadcast, Understanding Broadcast action, category and data, Sending Broadcast. Content Providers, Views, layouts and Common UI components, Creating UI through code and XML, Activity life cycle, Intents-,Intent Filters, Intent-matching rules, Filters in your manifest.
Communicating data among Activities. Selection components (Grid View, List View, Spinner), Adapters, Custom Adapters, Menus, Toast, Custom Toast, Dialogs, Status bar Notifications.
Overview of services in Android, implementing a Service, Service lifecycle, Inter Process Communication (AIDL Services). Web Services and WebView - Consuming web services,

Receiving HTTP Response (XML, JSON), Parsing JSON and XML, Using WebView.

Unit III : Data Storage [15 HRS]
Shared Preferences, Android File System, Internal storage, External storage.SQLite-Introducing SQLite, SQLiteOpenHelper and creating a database, Opening and closing a database, working with cursors, inserts, updates, and deletes.
Content Provider-Accessing built in content providers, Content provider MIME types, searching for content, Adding, changing, and removing content, creating content provider, Working with content files.

REFERENCES:

MANDATORY:
1. Wei-Ming Lee (2012) .Beginning Android 4 Development.John Wiley & Sons.

SUPPLEMENTARY:
1. Satya Komateneni,(2015).Pro Android 5.Springer Nature. (5th ed).
2. Ed Brunette.(2015).Hello Android - Introducing Google's Mobile Development platform -(4th ed.)The Pragmetic Bookshelf
3. Dimarzio, J.F.(2010). Android- A Programmer's Guide. Tata McGraw Hill

WEB BASED:
1. https://developer.android.com
2. https://www.appinventor.org
3. https://codelabs.developers.google.com
4. https://www.udacity.com
5. https://www.w3school.in

Practicals: Mobile Application Development
Credit: 1
Marks: 25
Duration:30 Hrs

1. Getting Started with Android – Installing the Development Environment, Configuring Android Stack
2. Creating the First Android Application - Creating a Simple Android Project, Debugging Application through DDMS. setting up environment. AVD Creation, Executing Project on Android Screen.
3. Android application development - Use of GUI components to implement a simple application such as a Calculator.
4. Review the earlier application making use of the advanced UI components.
5. Implementing Data storage application - an application to make Insert , update , Delete and retrieve operation on the database.

****

Course Title: Introduction to Data Science
Course Code: COM-V.E-11
Marks: 75
Credits: 3
Duration:45 Hrs

Prerequisite courses:

- Statistical Methods
- Basic probability and statistics.

Course Objectives:

- Become familiar with methods of data science and their practical usefulness.
- To learn, understand, and practice machine learning approaches.
- To analyze large and unstructured data with different tools.

Course outcomes:

At the end of the course students will be able to :

CO1: Describe what Data Science is and the skill sets needed to be a data scientist.
CO2:Explain in basic terms what Statistical Inference means. Identify probability distributions commonly used as foundations for statistical modeling. Fit a model to data.
CO3: Explain the significance of exploratory data analysis (EDA) in data science. Apply basic tools(plots, graphs, summary statistics) to carry out EDA.
CO4: Describe the Data Science Process and how its components interact.
CO5:Apply basic machine learning algorithms for predictive modeling.
CO6:Identify common approaches used for Feature Generation. Identify basic Feature Selection.
CO7: Reason around ethical and privacy issues in data science conduct and apply ethical practices.
CO8:Create effective visualization of given data (to communicate or persuade).
CO9: Use of Mining Social-Network Graphs in Data science out basic statistical modeling and analysis.

SYLLABUS:

UNIT I: [10HRS]
Introduction to Data Science
What is Data Science? Big Data and Data Science hype -and getting past the hype,
Why now? –Datafication, Current landscape of perspectives, Skill sets needed.
Statistical Inference:
Populations and samples, Statistical modeling, probability distributions, fitting a model,
Intro to R.

UNIT II: [20HRS]

Exploratory Data Analysis and the Data Science Process:

Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA,The Data Science Process, Case Study: Real Direct (online real estate firm).

Three Basic Machine Learning Algorithms:

Linear Regression, k-Nearest Neighbors (k-NN),k-means

Feature Generation and Feature Selection (Extracting Meaning From Data):

Motivating application: user (customer) retention,Feature Generation (brainstorming, role of domain expertise, and place for imagination) , Feature Selection algorithms ,Filters; Wrappers; Decision Trees; Random Forests.

UNIT III: [15HRS]

Mining Social-Network Graphs:

Social networks as graphs,Clustering of graphs,Direct discovery of communities in graphs, Partitioning of graphs, Neighborhood properties in graphs

Data Visualization:

Basic principles, ideas and tools for data visualization, Examples of inspiring (industry) projects,

Exercise: create your own visualization of a complex data set.

Data Science and Ethical Issues:

Discussions on privacy, security, ethics, A look back at Data Science,Next-generation data scientists

REFERENCES:

MANDATORY:

1. O'Neil, C., & Schutt, R. (2013). Doing data science: Straight talk from the frontline. " O'Reilly Media, Inc.".

SUPPLEMENTARY:

1. Jure.L,, Anand.R,Jeffrey.U(2014). Mining of Massive Datasets v2.1(2nd ed.).Cambridge University Press.
2. Kevin P. Murphy,(2012).Machine Learning: A Probabilistic Perspective.MIT Press.
3.Provost, F., & Fawcett, T. (2013). Data Science for Business: What you need to know about data mining and data-analytic thinking. " O'Reilly Media, Inc.".
4.Hastie, T., Tibshirani, R., & Friedman, J. (2009). The elements of statistical learning: data mining, inference, and prediction. Springer Science & Business Media..
5.Blum, A., Hopcroft, J., & Kannan, R. (2020). Foundations of data science. Cambridge University Press.
6. Zaki, M. J., Meira Jr, W., & Meira, W. (2014). Data mining and analysis: fundamental concepts and algorithms. Cambridge University Press.
7. Han, J., Pei, J., & Kamber, M. (2011). Data mining: concepts and techniques. Elsevier.

WEB BASED:

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline, O'Reilly https://classroom.google.com/u/0/w/NDA4ODg4MTQ3MjZa/t/all
2. Data Science E-Learning Course:
https://onlinecourses.nptel.ac.in/noc19_cs60/unit?unit=5&lesson=6
3. Simple Linear Regression Example:
https://www.spss-tutorials.com/simple-linear-regression/
4. https://www.kaggle.com/pavansanagapati/a-simple-tutorial-on-exploratory-data-analysis
5. Data visualization
6. https://paldhous.github.io/ucb/2016/dataviz/week2.html
7. https://www.targetprocess.com/articles/visual-encoding/

Practicals : Introduction to Data Science
Credit: 1
Marks: 25
Duration:30 Hrs

1. Implementation of probability distribution
2. Sampling and re-sampling.
3. Linear Models
4. K-Nearest neighbour
5. K-Means
6. Feature Selection Algorithm
7. Filters and Wrappers
8. Decision Trees

All the experiments will be implemented using Excel /R-Tool/ or equivalent.

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Course Title: Software Testing
Course Code: COM-V.E-12
Marks: 75
Credits: 3
Duration:45 Hrs

Prerequisite courses:

Software Engineering (COM-III.E-1)

Course Objectives:

- To understand the fundamental concepts in software testing
- To study the various software testing strategies
- To learn how to design test cases and execute them.

Course Outcomes:

At the end of the course students will be able to :

CO1 : Understand the different software testing strategies.
CO2 : Apply testing strategies to live projects.
CO3 : Design test cases
CO4: Execute test cases using software testing tools.

SYLLABUS:

UNIT I: [15HRS]

Software testing principles - Software Testing- Need for testing, Psychology of testing,Testing economics, SDLC and Testing, Verification & Validation. Quality Assurance, QualityControl.

Testing strategies and types - White box testing techniques - Statement coverage, BranchCoverage , Condition coverage, Decision/Condition coverage , Multiple condition coverage,Dataflow coverage, Automated code coverage analysis, Inspections, Walkthroughs Code Review Black box testing techniques - Boundary value analysis, Robustness testing ,Equivalence partitioning, Syntax testing, Finite state testing, Levels of testing, Unit, Integration and SystemTesting, Compatibility Testing, Domain Testing, Adhoc Testing ,Use of Requirement,Traceability Matrix.

UNIT II: [20HRS]

Integration Testing Waterfall - Top-down ,Bottom up ,Big bang, Sandwich System and Performance Testing - Types of system testing ,Functional and non-functional testing Acceptance Testing ,Setting entry and exit criteria for phases and typical product release scenarios ,Basic factors governing performance testing, Methodology for performance testing,Tools for performance testing.

Regression Testing - Purpose ,Timing, Choice of tests ,Smoke tests ,Best practices Internationalization and Localization testing - Preliminary concepts,Adhoc testing,Pair testing, Extreme testing, Agile testing, Exploratory testing,Defect seeding.

Usability Testing - Factors in usability testing ,Aesthetics testing ,Accessibility testing ,Tools for usability testing.

Testing object oriented software - Definitions and Challenge differences from testing non-OO Software, Class testing strategies Class Modality, State-based Testing, Message Sequence Specification.

UNIT III: [10HRS]
People and organizational issues in testing - Common people issues and myths in testing, Providing career paths in testing, Organizational structures for testing teams, Geographically distributed testing teams and success factors.

Test Management and Automation- Test
Planning,Test Management,Test Process,Test Reporting,Test Automation,Factors to consider in
automation, Challenges in test automation, Test Metrics, Product Metrics, Process Metrics, Progress Metrics. Use of metrics in ascertaining product release.

REFERENCES:

MANDATORY:
1. Srinivasan D. ,Gopalaswamy R.;(2009)Software Testing- Principles and Practices , 4th Edition: Pearson Publication.

SUPPLEMENTARY:

1. Jalote P., (2010)An Integrated Approach to Software Engineering, 3rd Edition :Narosa Publishing House
2. Pressman R., (2017) ,Software Engineering: A Practitioners Approach, 6th Edition:McGraw Hill Publication.

WEB BASED:
1. https://www.guru99.com

Practicals: Software Testing
Credit: 01
Marks: 25
Duration:30 Hrs

1. Planning Test Cases
2. Generating Test Cases/Test Suite
3. Enhancing Tests
4. Debugging Tests
5. Running Tests
6. Analyzing Results
7. Reporting Defects

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SEMESTER VI

Course Title: Computer Networks
Course Code: COM-VI. C-8
Marks: 75
Credits: 3
Duration:45 Hrs

Prerequisite Courses :

- Introduction to Programming (COM-I.C-2)

Course Objectives:

- To understand the basic concepts of Computer Networking.
- To understand the layered architecture of computer networks.
- To understand various transmission media used for networking.
- To understand working of various protocols in different layers.

Course outcomes:

At the end of the course students will be able to

CO1: Understand the need for Network and various layers of OSI and TCP/IP reference model.
CO2: Explain various Data Communications media.
CO3: Identify the different types of network topologies and Switching methods.
CO4: Describe various Data link Layer Protocols.
CO5: Identify the different types of network devices and their functions within a network.
CO6: Differentiate between various Classeless and Classfull IP addresses with Subneting concept.
CO7: Analyze and Interpret various Network and Transport Layer protocols.
CO8: Explain different application layer protocols.

SYLLABUS:

UNIT I [20HRS]

Introduction

Basics of Computer Networks, Classification: transmission technology, scale; Applications; Data Communications: data, signal, bandwidth, bit interval and bit rate, Modes of Communication.Layered network architecture, Networks models: OSI model, TCP / IP protocol suite; Guided and Unguided Transmission media, Multiplexing: FDM, TDM. Switching: Circuit switching, message switching, Packet Switching.

Data link layer

Data link control: Framing: Character Count, Character Stuffing, Bit Stuffing; , Error Detection and correction, Flow and error control, HDLC; Multiple access: Random access – Controlled access, ALOHA, CSMA, CSMA/CD and CSMA/CA; Ethernet : IEEE standards, standard Ethernet, Fast Ethernet, Gigabit Ethernet.

UNIT II [15 HRS]

Network layer

Connecting devices: repeater/hub, bridge, router and gateway, Backbone networks - Virtual LANS. Functions of Network layer; Network Service types: Virtual Circuits, Datagrams; Logical addressing: IPv4, private and public IP addressing, special IP addresses, subnetting, IPV6 addressing Internet Protocol: Internetworking:IPv4, Fragmentation and reassembly , Address mapping : ARP, RARP, BOOTP, DHCP, ICMP . Routing: classification of routing, Shortest path routing, Distance Vector routing, Link State routing;

UNIT III : Transport layer, Application layer and Wireless network [10HRS]

Transport layer : Process-to-Process delivery: User Datagram Protocol (UDP), Transmission Control Protocol (TCP), Quality of services (QoS)
Application Layer: Domain Name System (DNS) , E-mail, FTP, HTTP.
Basics of Wireless Networking

REFERENCES:

MANDATORY:

1. Tanenbaum A., W.(2010) Computer Networks (5th ed.) . Pearson Education.

SUPPLEMENTARY:

1. Behrouz A. Forouzan B.(2017) Data communication and Networking(5th ed.). McGraw Hill Education
2. Kurose J, K.(2017) Computer Networking – A Top-Down Approach (6th ed.) Pearson Education,
3. Mir N. (2006) Computer and Communication Networks, Prentice Hall Publishers.

WEB BASED:

1.https://www.youtube.com/watch?v=tj7f244tubM

2.https://www.youtube.com/watch?v=vFypCugyFoM

3.https://www.geeksforgeeks.org/computer-network-tutorials/

4. Slides of the Book . Andrew S. Tanenbaum, David J. Wetherall“Computer Networks”, Prentice-Hall, 5th Edition.:https://www.pearson.com/us/higher-education/product/Tanenbaum-Power-Point-Lecture-Slides-for-Computer-Networks-5th-Edition/9780132127066.html?tab=downloadable-resources

5.https://www.tutorialspoint.com/data_communication_computer_network/index.htm

6.https://www.cisco.com › training-events › netacad › course_catalog › docs

Slides for the book Behrouz A. Forouzan, “Data communication and Networking”, Tata McGraw – Hill,2011, 4th Edition :
8.http://www.mhhe.com/engcs/compsci/forouzan/dcn/index.mhtml

Practicals: Computer Networks
Credits : 1
Marks : 25
Duration:30 Hrs

Practical (Any 6 practical):

1. Setting up of LAN Network (2P)
2. IP address manipulation -Extract network id and Host id given netmask (2P)/Mini Project
3. Configuring routing tables
4. TCP Socket programming (2P)
5. UDP Socket programming (2P)
6. Mini Project / Simulation of IP fragmentation
7. Mini Project/Configuring E-Mail/DNS
8. Installing virtual machines, Ethernet cabling

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Course Title: Network Security
Course Code: COM-VI. E-13
Marks: 75
Credits: 3
Duration:45 Hrs

Prerequisite Courses:

- Introduction to Programming(COM-I.C-2)
- Object Oriented Programming(COM-II.C-3)

Course Objectives:

- To understand the theory and concepts of Network Security.
- To be able to secure a message over insecure channel by various means.
- To learn about how to maintain the Confidentiality, Integrity and Availability of a data.

Course Outcomes:

At the end of the course students will be able to :
CO1: classify the symmetric encryption techniques
CO2 : Illustrate various Public key cryptographic techniques
CO3 : Evaluate the authentication and hash algorithms.
CO4 : Discuss authentication applications.
CO5: Summarize the intrusion detection and its solutions to overcome the attacks.
CO6 : Basic concepts of system level security

SYLLABUS

UNIT I: [15HRS]
Concepts of Security & Classical Encryption Techniques:
Introduction, The need for security, Security Approaches, Security Attacks, Security Services,Security Mechanisms, A Model for Network Security, Classical Encryption Techniques :Substitution techniques, Transposition techniques, Steganography.

Design Principle of Block Cipher:
Block Cipher Operation: Electronic Code Book, Cipher Block Chaining, Cipher Feedback, Output
Feedback, Counter, Feistel Cipher, The Data Encryption Standard.

Cryptography:
Mathematical Tools
Introduction to Number Theory, Modular Arithmetic, Prime Numbers, Euler's Totient Function.

UNIT II: [15HRS]
Public Key Cryptography:
Principles of Public Key Cryptosystems, The RSA Algorithm, Other Public key cryptosystems, Diffie Hellman Key Exchange.

Cryptographic Hash Functions:
Applications of Cryptographic Hash Functions, Two Simple Hash Functions, Hash Functions

Based on Cipher Block Chaining, MD5 Message Digest Algorithm, Secure Hash Algorithm SHA 512.

Message Authentication Codes and Digital Signatures:

Message Authentication Requirements – Message Authentication Functions –Requirements for Security of MACs,MACs Based on Hash Functions, HMAC, MACs Based on Block Ciphers, Data Authentication Algorithm. Digital Signatures, Digital Signature Standard.

UNIT III: [15 HRS]

Key Management & Distribution And User Authentication:

Introduction, Digital Certificate, Private key Management, The PKIX Model, Public key cryptographic standards ,XML, PKI and security.

Program Security:

Flaws, Malicious code: viruses, Trojan horses, worms, Program flaws: buffer overflows, time-of check to time-of-use flaws, incomplete mediation.

Firewall and Virtual Private Network:

Introduction to network security techniques: IP Security, firewalls, virtual private networks.

REFERENCES:

MANDATORY:

1.William.S,(2017).Cryptography and Network Security – Principles and Practices(7th ed.).Prentice Hall of India.

SUPPLEMENTARY:

1.Charles P. Pfleeger and Shari L. Fleeger(2015).Security in Computing(7th ed.). Prentice-Hall.
2.Atul.K,(2007).Cryptography and Network Security(2nd ed.).Tata McGraw-Hill.
3.Menezes A. J., P.C. Van Oorschot and S.A. Vanstone(1997) ―Handbook of Applied Cryptrography(2nd ed.).Jaypee medical.

WEB BASED:

1. Cryptography and Network Security - Nptel
https://nptel.ac.in/courses/106/105/106105031/
2. William Stallings, ―Cryptography and Network Security – Principles and Practices‖, Prentice Hall of India
http://www.amorena.com.ar/PAG%20DE%20MATERIAS%20Y%20LIBROS/LIBROS%20TODOS/CRYPTOGRAPHY%20AND%20NETWORK%20SECURITY,%20PRINCIPLES%20AND%20PRACTICE.pdf
3. Cryptography Tutorial
https://www.tutorialspoint.com/cryptography/index.htm
4. IPSec, VPN, and Firewall Concepts
http://www.cs.unh.edu/~it666/reading_list/Networking/firewall_concept_terms.pdf
5. Implementation of Hill Cipher
https://www.tutorialspoint.com/cplusplus-program-to-implement-the-hill-cypher

Practicals :Network Security
Credits : 1
Marks : 25
Duration:30 Hrs

1. Implementation of Caesar Cipher
2. Implementation of One-Time Pad
3. Implementation of Playfair Cipher
4. Implementation of Hill Cipher
5. Implementation of Data Encryption Standard Algorithm
6. Implementation of Image Steganography
7. Implementation of RSA Algorithm
8. Implementation of Digital Signatures using RSA Algorithm
9. Design Network protocol analyzer tool to analyze network traffic.
10. Mini Project/ Case Study

****

Course Title: Cloud Computing
Course Code: COM-VI. E-14
Marks: 75
Credits: 3
Duration:45 Hrs

Prerequisite Courses:

- Operating Systems(COM-V.C-7)

Course Objectives:

- To make students understand the key elements of cloud computing.
- To understand the difference between deploying applications on the cloud and the local infrastructure.
- To understand various cloud service models.

Course Outcomes:
At the end of the course students will be able to :

CO1: Revise fundamentals of testing and learn about Functional testing and Object Oriented testing methods.
CO2: Gain knowledge of test case design, execution and report.
CO3: Understand testing of web applications and automated testing tools.
CO4: Apply knowledge of Software Testing in the industry.

SYLLABUS:

UNIT I: Introduction to cloud computing [15HRS]

Recent trends in Computing: Grid Computing, Cluster Computing, Distributed Computing,Utility
Computing, Cloud Computing.Cloud Computing definition, History of Cloud Computing, How Cloud
Computing Works, Benefits and challenges of cloud computing, Issues for Cloud Computing.

UNIT II: Cloud Computing Architecture and Infrastructure as a Service(IaaS) [15HRS]
Comparison with traditional computing architecture (client/server), Cloud Computing Service
Models, Deployment Models- Public cloud, Private cloud, Hybrid cloud and Community cloud, Key
drivers to adopting cloud, Impact of cloud on users, Governance in the cloud. Introduction to IaaS:
IaaSdefinition, Introduction to virtualization, Different approaches to virtualization,Hypervisors,
Machine Image, Virtual Machine(VM). Resource Virtualization: Server, Storage, Network. Examples:
Amazon EC2.

UNIT III: Platform as a Service(PaaS) and Software as a Service(SaaS) [15HRS]

Introduction toPaaS: What isPaaS, Service Oriented Architecture (SOA).Cloud Platform and Management: Computation, Storage, Examples: Google App Engine, Microsoft Azure, SalesForce.com. Introduction to SaaS, Web services,Web 2.0, Web OS, Introduction to MapReduce, Case Study on SaaS.

REFERNCES:

MANDATORY:

1. Tim mather, subra kumarswamry and sharhed Latif, “Cloud Computing Security and
2. Privacy”, O’Reilly publication.
3. Richard Hill, Laurie Hirsch, Peter Lake, SiavashMoshiri, “Guide to Cloud Computing Principles and Practices”, Springer.
4. Buyya, R., Broberg, J., & Goscinski, A. M. (Eds.). (2010). Cloud computing: Principles and paradigms (Vol. 87). John Wiley & Sons.
5. Nikos Antonopoulos, Lee Gillam“Cloud Computing: Principles, Systems and Applications”, Springer.
6. Vines, R. L. K. R. D., & Krutz, R. L. (2010). Cloud security: A comprehensive guide to secure cloud computing (pp. 35-41). Wiley Publishing, Inc.

Practicals: Cloud Computing
Credit : 1
Marks : 25
Duration:30 Hrs

1. Create virtual machines that access different programs on same platform.
2. Create virtual machines that access different programs on different platforms.
3. Install a C compiler in the virtual machine and execute a sample program.
4.Working on tools used in cloud computing online-
a) Storage
b) Sharing of data
c) Manage your calendar, to-do lists,
d) A document editing tool
5. Working with any cloud service to make spreadsheet and notes and collaborate online in real time and chat with other collaborators.
6. Exploring Public Cloud.
7. Exploring Cloud IDE’s.
8. Installation and Working of Google App Engine
9. Web Service deployment and usage over cloud.

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Course Title: Multimedia Techniques
Course Code: COM-VI. E-15
Marks: 75
Credits: 3
Duration:45 Hrs

Prerequisite Courses: Nil

Course Objectives:

- To understand basic concept of Multimedia.
- To develop skills for designing graphical images.
- To develop skills for audio and video editing.
- To acquire skills in using audio/video editing software.

Course Outcomes:
At the end of the course students will be able to :
CO1 :Understand the concept of Multimedia – Team members and their roles.
CO2 :Identify and describe the function of the general skill sets in the multimedia industry.
CO3 : Classify and realize the types of Authoring tools and their functions.
CO4 : Identify basic components of a multimedia project.
CO5 : Analyze the requirements of Multimedia product.
CO6: Assemble and deliver multimedia projects

SYLLABUS:

UNIT I: Introduction to Multimedia and Computer Graphics: [15HRS]
Commonly used terms associated with multimedia like CDROM, Storyboard, Script and Authoring tools. Stages of a Multimedia Project-Planning and Costing, Designing and Producing, Testing and Delivering. The Multimedia team and their roles- Project Manager, Writer, Video specialist, Audio specialist and Multimedia programmer. Multimedia Software. Multimedia Hardware. Social & Ethical considerations, Digital Representations & Standards.

Multimedia Authoring Tools:
Types of Authoring tools; Card and Page based tools; Icon-based; Time-based; Object-Oriented Tools.
TEXT: Text in graphics, character set, fonts, layout.
Vector graphics fundamentals, shapes, transforms and filters, Bitmapped graphics: resolution, image compression, manipulation, Geometrical transformations.

UNIT II : Sound and Color [15HRS]
Basic Sound Concepts, Digitizing and processing sound, Music, Speech, Compression, formats, MIDI and Digital Audio Human vision, Camera systems, Gamma correction, Color matching, different Color models – RGB, CYMK, Transformations among color model.

UNIT III : Video, Animation and Data compression [15HRS]
Digitizing video, streamed video, video standards, Introduction to Animation: Principles of Animation-Animation techniques-persistence of vision, animation file formats,Computer animation-kinematics and morphing

Data Compression: Types of compression: Lossy & Lossless, Symmetrical & Asymmetrical, Intraframe & Interframe, Hybrid. Study of different compression techniques for Text (Huffman coding, LZ & LZW), Image, Audio, Video (MPEG and AVI).
Multimedia on the Web: Bandwidth relationship, broadband technologies, Text in the web – Dynamic and embedded font technology, Audio on the Web – Real Audio and MP3/MP4, Audio support in HTML, Graphics – HTML safe color palate, Interlaced V/s Non interlaced model, Graphics support in HTML, Image Map, Video on the Web – Streaming video.

REFERENCES:

MANDATORY:

1. Chapman, N., & Chapman, J. (2005). *Digital multimedia*. John Wiley & Sons, Inc..
2. Li, Z. N., Drew, M. S., & Liu, J. (2004). *Fundamentals of multimedia* (pp. 253-265). Upper Saddle River (NJ):: Pearson Prentice Hall.
3. Vaughan, Tay; Multimedia: Making it Work; Tata McGraw-Hill, 9th edition.

SUPPLEMENTARY:

1. Jeffcoate, J. (1995). Multimedia in practice. *Technology and Applications. Great Britain: Prentice Hall.*

WEB BASED:

1. https://www.gimp.org/
2. https://www.audacityteam.org/
3. https://swayam.gov.in/nd2_ugc19_hs42/
4. https://www.tutorialspoint.com/multimedia

Practicals: Multimedia Techniques
Credit: 01
Marks: 25
Duration:30 Hrs

Practical can be done using Proprietary or FOSS for Text, Image, Audio and Video Editing. For example Scribus, GIMP, Audacity, Movie maker, Openshot, etc.

1. Design a Brochure for a given product, give details. Learn about different Image file Formats
2. Design a Poster with given information and learn about Image compression
3. Image Enhancements/ mixing and prepare images for web.
4. Edit the Sound file and Learn about Effects and Filters of sound
5. Record Your voice and learn about Audio Compression.
6. Record an Audio Program and Learn about streaming an audio content.
7. Learn about Video editing – Prepare video with rough cut
8. Prepare Video content with title and special effects.
9. Prepare multimedia content for web.

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Course Title: Digital Marketing
Course Code: COM-VI.E-16
Marks: 75
Credits: 3
Duration:45 Hrs

Prerequisite Courses:

- Web Designing (COM-III.E-4)

Course Objectives:

- To build Optimized and Accessible Websites for the Search Engines.
- To study various online Marketing Strategies.
- Analyze and research Internet to improve the quality and marketability of the Websites.

Course Outcomes:
At the end of the course students will be able to:
CO1: Optimize the website for various search engines.
CO2: Market the products/services/facilities using Search Engine.
CO3: Market the products/services/facilities using Social Media.
CO4: Market the products/services/facilities using Email.
CO5: Analyze the Web for improving the marketing strategy.
CO6: Understand the concept of Marketing Automation.
CO7: Use various software tools to implement Digital Marketing.

UNIT I: Search Engine Optimisation and Marketing (SEO & SEM) [15 HRS]
SEO: Introduction to Online Search; Function of Search Engines Google Page Rank; Introduction to Search Engine Optimisation; Building Accessible Site; Keyword Research and Optimisation; Link Building Strategies; Useful Tools for SEO; The Past, Present and Future of SEO.
SEM: Introduction to Internet and Search Engine Marketing; Google Adwords; Adwords Account Structure; Navigating in Google Adwords; Working with Keywords; Creating Ads in Google Adwords; Creating and Managing your First Ad Campaign; Adwords Reporting and Account Performance Reports.

UNIT II: Social Media and Email Marketing (SMM & EM) [15 HRS]
SMM: Introduction to the World of SMM; Why Social Media?; Getting Started with Social Media; Building Relationships via Facebook, Twitter, LinkedIn, YouTube; Handling Positive and Negative Comments; Social Media Content Base Creation.
EM: Importance of Email marketing; Email Marketing Software's; Subscriber List; Email Marketing Campaign; Newsletters; Measuring the results.

UNIT III: WEB Analytics and Marketing Automation [15 HRS]
Web Analytics and Intelligence Tools; Basic Metrics Demystified; Introduction to Google Analytics; Goals and Actionable Insights; Data Management; Social Media Analytics; Social Media Goals and KPI's; Tools for Social Media Analytics.
Marketing Automation: Introduction to Marketing Automation; Advantages of using Marketing Automation Software; Issues with Marketing Automation.

REFERENCES:

MANDATORY:
1. Ryan, D. (2014). The best digital marketing campaigns in the World II. Kogan Page Publishers.

SUPPLEMENTARY:

1Smith, N. (2013). Successful SEO and search marketing in a week: teach yourself. Hodder & Stoughton.
2.. Odden, L. (2012). Optimize: How to attract and engage more customers by integrating SEO, social media, and content marketing. John Wiley & Sons.
3. Kaushik, A. (2009). Web analytics 2.0: The art of online accountability and science of customer centricity. John Wiley & Sons.

WEB BASED:
1.https://www.tutorialspoint.com/digital_marketing/index.htm
2.www.iab.net/resources/ad_revenue.asp
3.www.searchenginestrategies.com/sew/winter06/index.html
4.https://developers.google.com/products/
5.www.freewebsubmission.com
6.https://www.semrush.com/analytics/seomagic/lists
7.https://neilpatel.com/ubersuggest/
8.https://adwords.google.com/home
9.https://hootsuite.com/
10.www.googleanalytics.com

Practicals: Digital Marketing
Credit: 1
Marks: 25
Duration:30 Hrs

1. Using Search Engine Optimization tools (like google & bing search console, hubspot, webceo, google page speed) [3P]
2. Using Search Engine Marketing tools (like google adwords, google adwords certifications, search, display, remarketing formats, facebook marketing, linkedin advertising) [2P]
3. Using Social Media Marketing tools (like hootsuite, buffer, sproutsocial, klear, twitonomy, socialmention, google alerts, mention) [2P]
4. Using Email Marketing tools (like mailchimp, campaign monitor, mailgun, mandrill, phplist, amazon ses [1P]
5. Using Web Analytics tools (like google analytics, compete.com, crazyegg, facebook insights, twitter insights) [2P]

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ANNEXURE II

Parvatibai Chowgule College of Arts and Science (Autonomous)

DEPARTMENT OF COMPUTER SCIENCE
COURSE STRUCTURE
THREE YEAR B.Sc. DEGREE COURSE IN COMPUTER SCIENCE

(Offered to Students who had taken admission to F.Y.B.Sc in the year 2019-20)

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	COM-I.C-1 Mathematical foundation of Computer Science – I	COM-I. C-2 * Introduction to Programming	---	---	---	---
II	COM-II. C-3A ** Database Management System I	COM-II.C-4 * Data Structures	---	---	---	---

III	COM-III.C-5A * Object Oriented Programming	---	COM-E1 Software Engineering	COM-E2 Digital Logic Design	COM-E3 Mathematical Foundation of Computer Science – II	COM-E4 Web Designing
IV	COM-IV.C-6 Computer Architecture and Organization	---	COM-E5 Design & Analysis of Algorithms	COM-E10 Mobile Application Development	COM-E7 Server Side Programming	COM -E8 HCI
V	COM-V.C-7 * Operating Systems	---	COM-E9 Embedded Systems	COM-E17 Data Base Management System II	COM-E11 Introduction to Data Science	COM-E12 Software Testing

VI	COM-VI.C-8 * Computer Networks	- - -	COM- E-13 Network Security	COM- E-14 Cloud Computin g	COM-. E-15 Multimedia Techniques	COM-VI. E-16 Digital Marketing

Note: * Core Compulsory Courses also offered for minor subject combination.

** Core Compulsory Courses also offered for minor subject combination in 4th Semester.

Parvatibai Chowgule College of Arts and Science (Autonomous)
Margao, Goa

B.Sc. Computer Science – Syllabus

Offered from (2020-21)

Semester I

Course Title: Mathematical Foundation of Computer Science I
Course Code: COM-I.C-1
Marks: 75
Credits: 3
Duration: 45 Hrs

Prerequisite Courses: Nil

Course Objectives:

- To build mathematical foundations that are essential requirement in understanding various concepts
 related to computer science.

Course Outcome:
At the end of the course students will be able to:

CO1: Explain various fundamental concepts.
CO2: Convert a given number from one base to another.
CO3: Apply counting principles to determine probabilities.
CO4: Demonstrate an understanding of relations and functions and determine their properties.
CO5: Evaluate Boolean functions and simplify expressions using the properties of Boolean algebra.

CO6: Write an argument using logical notation and determine if the argument is valid or not.
CO7: Construct and analyze finite state automata.

SYLLABUS

UNIT I: Combinatory and Number systems [15 HRS]

Permutations; Combinations; Counting; Summation; generating functions; recurrence relations.

★ Binary Number System-Decimal to binary conversion and vice versa, binary number representation (signed, 1's complement and 2's complement) binary addition, subtraction, binary to octal, hexadecimal Conversion and vice versa. Floating point representation.

UNIT II: Boolean Algebra, Set, Relations and Functions [15HRS]

Boolean functions, truth table, De Morgan's theorem, logic gates, Realization of Boolean Function using logic gates, Simplification using Karnaugh map. Set-Venn diagram, set operations,relations and properties, closures, equivalence, relations, ordering. Functions-function types, inverse of functions, composition of Partial functions, recursive functions,growth of functions.

UNIT III: Logic, Grammars, Languages and Automation [15 HRS]

Propositional logic, first order logic, mathematical induction, deduction, proof by contradiction, program correctness. Grammars and languages, finite automation of finite state machines, regular languages, regular expressions.

REFERENCES:

MANDATORY:

1. Rosen, K. H., & Krithivasan, K. (2012). Discrete mathematics and its applications: with combinatorics and graph theory. Tata McGraw-Hill Education.

SUPPLEMENTARY:

1. Sarkar, S. K. (2016). A Textbook of Discrete Mathematics. S. Chand Publishing.

WED BASED:

1. https://web.stanford.edu
2.https://www.cse.iitb.ac.in

Practical: Mathematical Foundation of Computer Science I
Credit: 1
Marks: 25
Duration: 30 Hrs

Programs to be written using C Language:

1. Generate all permutations of n symbols, where 2 <=n<= 5 is user defined.

2. Read a number and convert to other number formats.

a) Convert an integer into binary number
b) Convert a binary number to decimal number.
c) Convert a binary number to octal number.
d)Convert a number into normalized form.

3. String Manipulation
a) Read a string of decimal digits. Find the frequency distribution of digits.
b) Read a binary string. Check the occurrence of the pattern 1001 in the string.
c) Read two binary numbers. Add them using 1‘s complement and 2‘s complement method.

4. Read two integer numbers. Find their GCD using recursion.

5. Read the value of p. Find the p-th Fibonacci number from the following recurrence relation.
$f(0) = 0, f(1) = 1, f(n) = f(n-1) + f(n-2), n \geq 2$.

6. Given two functions $f(x) = x^3 + 2x + 3$, and $g(x) = 3x^2 /4 + 10$,
find $f \circ g\ (x)$.

7. Read an expression containing parentheses and check whether it is properly parenthesized.

a) Equal number of (and)‘ brackets
b) Equal number of { and }‘ brackets
c) Equal number of [and]‘ brackets s

8. Applications of set theory
a) Read a set and check whether a given number is a member of the set.
b) Read two sets. Find their union.
c) Read two sets. Find their intersection.

9. Applications of finite state machines, matrices, Boolean algebra, gates.

10. Bit-wise operations using C

****

Course Title: Introduction to Programming
Course Code: COM-I.C-2
Marks: 75
Credits: 3
Duration: 45 Hrs

Pr-requisites courses: Nil

Course Objectives :

- To understand the concept of basic computer algorithm and flowchart and use the algorithm for various problem solving.
- To implement algorithms using high level programming language.
- To understand basic principles of structured programming – example C.

Course Outcome: Upon completion of the course students will be able to:

CO1: Explain problem solving strategies.
CO2: Draw a flowchart for a given problem.
CO3: Write an algorithm for a given problem.
CO4: Explain and Apply sorting and searching algorithms.
CO5: Recognize and incorporate programming elements such as loops, decision making, functions, arrays,strings.
CO6: Recognize and incorporate programming elements such as structures, pointers and files into applications that solve real world problems.

SYLLABUS

UNIT I [10 HRS]

Introduction to Computer Problem Solving : Algorithm, Flowchart, The Problem-Solving Aspect, General problem-solving strategies, Top-Down Design, Implementation of Algorithms, Efficiency of Algorithms, Recursive algorithms.

Basic Algorithms : Exchanging the values, Summation of a set of numbers, factorial computation, generation of the Fibonacci series, reversing the digits of an integer, base conversion.

Factoring Methods : Finding divisors of an integer, finding the Greatest Common Divisor of two integers, generating prime numbers, computing prime factors of an integers.

Sorting and Searching : Bubble sort, Insertion Sort, Sequential Search and Binary Search.

UNIT II [20 HRS]

C Language : History, Structure of a C program, Keywords, Identifiers, variables, constants, data types, Arithmetic Operators & Expressions, Logical operators and Relational Operators, Precedence and Associativity rules.

Conditions and Iterations : Conditions and Actions, Condition statement, Simple control statement (if, if-else,switch), Iterative control statements (for, while, do-while).
Functions : What is a function, Advantages of functions, Standard library functions; User define functions – declaration, definition, function call, parameter passing, return keyword. Scope of variables, Storage classes, Recursion.

Arrays : One- and Two-dimensional arrays: Array declaration, initialization, accessing the values, passing arrays to functions.

Pointers : Pointer declaration, initialization, Pointer arithmetic, Pointer to Pointer, Arrays and Pointers, Functions and Pointers – passing pointers to functions, function returning pointer, dynamic memory allocation.

UNIT III [15 HRS]

Strings : Declaration and initialization, standard library string functions, strings and pointers, array of strings.

Structure and Union : Creating structures, accessing structure members, array of structures, passing structure to functions, nested structure, pointers and structures, union, difference between structures and unions.

File Handling : FILE variable, file access modes, operations on files, random access to files, command line arguments.

Pre-processing : Format of Preprocessor directive, File Inclusion directive, Macro substitution, conditional compilation.

REFERENCES:

MANDATORY:

1. Dromey, R. G. (1982). How to Solve it by Computer. Prentice-Hall, Inc..
2. Kanetkar,Y. (2012). Let us C, BPB Publications,
3. Forouzan, B. A., & Gilberg, R. F. (2000). Computer Science: A structured programming approach using C. Brooks/Cole Publishing Company..

SUPPLEMENTARY:

1. Horowith,E.,Sahni ,S.,Sanguthevar,R. (2008). Fundamentals of Computer algorithm, Orient Longman.
2. Gottfried,B. (2010). Programming with C, Tata McGraw Hill.

WED BASED:

1. GNU GCC (GNU Compiler Collection) @http://gcc.gnu.org, with source codes.

2. Bjarne Stroustrup's C++11 FAQ @http://www.stroustrup.com/C++11FAQ.html.
3. https://www.tutorialspoint.com/cprogramming
4. https://www.javatpoint.com/c-programming-language-tutorial
5. https://www.w3schools.in/c-tutorial/
6. https://www.guru99.com/c-programming-tutorial.html
7. https://www.geeksforgeeks.org/c-programming-language/
8. E Book - https://www.edutechlearners.com/download/books/Let%20Us%20C%20by%20Yashavant%20Kanetkar%20PDF.pdf
9. E Book - http://www2.cs.uregina.ca/~hilder/cs833/Other%20Reference%20Materials/The%20C%20Programming%20Language.pdf
10. E Book - http://www.kciti.edu/wp-content/uploads/2017/07/cprogramming_tutorial.pdf

Practical: Introduction to Programming
Credit: 1
Marks: 25
Duration: 30 Hrs

Programs using C language that covers the following concepts:

1. Conditions
   - if..else
   - nested if

2. Iterative Control Statements
   - for
   - while
   - do…while

3. Functions.
   - Standard Library functions
   - Call by Value
   - Call by reference
   - Recursive functions

4. Arrays.
   - One Dimensional Arrays
   - Two Dimensional Arrays

5. Sorting
   - Bubble sort
   - Insertion sort

6. Searching.
   - Sequential search
   - Binary search

7. Pointers.
    - Arrays and Pointers
    - Function returning pointers
    - Dynamic memory allocation

8. Strings.
    - Standard Library string functions
    - Strings and Pointers
    - Array of Strings

9. Structure and Union
    - Array of structures
    - Passing Structure to functions
    - Nested structure
    - Structure and Pointer
    - Union

10. File Handling.
    - Text file
    - Binary file
    - Random Access to a file
    - Command Line arguments

****

Semester II

Course Title: Data Base Management Systems -I
Course Code: COM-II.C-3A
Marks: 75
Credits: 3
Duration:45 Hrs

Prerequisites: Nil

Course Objectives:

- To provide basic knowledge of a database management system.
- To understand importance of Entity Relationship diagram.
- To formulate queries in Relational Algebra and SQL for Database manipulation.
- Familiarity with any RDBMS during practical sessions.

Course outcomes:

At the end of the course students will be able to:

CO1: Explain the various database concepts and the need for database systems.
CO2: Identify different entities and relationship between them.
CO3: Represent the given system using ER diagram.
CO4: Convert an ER diagram to a database schema.
CO5: Formulate queries in Relational Algebra, SQL to manipulate the database.
CO6: Analyze the schema to see if they fulfill Normalization criterion.
CO7: Design database using appropriate RDBMS.
CO8: Design User Interface for Database.
CO9: Design Reports for Database.

SYLLABUS:

UNIT I Overview of DBMS, Design and ER model. [15HRS]
Overview of database management : Data, information, database, database management system; Managing data; File systems versus a DBMS, advantages of a DBMS; Data abstraction, instances and schemas, data models; Data manipulation language, data definition language; Architecture of a DBMS; Users of a DBMS, database administrator.

Database design and the ER model : Design phases – conceptual design, logical design, physical design; ER model – entities, attributes, and relationships, mapping cardinalities, keys; ER diagrams – strong entities, weak entities, generalization, specialization, aggregation; Converting ER diagram to relational schemes.

Unit II : Functional dependency and normalization [10HRS]
Atomic domain, nested relation; Key, super key, primary key, candidate key; Functional dependency, axioms,closure of a set of attributes, closure of a set of functional dependencies; Purpose of normalization; 1NF; 2NF;3NF; BCNF.

UNIT III : Relational model and SQL [20HRS]
Relational model :Relation, properties of relational model; Entities, integrity constraints, referential integrity constraints; Relational algebra – select, project, cross product, set operations, rename operation; Other relational operations – natural join, outer join.

SQL:Basic structure of SQL query – Create, select, where, from, rename operation; Set operations; Aggregate functions; Group by, having clauses; DDL Nested queries; Views; Insert, delete, update.

REFERENCES:

MANDATORY:

1. Silberschatz, A. (2006). Database system concepts.—6th ed.

SUPPLEMENTARY:

1. Ramakrishnan, R., & Gehrke, J. (2000). Database management systems. McGraw Hill.

2. Elmasri, R., & Navathe, S. (2017). Fundamentals of database systems. Pearson.

WEB BASED:

1.https://www.db-book.com/db6/slide-dir/ (Sixth edition Powerpoint , PDF of A Silberschatz, H F Korth, S
Sudarshan, Database system concepts,)
2.https://www.db-book.com/db7/
3.https://www.tutorialspoint.com › dbms
4.https://www.w3schools.in › dbms
5.https://www.studytonight.com › dbms
6.https://www.oracletutorial.com

Practical: :Database Management Systems I
Credit :1
Marks :25
Duration: 30 Hrs

1. ER diagram (1P)
2. ER diagram with specialization/generalization and aggregation.(1P)
3. Converting ERD into Schema.(2P)
4 SQL (2P)
5 Nested Queries (2P)
5Normalization(2P)
6 Report Writing (1P)
7. Mini project (4P)

****

Course Title: Data Structures
Course Code: COM-II.C-4
Marks: 75
Credits: 3
Duration:45 Hrs

Prerequisite Courses: Nil

Course Objectives:

- To impart the basic concepts of data structures and algorithms.
- To understand concepts about searching and sorting techniques.
- To Understand basic concepts about stacks,queues,lists,trees and graphs.
- To understanding about writing algorithms and step by step approach in solving problems with the help of fundamental data structures.

Course outcomes:

At the end of the course students will be able to :

CO1 : Define relevant standard algorithms for various data structures. Learn various applications of data structures.
CO2 : Implementation of data structures.

CO3 : Use various data structures for sorting and searching.
CO4 : Analyze and compare algorithms for efficiency using Big-O notation.
CO5 : Formulate new solutions for programming problems.

SYLLABUS

UNIT I: [15HRS]

Introduction to data structures:

Concept, Data type, Data object, ADT, Need of Data Structure, Types of Data Structure.

Algorithm analysis:

Algorithm – definition, characteristics, Space complexity, time complexity, Asymptotic notation (Big O).

Linked List:

Introduction to List, Implementation of List – static & dynamic representation, Types of Linked List, Operations on List, Applications of Linked List, polynomial manipulation, Generalized linked list –

concept & representation.

Stacks:
Introduction, Representation-static & dynamic, Operations

UNIT II [15HRS]

Stack Applications :

Application - infix to postfix& prefix, postfix evaluation, Simulating recursion using stack.

Queues:
Introduction, Representation -static & dynamic, Operations, Circular queue, priority queue (with implementation), Concept of doubly ended queue.

Trees:
Concept & Terminologies, Binary tree, binary search tree, Representation – static & dynamic, Operations on BST – create, Insert, delete, traversals (preorder, inorder, postorder), counting leaf, non-leaf & total nodes, non recursive in order traversal, Expression Tree. Introduction to AVL Trees

UNIT III [15HRS]

M-Way Search Trees : Introduction, B Tree, B+ Tree.

Searching and Sorting :

Use of various data structures for searching and sorting, selection sort, merge sort, quick sort, heap sort and hashing.

Graph :
Concept & terminologies, Graph Representation – Adjacency matrix, adjacency list, Traversals – BFS & DFS, Application of BFS, DFS – Shortest path, Backtracking.

REFERENCES:

MANDATORY:

1.Horowitz,E., Sahni,S. (2008). Fundamentals of Data Structures in C, University Press.

SUPPLEMENTARY:

1. Langsam Yedidyah, Augenstein J. Moshe, Tenenbaum M. Aaron ,(2018),Data Strutcure using C, Pearson Education

2. Richard.G, Behrouz.F, Data Structures: A Pseudocode Approch with C, Cengage Learning.

WEB BASED:

1. https://www.tutorialspoint.com/data_structures_algorithms
2. https://www.w3schools.in/data-structures-tutorial
3. https://www.studytonight.com/data-structures/
4. https://www.programiz.com/dsa
5. https://www.geeksforgeeks.org/data-structures/
6. https://www.javatpoint.com/data-structure-tutorial
7. E Book - https://www.scribd.com/doc/261233741/Data-Structures-Through-C-Yashavant-Kanetkar

Practical: Data Structures
Credit: 1
Marks: 25
Duration: 30 Hrs

Programs using C language that covers the following concepts:

1. Stack: Static/Dynamic stack implementation.
2. Stack: infix to postfix.
   Stack: Evaluation of Postfix expression.
3. Queues: Static and Dynamic Queue Implementation
   Queues: Circular queue
4. List: Singly Linked List,
5. List: Doubly Linked List
6. List: Circular Linked List
7. Linked List: Polynomial addition
8. Trees: Binary Search Tree: create, add, delete, display nodes.
9. Trees: BST traversal.
10. Graph: Representation of Graphs, Graph Traversals.
    Graph: DFS, BFS.

****

SEMESTER III

Course Title: Object Oriented Programming
Course Code: COM-III.C-5A
Marks : 75
Credits: 3
Duration:45 Hrs

Prerequisite Courses : Nil

Course Objectives:

- To teach the basic concepts and techniques which form the object oriented programming paradigm.
- To introduce object oriented programming (OOP) using Java.

Course Outcomes:

At the end of the course students will be able to :

CO1 : Apply fundamental object-oriented concepts in problem solving.
CO2: Analyze problem scenario and identify classes/objects, their properties/functionalities and

associations.
CO3 : Analyze the problem scenario and model the system using UML diagrams.
CO4 : Implement the object oriented model in any object oriented language.

SYLLABUS:

UNIT I: Introduction [15 HRS]
Principles of OOP
Programming paradigms.Basic concepts in OOP. OOP: major principles - encapsulation, abstraction,inheritance, polymorphism. Benefits of OOP. Applications of OOP.
Introduction to Java
Basics of Java programming, Data types, Variables, Operators, Control structures including selection,Looping, Java methods, Overloading, java.Math class, Arrays in java.

UNIT II Principles of OOP [15 HRS]
Basics of objects and classes in java, Constructors, Finalizer, Visibility modifiers, Methods and objects,object serialization, Inbuilt classes like String, Character, StringBuffer, File, this reference.
Inheritance and Polymorphism:
Inheritance in java, Super and sub class, Overriding, java.lang.Object class, Polymorphism, Dynamic binding, Generic programming, Casting objects, Instance of operator, Abstract class, Interface in java, Package in java, java.util package.

UNIT III: Exceptions, Multi-threading and GUI programming: [15 HRS]
Event and GUI programming
Design patterns – what and why? It's classification. Introduce the Observer design pattern.
Event handling in java, Event types, Mouse and key events, GUI Basics, Panels, Frames, Layout Managers:
Flow Layout, Border Layout, Grid Layout, GUI components like Buttons, Check Boxes, Radio Buttons,Labels, Text Fields, Text Areas, Combo Boxes, Lists, Scroll Bars, Sliders, Windows, Menus, Dialog Box,Applet and its life cycle.
Multi-threading in java
Multi-threading in java, Thread life cycle and methods, Runnable interface, Thread synchronization.
Exception handling
Exception handling – what and why? Try and catch block. Multiple catch blocks. Nested try, finally block,throw keyword, throws keyword. Custom Exception.Introduction to the Collections Framework.

REFERENCES:

MANDATORY:

1. Deitel, P., & Deitel, H. (2011). Java How to program. Prentice Hall Press.
Supplementary:
2. Naughton.P, Schildt.H, (2000), Java 2 – The Complete Reference TMH publications
3. Patrick,N. (1997). The Java Handbook –TMH publications
4. Mughal, K. A., & Rasmussen, R. W. (2003). A programmer's guide to Java certification: a comprehensive primer. Addison-Wesley Professional.
5. Flanagan, D. (2004). Java examples in a nutshell.
6. Arnold, G., H.(2005)"The Java Programming Language" Addison-WesleyProfessional,

WEB BASED:
1.www.javapoint.com
2.www.tutorialspoint.com
3.www.gurugg.com
docs.logout.org>Programmation>Java>Programming with Java_A primer

Practicals: Object Oriented Programming
Credit: 1
Marks: 25
Duration: 30 Hrs

Programs using Java language that covers the following concepts:
1) Classes and instances
2) Working with the java.Math class
3) Inheritance
4) Composition v/s inheritance
5) Polymorphism, abstract classes and interfaces
6) Algorithm and Data Structures
7) Utilizing the java.util package
8) Event handling and GUI
9) Applets
10) I/O programming
11) Exception handling
12) Multi-threading
13) Collections framework

****

Course Title: Software Engineering
Course Code: COM-E1
Marks: 75
Credits: 3
Duration: 45 Hrs

Prerequisite Courses : Nil

Course Objectives:

- To Understand the various software development methodologies and estimation of software projects.
- To analyze and design software projects.
- To study the various phases of a S/W Development Project.

Course Outcomes:

At the end of the course students will be able to:

CO1: Understand the various Software Development Methodologies.
CO2: Apply Estimation techniques to live projects.
CO3: Analyze Software Projects.
CO4: Design Software Projects.

SYLLABUS:

UNIT I: [15 HRS]
SOFTWARE PROCESS:
Characteristics of software process.
Software Development Processes and Methodologies: waterfall, prototyping, iterative, spiral,unified process. Benefits of iterative and incremental approach with emphasis on Unified process, CASE Tools,Agile methodologies.

PROJECT MANAGEMENT:
Planning a Software Project – Cost estimation, Project Scheduling, Software configuration management plans, Quality Assurance plans, Project Monitoring plans and Risk Management.Techniques such as Interviewing , Requirement Workshop, brainstorming, prototyping.Characteristics of SRS.

UNIT II: [15 HRS]
OOAD and UML:
OOAD: Definition; object oriented analysis; object oriented design and modeling; Assigning responsibilities.
UML: Main UML diagrams – Class diagram , sequence diagram, activity diagram, use case diagram.
Use case model – use case diagram , use case descriptions, use case realization using sequence and activity diagrams. Supplementary requirements. Advanced use case model features.

Requirements: Functional and non-functional

System Design : Class diagram, sequence diagram, activity diagram, state chart diagram,deployment diagram. Brief introduction to other UML diagrams.
SOFTWARE ARCHITECTURE PATTERNS:
Major Architectural Styles (patterns) like Layered Architecture, Pipe and Filter, Shared (Central)Data Store, Event Driven,
Model-View-Controller (MVC), “Distributed & Emerging” Service Oriented Architecture (SOA) and Elementary GRASP
Patterns.

UNIT III [15 HRS]
HUMAN COMPUTER INTERACTION:
HCI Definition; User categories, Interface Design-Internal & External Interface design, user interface design, Interface design guidelines.
CODING:
Coding styles, standards, peer reviews, checklist.
TESTING:
Testing Fundamental, Functional Testing, Structural Testing, Testing Object-Oriented Programs, Testing Process and Metrics.
DOCUMENTATION and MAINTENANCE:
Need for Software Documentation. Types of documentation, Need for Maintenance; Types of Maintenance.
REENGINEERING:
Business Process Reengineering, Software Reengineering, Reverse Engineering,Restructuring, Forward Engineering, The Economics of Reengineering.

REFERENCES:

MANDATORY:

1. Pressman, R. S. (2005). *Software engineering: a practitioner's approach*. Palgrave Macmillan.
2. Larman C.,(2015) *Applying UML and patterns*. Addison Wesley.
3. Bourque, P., & Fairley, R. E. (2014). *Guide to the software engineering body of knowledge (SWEBOK (R)):* Version 3.0. IEEE Computer Society Press.

SUPPLEMENTARY:

1. Jalote, P. (2012). An integrated approach to software engineering. Springer Science & Business Media.
2.Sommerville I.,(2015) Software Engineering.Adison Wesley.
3. Fowler, M. (2003). UML Distilled: A Brief Guide to the Standard Modeling Object Language. Object Technology Series, 3rd edition, Addison-Wesley.

WEB BASED:
1.https://www.tutorialspoint.com/software_engineering
2.https://www.w3schools.in/sdlc-tutorial
3.https://www.geeksforgeeks.org/software-engineering
4.https://www.javatpoint.com/software-engineering-tutorial

Practicals : Software Engineering
Credit : 1
Marks : 25
Duration: 30 Hrs

List of suggested PRACTICALS :
For a given project/case study
1) Requirements Gathering Techniques [2P]
2) Gantt Chart [2P]
3) USE Case diagram and Use Case descriptions for the Use Cases [3P]
4) Class Diagram [2P]
5) Sequence Diagram [2P]
6) Activity Diagram [2P]
7) State Chart Diagram [2P]

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Course Title: Digital Logic Design
Course Code: COM - E2
Marks: 75
Credits: 3
Duration: 45 Hours

Prerequisite Courses: Nil

Course Objectives:

- To understand the basics of Boolean algebra and the operation of logic components, combinational, sequential circuits and design of digital systems.

Course Outcomes:

After completing this course, students will be able to:

CO1: Convert values between various number systems/codes.
CO2: Simplify the logical expression using Boolean algebra.
CO3: Design, simplify and implement combinational logic circuits.
CO4: Design and implement the sequential logic circuit and their applications.
CO5: Explain the methods of D/A converter and A/D converters (Successive Approximation method).
CO6: Explain the classifications and characteristics of semi conductor memories with memory expansion.

SYLLABUS:

UNIT I:Number Systems,Boolean Algebra and Convertors: [15 HRS]
Number Systems: Decimal, Binary, Hexadecimal, and Octal number systems; BCD Code, Gray Code, Excess-3 Code, ASCII code, Unicode.
Boolean Algebra: Basic Boolean functions, Postulates and theorems of Boolean Algebra, logic gates, Sum-of-Products and Product-of-Sums forms of Boolean functions;Canonical and Standard forms. Simplification of Boolean Functions, Plotting of K-Maps, POS and SOP Simplification, NAND and NOR implementation.
D/A & A/D Converters: Digital to Analog converter – Introduction, Weighted-Resistor & R-2R Ladder,Analog to Digital Converter – Introduction, Successive Approximation method.

UNIT II:Combinational and Sequential Circuits: [15 HRS]
Combinational Circuits: Design procedure for combinational logic circuits; design andanalysis of Half Adder, Full Adder; their use in designing other combinational logic circuits; Analysis & Design of Encoders and Decoders; Multiplexer and demultiplexers;
their use in designing combinational circuits.

Sequential Circuits (Registers):SR, JK, T, D Flip-flops and Latches, their schematic symbols, Truth tables. Shift Registers - SISO, SIPO, PISO, PIPO, Bi-directional Shift Registers, Loading methods for Shift, Registers.

UNIT III:Sequential Circuits(Counters) and Semiconductor memories: [15 HRS]

Counters: Design and analysis of Counters: Synchronous Counters, Modulo Counters,Asynchronous, Ripple and Ring Counters; Application of Counters.

Semiconductor memories:Memory organization and operation, expanding memory size,Classification and characteristics of memories, RAM, ROM, Synchronous DRAM SDRAM),Double Data Rate SDRAM, Synchronous SRAM, DDR and QDR SRAM,Content Addressable Memory.

REFERENCES:

MANDATORY:

1. Jain, R. P. (2003). Modern digital electronics. Tata McGraw-Hill Education.

SUPPLEMENTARY:

1. Leach.D, Malvino,M , Saha.G, Digital Principles and Applications, ,Mc. Graw Hill (SiE).
2. Mano, M. M. (2017). Digital logic and computer design. Pearson Education India.
3. Taub, H., & Schilling, D. L. (1977). Digital integrated electronics. McGraw-Hill College.

WEB BASED:

1. https://nptel.ac.in/courses/117/106/117106114/
2. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/
3. https://logisim.en.uptodown.com/windows
4.https://www.edutechlearners.com/download/books/Morris%20Mano%20Digital%20Design%203rd%20Edition.pdf
5.https://books.google.co.in/books?id=dnq3HmDN1ZAC&printsec=frontcover&redir_esc=y#v=onepage&q&f=false

Practicals :Digital Logic Design
Credits :1
Marks :25
Duration: 30 Hrs

Practicals:
1. Introduction to digital ICs, specifications, verification of the truth tables of logic gates1 (2 Lab sessions)
2. Introduction to digital ICs, specifications, verification of the truth tables of logic gates2. (2 Lab sessions)
3. Implementation of the given Boolean function using logic gates in SOP form .

(adder/subtractor -2 sessions)
4. Decoder and Encoder (2 sessions).
5. Multiplexer –Demultiplexer (2 sessions).
6. Verification of state tables of RS, JK, T and D flip-flops.
7. Design and verification of the 4-bit asynchronous and Synchronous counter (3 sessions)

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Course Title: Mathematical Foundation of Computer Science - II
Course Code: COM - E3
Credits: 3
Marks: 75
Duration:45 Hrs

Prerequisite Courses: Nil

Course Objectives:

- To build mathematical foundations in the areas namely graph theory.
- Application of numerical analysis related to topics of computer science.

Course Outcomes:

On completion of the course students should be able to:

CO1: System of linear equations in solving the problems
CO2: Apply the Interpolation methods for solving the problems numerically.
CO3: Demonstrate the process of curve fitting of data.
CO4: Determine the roots of polynomial equations.

SYLLABUS:

UNIT I: Systems of Linear Equations and Matrices, Linear Combinations and [10 HRS]
Linear Independence

Systems of Linear Equations, Matrices and Elementary Row Operations, The Inverse of a Square Matrix, Matrix Equations, Applications of Systems of Linear Equations.Linear Combinations and Linear Independence.

UNIT II: Vector Spaces, Linear Transformations, Eigenvalues and Eigenvectors [15 HRS]

Definition of a Vector Space, Subspaces, Basis and Dimension, Coordinates and Change of Basis Linear Transformations, The Null Space and Range, Isomorphisms, Matrix Representation of Linear Transformations, Similarity.Eigen values and Eigen vectors, Diagonalization.

UNIT III: Interpolation, Numerical Integration, algebraic and transcendental equations [20 HRS]

Introduction; Various methods of interpolation; Various methods of curve fitting; Newton's method of forward interpolation formula; Newton's method of backward interpolation formula. Lagrange's formula.
General quadrature formula; Trapezoidal rule; Simpson's one-third rule; Simpson's three-eighth rule; Weddle's rule.
Graphical method; Bisection method; Method of false position; Secant method; Newton-Raphson method.
Adjoint, inverse of a matrix; Rank; Linear equations; Characteristics roots and vectors.

REFERENCES:

MANDATORY:

1. Defranza, J., & Gagliardi, D. (2015). Introduction to Linear Algebra with applications. Waveland Press.
2. Parthasarathy.K,(1994) Basic Graph Theory, Tata McGraw-Hill Publishing
3. Goel,B., & Mittal,S. (1998) Numerical Analysis, PragatiPrakashan,
4. Iyengar,S.N.,(2010) Matrices, Anmol Publications.

SUPPLEMENTARY:

1. Clark, J., & Holton, D. A. (1991). A first look at graph theory. World Scientific.
2. Chatterjee,P. (1996) Numerical Analysis, RajhansPrakashanMandir.
3. Krishnamurthy,V. (1976) Introduction to Linear Algebra, Affiliated East-West Press.

WEB BASED:

1.https://www.cse.iitb.ac.in

Practicals : Mathematical Foundation of Computer Science - II
Credit: 1
Marks: 25
Duration: 30 Hrs

Linear equations
1. Systems of Linear Equations
2. Linear Transformations
3. Matrix Representation of Linear Transformations

Numerical Analysis
4) Find the value of dependent variable using Newton's forward formula for a given value of independent variable.
5) Use Newton's backward formula to estimate a value.

6) Estimate a value using Lagrange's formula.
7) Apply Simpson's three-eighth rule to find the value of integration.
8)Apply Newton-Raphson method OR secant method to estimate the root of a equationLinear Algebra.
9) Find the rank of a matrix.
10) Find solutions of a system of equations
11) Find the Eigen values and Eigen vectors

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Course Title: Web Designing
Course Code: COM-E4
Marks: 75
Credits: 3
Duration:45 Hrs

Prerequisite Courses: Nil

Course objectives:

- Design good user interfaces.
- Apply design principles such as learnability, visibility, error prevention, efficiency and graphic design.

Course Outcomes:

On completion of the course students will be able to:

CO1:Design Content for a web application.
CO2:Style content so as to provide an effective User Interface.
CO3:Provide for dynamism in the User Interface to enhance usability.
CO4:Develop a static web application.

SYLLABUS:

UNIT I: Structuring the UI with HTML/HTML5 [15 HRS]
User Interface – Introduction, its importance, design principles – learnability, visibility, error prevention, efficiency, graphic design. Design Patterns for GUI – View tree, Listener, Widget, Model-ViewController.

HTML - Introduction. The development process, basic HTML, formatting and fonts, commenting code, color, hyperlink, lists, tables, images, simple HTML forms, web site structure, Meta tags, Character entities, frames and frame sets.

HTML5 - Introduction, New Elements, Canvas, SVG, Drag/Drop, Geolocation, Video, Audio, Input types, form elements, form attributes, semantic, web storage, app cache, web workers, SSE

UNIT II : Styling the UI with CSS/CSS3 [10 HRS]

CSS - Introduction – Syntax, Id & Class, Backgrounds, Text, Fonts, Links, Lists, Tables. CSS Box Model – Border, Outline, Margin, Padding. Advanced - Grouping/Nesting, Dimension, Display, Positioning, Floating, Align, Pseudo-class, Pseudo-element, Navigation Bar, Image Gallery, Image Opacity, Image Sprites, Media Types, Attribute Selectors.

CSS3 - Introduction, Borders, Backgrounds, Gradients, Text Effects, Fonts, 2D Transforms, 3D Transforms, Transitions, Animations, Multiple Columns.

UNIT III: Dynamism in UI [20 HRS]

JavaScript - Introduction - What is JavaScript, Understanding Events, JavaScript Example, External JavaScript. Basic Elements – Comment, Variable, Global Variable, Data Types, Operators, If Statement, Switch, Loop: for and while, Function. JavaScript Objects – objects, Array. Browser Object Model - Browser Objects, Window Object, Document Object – getElementById, getElementsByName, getElementsByTagName, innerHTML property, inner Text property. Validation- form validation, email validation.

JQuery : Introduction - Syntax, Selectors, Events. Effects- Hide/Show, Fade, Slide, Animate, stop(), Callback, Chaining. HTML/CSS- Add, Remove, CSS Classes, css(), Dimensions, slider. Traversing – ancestors, descendants, siblings, filtering.

REFERENCES:

MANDATORY:

1. D.T,(2018) Web Technologies, Black Book,DreamTech

WEB BASED:

1.https://www.w3schools.com
2.https://www.tutorialspoint.com/html/index.htm
3.https://www.tutorialspoint.com/css/index.htm
4.https://www.tutorialspoint.com/javascript/index.htm
5.https://www.tutorialspoint.com/jquery/index.htm
6.https://www.udemy.com/courses/development/web-development/

Practicals : Web Designing
Marks: 25
Credits: 1
Duration: 30 Hrs

List of Assignments: (the numbers in brackets indicate number of practicals) :
1) Case studies to review UI designs [2 P]
2) Create a HTML page with the following: [3 P]
a) title heading paragraph emphasis strong and image elements

b) complex HTML table
c) simple HTML Form covering major form elements
d) Embed Video in an HTML page

3) Using CSS do the following: [3 P]
a) Create a Navigation bar (with dropdown) with CSS
b) Create a CSS Grid
c) Create a CSS3 based button
d) Make an image rounded shape
e) Create a CSS based sticky footer
f) Create CSS3 Corner Ribbon
g) Create CSS3 blurry text effect
h) Create CSS3 speech bubble shape
i) Create image cross fade with CSS3 transition
j) Set style for link hover active and visited states of hyperlink

4) Write JavaScript functions to : [4 P]
a) accept a string as a parameter and converts the first letter of each word of the string in upper case.
b) check whether a given credit card number is valid or not.
c) check whether a given value is an valid url or not.
d) check whether a given email address is valid or not.
e) print an integer with commas as thousands separators
f) remove items from a dropdown list.

5) Use JQuery to : [3 P]
a) Disable buttons
b) Make textbox read only
c) Uncheck check boxes
d) Confirm again
e) Sort
f) Switch rows and columns

A mini project combining all the technologies learnt using a front-end development framework such as bootstrap is recommended.

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SEMESTER IV

Course Title: Computer Architecture and Organization
Course Code: Com-IV. C-6
Marks: 75
Credits: 3
Duration: 45Hours

Prerequisite Courses: Nil

Course Objectives:

- Conceptualize the basics of organizational and architectural issues of a digital computer.
- Analyze processor performance improvement using instruction level parallelism.
- Explain different types of addressing modes and memory organization.
- Study various data transfer techniques in digital computer.
- Learn microprocessor architecture and study assembly language programming.
- Understand the taxonomy of Parallel Processor.
- To have a thorough understanding of the basic structure and operation of a digital computer.

Course Outcomes:

At the end of the course students will be able to:

CO1: Identify various components of the Computer System.
CO2: Explain the detailed function of a typical microprocessor and its control unit.
CO3: Implement Assembly Language Program for 8086 processor for a given task.
CO4: Differentiate the function and role of semiconductor memories and map the cache memory for the given scenario.
CO5: Appraise the importance of input/output modules and Interrupts and their functions.
CO6: Distinguish the characteristics and function of I/O interfaces to computer system.

CO7: Illustrate the function of pipelined architecture and classify the Multiprocessor systems.

SYLLABUS

UNIT I: Computer System and Processor Unit: [15 HRS]

Function and structure of a computer, Interconnection of components, Performance of a computer. Computer Architecture – Princeton (Von Neumann) and Harvard architecture.Architecture of 8086 processor - Registers, ALU and Control unit, Data path in a CPU.Instruction cycle, Organization of a control unit – Block Diagram of Hardwired andMicroprogrammed control unit.

UNIT II: Instruction Set and Memory Subsystem: [15 HRS]

Machine instructions characteristics, Types of operations-data transfer, arithmetic,logical, conversion, I/O, system control, transfer of control; 8086 Instruction Set and Assembly language: Addressing modes-immediate, direct, indirect, register, register indirect, displacement, stack. Instruction formats - instruction length, allocation of bits,variable length instructions, Instruction set architectures – CISC and RISC architectures.Characteristics of memory system, the memory hierarchy, Semiconductor memories,Types of ROM & RAM, Cache memory unit - Concept of cache memory,Organization of a cache memory unit, Mapping methods, replacement algorithms,write policy, block size.

UNIT III: Input/Output Subsystem and Parallel Processing: [15 HRS]

General block diagram of External device & I/O module, Programmed I/O, Interrupt driven I/O, DMA, I/O channels and I/O processors. I/O interfaces – Serial port, Parallel port, PCI bus, SCSI bus, USB bus, Firewire and Infiniband.Classifications, Introduction to pipeline processing: Instruction pipeline & Arithmetic pipeline, Introduction to Array & Vector processors, Introduction to Multiprocessors.

REFERENCES:

MANDATORY:

1. Stallings, W. (2003). Computer organization and architecture: designing for performance. Pearson Education India..

SUPPLEMENTARY:

1. Mano, M. M. (2005). Computer system architecture. Dorling Kindesley Pearson.
2. Patterson, D. A., & Hennessy, J. L. (2013). Computer organization and design MIPS edition: the hardware/software interface. Newnes.
3. Douglas V. Hall, (2012), Microprocessors and its Interfacing, McGraw Hill Education (India) Private Limited.

WEB BASED:

1. http://williamstallings.com/ComputerOrganization/
2. https://www.tutorialspoint.com/computer_fundamentals/index.htm
3. http://www.ecs.umass.edu/ece/koren/architecture/
4. http://www.cs.colby.edu/djskrien/CPUSim/
5. https://teachcomputerscience.com/little-man-computer/
6. https://vivaxsolutions.com/web/lmc.aspx

Practicals: Computer Architecture and Organization
Credits: 1
Marks: 25
Duration: 30 Hrs

1. Study of Motherboard, Peripherals and the Computer System:O.S. Installation (Dual Boot): BIOS; Manage disk partitions: understand MBR-style partitions, (primary, extended, logical); list/create/delete partitions; Manage logical volumes: create/remove physical volumes, create/delete logical volumes, Boot loader.Installation of drivers; updating software packages
2. DOS Commands, Tools for Computer Management (Disk Management, Disk Cleanup, Defragmentation, Performance Monitor, System Restore etc).

Assembly language programs for 8086 using MASM / compatible assembler or Simulator, either in Windows or Linux.

3. Study of addressing modes.
4. Programs for arithmetic operations1
5. Programs for arithmetic operations2
6. Programs for arithmetic operations3
7. Programs for data transfer operations
8. Programs for logical operations1
9. Programs for logical operations2
10. Programs code conversion1
11. Programs code conversion2
12. Programs on sorting
13. Programs on searching
14. DOS/BIOS – Programming1
15. DOS/BIOS – Programming2

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Course Title: Design and Analysis of Algorithms
Course Code : COM-E5
Marks :75
Credits :3
Duration :45 Hrs

Prerequisite Courses: Nil

Course Objectives:

- To study paradigms and approaches used to analyze and design algorithms and to appreciate the impact of algorithm design in practice.
- To ensure that students understand how the worst-case time complexity of an algorithm is defined, how asymptotic notation is used to provide a rough classification of algorithms and compare with one another, and how there are still some problems for which it is unknown whether there exist an efficient algorithm, and how to design efficient algorithms.

Course Outcomes:

At the end of the course students will be able to :

CO1: To analyze the performance of algorithms.
CO2: Choose appropriate algorithm design techniques for solving problems.
CO3: Analyze empirical results to get a deeper understanding of the algorithmic solutions.
CO4: Apply important algorithmic design paradigms and methods of analysis.

SYLLABUS:

UNIT I: Algorithm Analysis and Divide and Conquer Strategy [15 HRS]

What is an Algorithm?, Rules for writing Algorithms, Properties of Algorithms, Framework for design and analysis of algorithms(RAM model of computation),Recursive Algorithms, Space and Time Complexity by Tabular method(Performance Analysis) Elements of Divide and Conquer Algorithms, QuickSort algorithm, Merge sort analysis, Strassen's algorithm for matrix multiplication, Analysis of Binary Search,The Maximum subarray Problem.

UNIT II: Dynamic programming and Greedy Techniques [15 HRS]
General Method, caching v/s computation, Fibonacci numbers by recursion, Fibonacci numbers by cashing, Fibonacci numbers by dynamic programming,Optimal Binary Search Tree,Rod Cutting Problem. Elements of greedy strategy, Activity-selection problem, Job sequencing with deadlines.Knapsack problem.

UNIT III: Graphs and Complexity Classes [15 HRS]
Elementary graph algorithms- Minimum spanning tree, growing a spanning tree, Kruskal and Prim algorithms, Breadth First search and Depth First Search, Travelling salesman problem. Introduction to polynomial time algorithms, NP, NP Complete, NP Hard, Approximation and Randomisation algorithms.

REFERENCES:

MANDATORY:

1. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2009). Introduction to algorithms. MIT press.

SUPPLEMENTARY:

1.Horowitz.T, Sahni.S, Rajasekaran.S,(2010) “Fundamentals of Computer Algorithms”, Universities Press Maryland,

2. A. Aho, J. Hopcroft, J. Ullman (2016).“The Design and Analysis of Computer Algorithms” Pearson Education India New Delhi,

WEB BASED:

1.http://www.iitk.ac.in/esc101/2009Jan/lecturenotes/timecomplexity
2. https://home.cse.ust.hk/~dekai/271/notes/L12/L12.pdf
3. https://nptel.ac.in/courses/106106131/
4. https://www.cs.cornell.edu/courses/cs3110/2012sp/lectures/lec20-master/lec20.html
5. https://www.cs.indiana.edu/~achauhan/Teaching/B401/LectureNotes/complexityClasses.html

Practicals: Design and Analysis of Algorithms
Credit : 1
Marks : 25
Duration: 30 Hrs

1 Program to find GCD of 2 numbers using Iterative approach and Recursive approach
2 Program for quickSort
3 Program for Mergesort
4 Program to perform Binary Search using Recursive approach
5 Program to implement maximum subarray problem.
6 Program to generate Fibonacci numbers using Dynamic Programming approach.
7 Program to implement Activity Selection Problem.
8 Program to implement job sequencing with Deadlines.
9 Program to implement Knapsack Problem
10 Program to implement Rod Cutting Problem.
11 Program to implement Binary Tree.

12 Program to represent graph using matrix/ Linked List.
13 Program to implement BFS/DFS Traversal on graph.
14 Program to implement Kruskal's Algorithm
15 Program to implement Prim's Algorithm

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Course Title: Mobile Application Development
Course Code: COM-E10
Marks: 75
Credits: 3
Duration:45 Hrs

Prerequisite Courses: Nil

Course Objective:

- Students learn how to develop applications for mobile devices, including smart phones and tablets. Students are also introduced to the current mobile platforms, mobile application development environments and mobile device input methods. Students will design and build a variety of apps on a popular platform throughout the course to reinforce learning and todevelop real competency.

Course Outcome :

At the end of the course students will be able to :

CO1: Explain mobile devices, including their capabilities and limitations.
CO2: Review current mobile platforms and their architectures.
CO3: Develop mobile applications on a popular mobile platform.
CO4: Evaluate development with another mobile platform.

SYLLABUS:

UNIT I:Introduction to mobile devices: [15 HRS]
Mobile devices vs. desktop devices, Why we Need Mobile App, Different Kinds of Mobile Apps, ARM and intel architectures, Power Management, Screen resolution, Touch interfaces,Application deployment - App Store, Google Play, Windows Store,Development environments – Android Studio, PhoneGAP,Native vs. web app, Browser-detection, Touch interfaces, Geolocation, Screen orientation,
Mobile browser ?interpretations? (Chrome/IE).Comparing and Contrasting architectures of Android, iOS and Windows, Underlying OS(Darwin vs. Linux vs. Windows), Kernel structure and native level programming,Runtime (Objective-C vs. Dalvik vs. WinRT), Security.Introduction to Android Operating System, Overview of android stack, Android features.Linux Kernel, Libraries, Android Runtime, Application Framework, Dalvik VM,Multithreading in Android-Async Task,Handler Post

UNIT II:Android Components: [15 HRS]
Activities, Services, Broadcast Receivers, Creating Broadcast receiver, Receiving System Broadcast, Understanding Broadcast action, category and data, Sending Broadcast. Content Providers, Views, layouts and Common UI components, Creating UI through code and XML,Activity life cycle, Intents-,Intent Filters, Intent-matching rules, Filters in your manifest.Communicating data among Activities. Selection components (Grid View, List View,Spinner), Adapters, Custom Adapters, Menus, Toast, Custom Toast, Dialogs, Status bar Notifications.Overview of services in Android, implementing a Service, Service lifecycle, Inter Process Communication (AIDL Services). Web Services and WebView - Consuming web services,Receiving HTTP Response (XML, JSON), Parsing JSON and XML, Using WebView.

UNIT II:Data Storage: [15 HRS]
Shared Preferences, Android File System, Internal storage, External storage.SQLite-Introducing SQLite, SQLiteOpenHelper and creating a database, Opening and closing a database, working with cursors, inserts, updates, and deletes.
Content Provider-Accessing built in content providers, Content provider MIME types, searching for content, Adding, changing, and removing content, creating content provider,Working with content files.

REFERENCES:

MANDATORY:
1. Lee, W. M. (2010). Beginning iPad application development. John Wiley & Sons.
2. Satya.K, Pro Android 4 ; Dave MacLean (Apress)
3. Burnette, E. (2009). Hello, Android introducing Google's mobile development platform 2nd.
4. Cinar, O. (2012). Android apps with Eclipse. Apress.
5., Dimarzio, J.F. Android- A Programmer‘S Guide (Tata McGraw Hill)

WEB BASED:

1. http://developer.android.com/index.html
2. http://www.appinventor.org/

Practicals : Mobile Application Development
Credit: 1
Marks: 25
Duration: 30 Hrs

1. Getting Started with Android – Installing the Development Environment, Configuring Android Stack
2. Creating the First Android Application - Creating a Simple Android Project, Debugging Application through DDMS. setting up environment. AVD Creation, Executing Project on Android Screen.

3. Android application development - Use of GUI components to implement a simple application such as a Calculator.
4. Review the earlier application making use of the advanced UI components.
5. Implementing Data storage application - an application to make Insert , update , Delete and
retrieve operation on the database.

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Paper Title: Server Side Programming
Paper Code: COM-E7
Marks: 75
Credits : 3
Duration:45 Hrs

Course Prerequisite: Nil

Course Objectives:

- Provide an in depth understanding of :
- Object oriented approaches to software development, in particular to the development of web applications.
- Server side scripts and their purpose

Course Outcomes:

On completion of the course students will be able to:

CO1:Design and implement server-side scripts.
CO2:Create and manipulate databases using SQL and server side technologies.
CO3:Create data documents using XML/JSON.
CO4:Enhancing web applications using AJAX and XML/JSON.
CO5:Develop dynamic web applications using the object oriented paradigm.

SYLLABUS:

UNIT I: Application of Object Oriented Approach to Software Development [10 HRS]

Review of Object Oriented Concepts - Class, Object, member variable, member function, Inheritance, Polymorphism, overloading, Data Abstraction, Encapsulation.Object oriented design and modeling.

UNIT II: Developing dynamic web applications with Server-side technologies [20HRS]

Static vs. Dynamic web pages, Need for Server Side technologies, Multitier Web Architecture. Common Gateway Interface standard, server-side includes, server APIs,server-side scripting – working principles, and implicit objects. Database and fileaccess. Comparison of Web servers.

UNIT III:Enhancing Web Applications with Ajax and XML/JSON [15HRS]

AJAX – introduction, purpose, advantages and disadvantages. Key elements of AJAX – introduction to XML. XML processing with server sidescript. XSL, transforms and templates. The XML Http Request object–methods and properties. Creating and using XML Http Request objects. Using XSLT with AJAX. JSON – Syntax, mixing literals, Array, object, encoding/decoding, JSON versus XML, server-side JSON tools.

Web Services - Introduction, its role. Basics – Creating, Publishing, Testing and Describing a Web services (WSDL)-Consuming a web service. SOAP – introduction, requests and responses. Role of UDDI – accessing registries. REST based webservices – building, deploying and consuming

REFERENCES:

MANDATORY:
1.Steelman, Murach'S Java Servlets & JSP, 2/E, PHI

SUPPLEMENTARY:
1. Chappell.D, Jewell.T, “Java Web Services : Using Java in Service Oriented Architectures”, O’Reilly
2. DT Editorial Services, (2018). Web Technologies, Black Book, DreamTech

WEB BASED:
1. https://docs.oracle.com/cd/E14571_01/web.1111/e13712/basics.htm#WBAPP117

Practicals: Server Side programming
Credit : 1
Marks : 25
Duration: 30 Hrs

List of suggested PRACTICALS (the numbers in brackets indicate number of practicals)
1) Perform OOAD of a given system using the following diagrams: [3 P]
a) use case diagram b) class diagram
2) Using server side programming and following OOAD principles develop a dynamic web
application. [6 P]
3) Add AJAX and Web service(s) to the application. [3 P]

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Course Title: Human Computer Interface
Course Code: COM-E8
Marks: 75
Credits: 03
Duration: 45 Hours

Pre-requisite course: Nil

Course Objectives:

- To study the different aspects of human computer interaction.
- To study computer interface design concepts.

Course Outcomes:

Upon completion of the course student will be able to:

CO 1: To understand the intricacies of human interaction with a computer System.
CO 2: To understand the concept of a graphical user interface, and its design characteristics.
CO 3: To recognize the human element its strengths and weakness for computer interaction.
CO 4: To know the principles of good screen design and layouts.
CO 5: To know the different navigation schemes on windows-based interface; learn the different
types of selection devices and components of a window-based interface.
CO 6: To know the different types of interaction devices and media.

SYLLABUS:

UNIT I: Introduction to Human Computer Interaction: [10 HRS]
Human-Computer Interaction, Evaluating Designs, The Birth of HCI. Importance of user Interface, Importance of good design, Benefits of good design, principles & heuristics of good design.
Importance of: Human characteristics, Human consideration, Human interaction speeds,Understanding business functions. User centered design- Need-finding: Participant Observation,Interviewing, Additional Need finding, contextual inquiry & persona.

UNIT II: Rapid Prototyping and Graphical Interface Design: [20 HRS]
Rapid Prototyping: Story boarding. Paper Prototyping and Mockup, Video Prototyping, Creating and Comparing Alternatives.

Direct Manipulation. Mental Models. Heuristics (guidelines) for design.

Graphical Interface Design: Graphical user interface, standards such as Microsoft windows HCI guidelines, Windows: Navigation schemes selection of window; Selection of devices based and screen-based controls, Components, Text and messages, Icons, Multimedia, Colors., controls,help & error messages design.

UNIT III: Heuristic Evaluation and Visualization [15 HRS]

Web user interface design – Jessy James Garette five layers of user experience.
Heuristic Evaluation: Heuristic Evaluation — Why and How?
Visualization, Amount of information, Focus and emphasis, Presentation information simply and meaningfully, Information retrieval on web, Statistical graphics.

REFERENCES:

Mandatory:
1. Cooper, A., Reimann, R., & Dubberly, H. (2003). About face 2.0: The essentials of interaction design. John Wiley & Sons, Inc..
2. Alan.D, Janet.F, Gregory D. and Russell,B. (2012) Human-Computer Interaction, Prentice Hall.

Supplementary:
1. Shneiderman, B., & Plaisant, C. (2010). Designing the user interface: strategies for effective human-computer interaction. Pearson Education India.
2. Donald.A.N. (2010) The Design of Everyday Things Basic Books.

WEB BASED:
1. http://hcibib.org/
2. https://www.tutorialspoint.com/human_computer_interface/index.htm.
3.https://www.academia.edu/4955516/Wiley_The_Essential_Guide_to_User_Interface_Design_3rd_Edition_Apr_2007?auto=download.
4. https://www.slideshare.net/busaco/hci-2015-110-humancomputer-interaction-overview?qid=1c116f30-ec87-4eb4-a375-49b2bbe65d75&v=&b=&from_search=2

Practicals: Human Computer Interface
Credit : 1
Marks : 25
Duration: 30 Hrs

Suggested list of practical (Numbers in brackets indicate number of practicals)
1. Paper Prototyping using templates (1)

2. Conducting survey interview and summarizing the result(1)
3. Persona- conducting contextual interview and developing persona(1)
4. GUI design- form design, menu design, help, error messages(2)
5. Web UI design- pages, navigation, controls, Page submission – Asynchronous (2)
6. Report designs (2)
7. Visualization and info graphics (1)
8. Heuristic evaluation(2)
9. Story boarding (1)

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ANNEXURE III
Parvatibai Chowgule College of Arts and Science (Autonomous)

DEPARTMENT OF COMPUTER SCIENCE

SYLLABI OF SKILL ENHANCEMENT COURSE (SEC) AND GENERIC ELECTIVES COURSES (GEC)

*GEC are offered to Arts as well as to Science stream

(2020 - 2021)

SKILL ENHANCEMENT COURSE (SEC)

Course Title: Python Programming
Course Code: COM-SEC1
Marks: 100
Credits: 4
Duration: 60 HRS

Prerequisite Courses: Nil

Course Objectives:
To provides skills of data analysis using Python programming language.

Course Outcomes:

At the end of the course students should be able to :

CO1: Understand syntax of Python Programming.
CO2: Write program using conditional statements, loops.
CO3:Apply required List function.
CO4: Write Python program specific to the domain of the given problem.

SYLLABUS:

UNIT I : Introduction to Python [15HRS]
Motivation, programming paradigms, What Python can do, Python’s technical strength, Python interpreter, Program execution, Execution model variations, How to run programs.

Basic Syntax
Variable and Data Types, Operator, Conditional Statements - if, if- else, Nested if-else. Looping – For, While, Nested loops. Control Statements – Break, Continue, Pass.

UNIT II: String Manipulation,Tuple and Lists : [15HRS]
Accessing Strings, Basic Operations, String slices, Function and Methods.
Tuple and Lists
Introduction, Accessing list, Operations, Working with lists, Function and Methods.
Introduction Accessing tuples, Operations, Working, Functions and Methods.

UNIT III: Dictionaries & Functions [15HRS]
Introduction, Accessing values in dictionaries, Working with dictionaries, Properties, Functions.
Functions
Defining a function, Calling a function, Types of functions, Function Arguments, Anonymous functions, Global and local variables.

UNIT IV:Modules: [15HRS]

Importing module. Math module. Random module.

Exception Handling

Exception. Exception Handling - Except clause, Try , except,finally clause. User Defined Exceptions

Input-Output

Printing on screen, Reading data from keyboard, Opening and closing file, Reading and writing files, Functions.

Printing on screen, Reading data from keyboard, Opening and closing file, Reading and writing files, Functions.

REFERENCES:

MANDATORY:

1. Mark Lutz,Learning Python, O'Reilly Media, Fifth Edition.

SUPPLEMENTARY:

1. Alex Martelli, (2006)Python – A Nutshell, O'Reilly Media, Second Edition.
2. Wes McKinney, (2012)Python for Data Analysis, O'Reilly Media.

WEB BASED:

1. https://www.w3schools.com
2. https://www.tutorialspoint.com
3. https://www.javatpoint.com
4. https://www.geeksforgeeks.org
5. https://www.guru99.com

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Course Title: R Programming
Course Code: COM-SEC2
Marks: 100
Credits: 4
Duration:60 Hrs

Prerequisite Courses : Nil

Course Objectives:
To make the student understand the fundaments of R language.
To implement algorithms using R.
To connect R with other data sources and perform computation
To use R for plotting charts and graphs

Course Outcomes:

At the end of the course students will be able to :

CO1 : Develop solutions to problems and implement these solutions in R.
CO2 : Use R with various data sources and perform computation.
CO3 : Solve mathematical problems using R.
CO4 : Plot charts and graphs using R.

UNIT I: Introduction, Data types and Operators in R : [15HRS]
Introduction to R:
Install and configure R software and R Studio, Using R console to perform basic arithmetic operations, display strings and workspace variables, R Overview, Getting help

R Data Types:
Determining the data type of a variable, boolean, integer, numeric, character, complex and raw. Vectors, Lists, Matrices, Data Frames, Factors and Arrays.

R Operators:
Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators Miscellaneous Operators (Colon, %in% and %*%).

UNIT II: Control Flow and Iterations [10 HRS]
The if, if-else, if – else if-else and switch statements, while and for loops, loops for vectors,matrices, data frames and lists. Programs to test understanding of the same.

UNIT III:Functions and Apply Family in R [20HRS]
Functions in R:
Writing an R function, Nested Functions, Function Scoping, Recursion, Loading an R package, Mathematical Functions, Cumulative sums and products, Calculus, Input and Output operations, Selection and Bubble sort, Linear and Binary Search. Apply Family in

R:Using apply, lapply, sapply, tapply and mapply, Differences between lapply and sapply,Applications of mapply, Split Function.

UNIT IV: R Data Interfaces, Charts and Graphs [10HRS]

R Data Interfaces:

R and Database Connectivity , creating and dropping tables, inserting data and updating table rows, querying and querying with filters.

R and CSV files – Inputting, Reading, Writing to and Analyzing a csv files.

R and Spreadsheets – Reading from, writing to and analyzing spreadsheets.

R and XML files – Reading and processing XML files.

Charts and Graphs :

Generating Pie charts, Bar Charts and Line Graph.

REFERENCES:

MANDATORY:

1. K. G. Srinivasa, G. M. Siddesh et al(2017). Statistical Programming in R(1st ed.). Oxford University Press.

SUPPLEMENTARY:

1. Sandip Rakshit(2017). R Programming for Beginners(1st ed.).McGraw Hill Education.

WEB BASED:

1.https://www.tutorialspoint.com/r/
2.https://www.guru99.com/r-programming-introduction-basics.html
3.https://nptel.ac.in/courses/111104100/
4.http://uc-r.github.io/apply_family
5.https://www.w3schools.in/r/

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Course Title: Scilab Programming
Course Code: COM-SEC3
Marks: 100
Credits: 04
Duration: 60 Hours

Pre-requisite course: Nil

Course Objectives:
To make the student understand the fundaments of Scilab.
To implement algorithms using Scilab.
To handle polynomials and implement numerical methods using Scilab.
To use Scilab for plotting charts and graphs.

Course Outcomes:

Upon completion of the course student will be able to:

CO1: Develop solutions to problems and implement these solutions in Scilab.
CO2: Use Scilab to handle Polynomials.
CO3: Use Scilab to implement Numerical Methods.
CO4: Plot charts and graphs using Scilab.

SYLLABUS:

UNIT I: Introduction to Scilab and Working with Matrices: [15 HRS]
Introduction: Install and configure Scilab software, Starting and ending a Scilab session,Scilab environment, Getting help, Some useful Scilab commands.
Fundamentals: Data types, Constants and Variables, Operators, Scilab Expressions, Hierarchy of operations, Built in Functions.

Vectors and Matrices: Creating matrices, empty matrix, row vectors, column vectors, scalars, special matrices, sparse matrices, matrix size, accessing matrix elements, creating sub-matrices,creating multi-dimensional array, operations on matrices and arrays, matrix manipulation, useful matrix commands.

UNIT II: Polynomials and Scilab Graphics: [15 HRS]
Polynomials: Polynomial creation and evaluation, roots of a polynomial, Polynomial arithmetic operations, differentiation and integration, Curve fitting.
Scilab Graphics: Two-dimensional plots, sub-plots, creating commonly used 2D plots, 3D plots.

UNIT III: Programming in Scilab: [15 HRS]
Keywords, Predefined variables, input and output statements, Control structures, looping, File Handling, Scripts and Functions, Error-handling, Coding conventions.

UNIT IV: Numerical Methods using Scilab [15 HRS]
Solutions of Algebraic and Transcendental equations, Interpolation, Numerical Differentiation and Integration, Solution of Linear Systems of Equations.

REFERENCES:

MANDATORY:

1.Verma.R, Kumar,A. Introduction to Scilab (1 st ed.) Pearson.

SUPPLEMENTARY:

1.Dr. M Affouf, Scilab by Example (2 nd ed.). CreateSpace Independent Publishing Platform.
2.Er.Ramachandran.H, Dr. Nair.A. Scilab a free software to Matlab (1 st ed.). S Chand & Company

WEB BASED:

1. https://wiki.scilab.org/
2. https://scilab.in/fossee-scilab-toolbox/optimization-toolbox/functions/symphonymat
3. http://www.sze.hu/~molnarka/SCILAB/book_SCIALB.pdf
4. http://www.ee.iitm.ac.in/~hsr/scilab/manual.pdf

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Parvatibai Chowgule College of Arts and Science
(Autonomous)
GENERIC ELECTIVE COURSES (GEC)

List of Generic Electives:

Multi-Media
E-Learning
Cyber Security
E-commerce

Web designing GEC is not offered from 2020-21 onwards.

Course Title: Multimedia
Course Code: COM-GEC.1
Marks: 100
Credits: 4
Duration: 60 HRS

Prerequisite Courses: Nil

Course Objectives:
To understand basic concept of Multimedia.
To develop skills for designing graphical images.
To develop skills for audio and video editing.
To acquire skills in using audio/video editing software.

Course Outcomes:

At the end of the course students will be able to :

CO1 :Understand the concept of Multimedia – Team members and their roles.
CO2 :Identify and describe the function of the general skill sets in the multimedia industry.
CO3 : Classify and realize the types of Authoring tools and their functions.
CO4 : Identify basic components of a multimedia project.
CO5 : Analyze the requirements of Multimedia product.
CO6: Assemble and deliver multimedia projects.

SYLLABUS:

UNIT I. Introduction to Multimedia and Text: [15HRS]
Commonly used terms associated with multimedia like CDROM, Storyboard, Script and Authoring tools.
Stages of a Multimedia Project-Planning and Costing, Designing and Producing, Testing and Delivering.
The Multimedia team and their roles- Project Manager, Writer, Video specialist, Audio specialist and Multimedia programmer.
Multimedia Software. Multimedia Hardware.
Social & Ethical considerations, Digital Representations & Standards.
Text in graphics, character set, fonts, layout

Activities:
Design a Brochure for a given product, give details.
Learn about Multimedia product development and applications of text in Multimedia products

UNIT II. Images: [15HRS]
Vector graphics fundamentals, shapes, transforms and filters, Bitmapped graphics: resolution, image compression, manipulation, Geometrical transformations
Human vision, Camera systems, Gamma correction, Color models – RGB, CYMK, Transformations among color model.

Activities:

1.Design a Poster with given information and learn about Image compression

2.Image Enhancements/ mixing and prepare images for web.

UNIT III. Sound: [15HRS]

Basic Sound Concepts, Digitizing and processing sound, Music, Speech, Compression, formats, MIDI and Digital Audio

Activities:

1.Edit the Sound file and Learn about Effects and Filters of sound

2.Record Your voice and learn about Audio Compression.

3.Record an Audio Program and prepare it for web.

UNIT IV. Video and Animation : [15HRS]

Digitizing video, streamed video, video standards, compression: mpeg, dv, codec Introduction to Animation: captured, sprite, key frame, web, 3-D.

Activities:

1.Learn about Video editing
2.Prepare Video content with title and special effects.
3.Prepare multimedia content for web.

REFERENCES:

MANDATORY:

1. Nigel Chapman, Jenny Chapman.(2009). Digital Multimedia(3rd ed.).Wiley India Edition.
2. Ze-Nian Li & Mark S Drew(2003). Fundamentals of Multimedia. Pearson Education
3. Vaughan, Tay(2017). Multimedia: Making it Work(9th ed.). Tata McGraw-Hill.

SUPPLEMENTARY:

1. Jeffcoate, Judith(1995). Multimedia in Practice, Technology and Applications.New York : Prentice Hall.

WEB BASED:

https://www.gimp.org/
https://www.audacityteam.org/
https://swayam.gov.in/nd2_ugc19_hs42/
https://www.tutorialspoint.com/multimedia

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Course Title: E-Learning
Course Code: COM-GEC.2
Marks: 100
Credits: 4
Duration: 60 HRS

Prerequisite Courses: Nil

Course Objectives:

To understand basic concept of ICT (Information Communications Technology) in education.
To understand basic concept of Instructional Design principles.
To develop and apply the various concepts of Instructional Design skills learnt wrt E-Learning .
To develop E-content in various application areas related to ICT and Education.

Course Outcomes:

On completion of this course the student will be able to:

CO1: Explain the working of an E-learning module.
CO2: Explain the various Instructional Design Principles.
CO3: Develop own course material and upload it using an appropriate LMS.
CO4: Evaluate and apply appropriate Assessment techniques to the E-content
CO5: Differentiate between Summative and Formative assessment.
CO6: Write Learning and Course objectives.

SYLLABUS

UNIT I: Introduction and E-learning Strategies [15 HRS]
Scope and form of E-learning, Role of an E-learning project Phases in E-learning project. E-learning Strategies: Simulation, Drill, Interactive Learning, Problem Solving,Tutorials.
Activity:
1. Construct a Mindmap (using Freemind or any other FOSS).

UNIT II: Course Development [15 HRS]
Introduction to Instructional Design.The process of Designing Instruction.Developing Materials.(Story Boarding, Content Integration, and SCORM Compliance).Working with L.M.S. (Learning Management System)- Installation and use of the administrator, teacher and student interface. Course Definition, Registration and upload, tracking of results).

Activities:
1. Creating and Running a complete course using LMS Course Administration: Creation and using Resources and Planning Activities.
2. Creating Storyboards (using Movie Maker/PPT or similar FOSS).

UNIT III :E-learning & Pedagogical Approaches [15 HRS]

The Behaviorist School of learning and its implications on E-learning, The Cognitive School of Learning and its Implication on E-learning, The Constructivist School of Learning and its implications on E-learning, Blooms Taxonomy of Educational Objectives, Types of Learning Objectives, Content Analysis (Types- Facts, concepts, process, procedure, principles). The Teaching of concepts, procedure, principles, understanding. Enabling a motivated Learning Environment.

Activity:

1. Prepare a 10-minute Video tutorial on some system (e.g. how to search for free images in Google) using screen cast/Powtoon. Example tool that can be used: screen cast-o-matic).

UNIT IV:Assessment Design [15 HRS]

Online formative and summative assessment. Rubrics for Assessment- Analytic and Holistic Rubrics,

Security and Authentication.

Activities:

1. Design Rubrics using any application (for a given scenario).
2. Create a fully tagged 10-question QB on a topic and load onto Moodle.

REFERENCES:

MANDATORY:

Shelly Cashman Gunter.(2011).Teachers Discovering Computers: Integrating Technology in the Classroom,(7th ed.).Wadsworth Publishing Co Inc.

SUPPLEMENTARY:

1. Smith, P. L. & Ragan, T. J.(2008). Instructional design(4rth ed.). New York: John Wiley & Sons. ISBN:0471393533
2. M.D. Roblyer, Aaron H. Doering(2018). Integrating Educational Technology into Teaching: Student Value Edition (8th ed.). Publisher: Pearson ISBN-10: 013289680X, ISBN-13:978-0132896801.
3. Dick, W., Carey, L., & Carey, J. O.(2014). The systematic design of instruction (8th ed.). Boston: Allyn and Bacon.
4. Wiggins, G. P., & McTighe, J.(2005). Understanding by design (2nd ed.). Assn. for Supervision & Curriculum Development;
5. Alexandria, VA: Association for Supervision and Curriculum Development.
6. Christensen, C. M., Horn, M. B., & Johnson, C. W.(2016). Disrupting class: How disruptive innovation will change the way the world learns(2nd ed.). New York: McGraw- Hill.

WEB BASED:

1.https://www.udemy.com/course/instructional-design-for-elearning/
2.https://nptel.ac.in/courses/127101013/
3.https://nptel.ac.in/courses/121105010/
Better learning (Bloom's Taxonomy):
4. https://www.plesyoutube.com/watchv=0flnAoX9QEw

Assessment:
5.https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/121106012/lec13.pdf

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Course Title: Cyber Security
Course Code: COM-GEC.3
Marks: 100
Credits: 4
Duration: 60 Hrs

Prerequisites : Nil

Course Objectives:
To develop awareness and understand the concept of Cyber Security.
To understand the aspects related to Cyber Security.
To take measures to protect individual privacy and prevent loss/theft of data.

Course Outcome:

On completion of this course the student will be able to:

CO1: Explain the working of a computer network.
CO2: Explain the various measures that need to be taken in order to protect data. CO3: Analyze various forms of crimes in Cyber world.
CO4: Gain knowledge about various rights given to the individual to protect their intellectual property.
CO5: Identify the various threats in Cyber Space.

SYLLABUS:

UNIT I: Basics of Computer Networking [10HRS]
Networking basics, why networking of computer is needed, Introduction to Wireless networks, Internet – role and importance, IP Addressing– public Vs Private, Static Vs Dynamic, www & related protocols.

Activities:
1. Connecting to Network, Sharing directories.
2. Connecting to shares, Set up a common storage.

UNIT II : Emerging threats in CyberSpace [15HRS]
Threats in Cyber Space, Classification of threats, BYOD and portable devices threats, 0-day attacks, insider threats, Cyber Warfare, Malware threats, mobile apps threats. Social media and its safe usages: Social media- its usages, Social Networking - types, usages, importance, social networking safety.

Activity:
1. Advanced Networking: Identify IP address,ping.

UNIT III: Online Privacy & Cyber Crimes [20HRS]

Online Privacy:

Privacy – basic concepts, Sensitive personal information, Privacy policies (case study of Google/Facebook or any other privacy policies), Privacy laws, IPR, Ethics & safe practices.

Cyber Crimes –An Introduction:

Introduction – Types of cyber crimes (Phishing, Social Engineering, Denial of Service, Cyber stalking, ID-theft, etc), How to report cyber crimes, its impact– social, personal, financial; Cyber Terrorism.

Activities:

1)Set up a basic firewall, Setup a wireless n/w, Set up a security level, Setup free online backup

2) Ensuring secure-environments with respect to online shopping, Wi-fi networks, passwords, social networking and online banking)

UNIT IV : Cyber Laws & Cyber Forensic: [15HRS]

Cyber Laws:

Evolution and purpose, offense; defense, bailable and non-bailable offenses,provisions related to e-commerce, provisions for cyber crimes, adjudicating officers, CERT-IN- its role and powers

Cyber Forensic:

Data recovery, evidence collection, cloning of devices, media sanitization

Activity:

1. Setting up and maintaining the laptop, data storage devices and smartphone.

REFERENCES:

MANDATORY:

Rick Lehtinen and G.T. Gangemi, Computer Security Basics, O'ReilllyMedia, Inc.,2nd edition,

Wall, David, Cybercrime: The Transformation of Crime in the InformationAge. Polity Publishing.

Michael Cross, Scene of the Cyber Crime: Cyber Forensics Handbook, Syngress Publishing, 2ndEdition.

Chander, Harish, CyberLaws and IT Protection, Prentice Hall IndiaLearning

WEB BASED:

1)Michael Cross, Scene of the Cyber Crime: Cyber Forensics Handbook, Syngress Publishing,
2ndEdition.
http://index-of.es/Hack/Scene%20of%20the%20Cybercrime%20
-%20Computer%20Forensics
%20Handbook%20(Syngress).pdf
2)https://www.tutorialspoint.com/fundamentals_of_science_and_technology/
cyber_crime_and_cyber_security.htm
3)https://cyberdialogue.ca/wp-content/uploads/2011/03/David-Wall-Policing-CyberCrimes.pdf
4) Chander, Harish, CyberLaws and IT Protection, Prentice Hall IndiaLearning
http://index-of.es/Hack/Scene%20of%20the%20Cybercrime%20
-%20Computer%20Forensics
%20Handbook%20(Syngress).pdf
5) Cyber Crimes
https://www.coursera.org/lecture/cyber-conflicts/evolution-and-types-of-cybercrime-MeWFG

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Course Title: E-Commerce
Course Code: COM-GEC.5
Marks: 100
Credits: 4
Duration : 60Hrs

Prerequisites:Nil

Course Objectives:
To learn the working of E-Commerce website
To learn the various background processes involved to study the activities associated with e-commerce like buying, selling and payment.
To understand the various technologies used in e-commerce websites
To learn the security mechanisms involved in e- commerce websites.

Course Outcomes:

On completion of this course the student will be able to:

CO1:Explain the various E-Commerce Strategies.
CO2: Explain the working of an E-Commerce Website.
CO3: Evaluate the various Payment Mechanisms.
CO4: Develop an E-Commerce Website.
CO5: Create an online store.
CO6: Recognize and discuss global E-commerce issues
CO7:Analyze the impact of E-commerce on business models.

SYLLABUS:

UNIT I: Introduction to Electronic Commerce & Vailue Chain [15HRS]
The Scope of Electronic Commerce, Definition of Electronic Commerce,Electronic Commerce and the Trade Cycle,Electronic Markets, Electronic Data Interchange, Internet Commerce,Electronic Commerce in Perspective. The Value Chain: Supply Chains, Porter's Value Chain Model,Inter Organizational Value Chains Competitive Advantage, Porter's Model, First Mover Advantage, Sustainable Competitive, Competitive Advantage using e-commerce.

Activity:
1.Comparative study of E-commerce websites.

UNIT II: Business Strategy & Electronic Data Interchange [10HRS]
1.Michael Porter's 5 force, analysis.EDI Definition, EDI Technology, EDI Standards, EDI Communications.

Activity:

1.SHOPIFY:Create online stores, add products, categories & handle payments.
(http://www.shopify.com)

UNIT III: Electronic payment systems & E-business [20HRS]

Overview of the electronic payment technology; limitations of traditional payment instruments;Electronic or Digital Cash-Properties of Electronic Cash, Digital Cash in action,Electronic Checks-benefits of electronic checks, electronic checks in action, Net Check: A Prototype Electronic Check System;Online Credit Card-Based Systems- types of credit card payments, Secure Electronic Transactions(SET);Other Emerging Financial Instruments: POS (Point of Sale), E-Cash, Net Banking, Credit/Debit Cards and Electronic Benefits and Security Issues; Case Studies of the various modes of electronic payment of various types of websites
E-business: EDI Application in business, E- Commerce Law, Forms of Agreement, Govt policies and Agenda; Case Study of Internet bookshops, Grocery supplies, software supplies and support,electronic newspapers, Internet banking, Virtual auctions, online, share dealing; Business to legal issues: Risks involved; Paper Document vs. Electronic document, Authentication of Electronic document, Laws, Legal issues for Internet Commerce: Trademarks and Domain names, Copyright, Jurisdiction issues, Service provider liability, Enforceable online contract.

Activity:

1. WIX: Using drag & drop features of this website builder to build an e-commerce website.
(http://www.wix.com)

UNIT IV:Firewalls and Transaction Security & M-Commerce: [15HRS]

Firewalls and Network Security: Types of firewalls, Firewall Security Policies, Emerging Firewall Management Issues; Transaction Security: Types of Online Transactions, Requirements for Transaction Security; Encryption and Transaction Security: Secret-Key encryption,Public-Key Encryption, Implementation and Management Issues; Digital Certificate; Security Threats to E Commerce, Virtual Organization, Business Transactions on Web, E Governance and EDI.

CONSUMER E-COMMERCE:Consumer trade transaction, Internet, Page on the Web,

M-COMMERCE:Basic concept and applications, difference with E-Commerce, benefits of integration with ERPs.

Activity:

1. BLOGGER : Using this blogging service provided by google, customize to create an online store. (http://www.blogger.com)

REFERENCES:

MANDATORY:

1. David Whiteley.(2014).E-Commerce Strategy Technologies and Applications. TataMcGraw Hill

SUPPLEMENTARY:

1. Ravi Kalakota and Andrew B. Whinston.(2014).Electronic Commerce A Manager's Guide.PearsonEducation.
2. Kamlesh K Bajaj and Debjani Nag.(2005).E-Commerce The Cutting Edge of Business(2nd ed.). Tata McGraw Hill.

WEB BASED:

1)https://nptel.ac.in/content/storage2/courses/106108103/pdf/PPTs/mod13.pdf
2)http://assets.vmou.ac.in/MCA23.pdf
3)https://www.tutorialspoint.com/e_commerce/e_commerce_tutorial.pdf
4)http://164.100.133.129:81/econtent/Uploads/Session%206%20-%20e-Business%20and%20e-commerce.pdf
5)https://www.tutorialspoint.com/mobile_marketing/m_commerce.htm
6) https://www.tutorialspoint.com/internet_technologies/firewall_security.htm

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ANNEXURE IIA

Parvatibai Chowgule College of Arts & Science (Autonomous)

DEPARTMENT OF COMPUTER SCIENCE
COURSE STRUCTURE
THREE YEAR B.Sc. DEGREE COURSE IN COMPUTER SCIENCE

(To be offered to students taking admission to First Year B.Sc. From 2019-20)

Syllabi for all courses has been regrouped unit wise in three units for 75 marks course and 4 units for 100 marks course. Below table shows modifications to the courses in terms of addition or deletion of contents.

Sr No	Semester	Course	Course Code	Existing	Proposed	Justification
1	II	Database Management System I	COM-II. C-3A		Introduction to Transaction is deleted. List of Practical is changed	This unit is present in DBMS II course. Practical on designing User Interface are removed . More practical added for Queries and Normalization.
2	III	Digital Logic Design	COM-III. E-2		Modified course outcomes. Updated experiment lists.	

	III	Mathematical foundation of Computer Science - II	COM-III. E-3	Unit I. Graph Terminologies, Eulerian graphs, Diagraphs Unit II. Trees and Cycles, Connectivity, Planarity These units are removed	Unit I.Systems of Linear Equations and Matrices, Linear Combinations and Linear Independence Unit II.Vector Spaces, Linear Transformations, Eigenvalues and Eigenvectors Are added	Some part of Unit I & Unit II are present in the Data Structures. Proposed syllabus will help students in machine learning.
3	V	Operating Systems	COM-V. C-7		Deletion of Protection and Security	This unit was deleted as the syllabus was becoming bit lengthy. Certain concepts of security are covered during practical sessions.
4	VI	Multimedia Techniques	COM-VI. E-15		Unit 1: Authoring tools are elaborated Unit 3: Animations and compression is elaborated	Earlier it was in brief Earlier it was in brief

					Multimedia on web is added	Relevant topic and earlier syllabus was short

GEOGRAPHY

Parvatibai Chowgule College of Arts and Science

(Autonomous)

DEPARTMENT OF GEOGRAPHY

COURSE STRUCTURE

THREE YEAR B.Sc. DEGREE COURSE IN GEOGRAPHY

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	GEG-I. SC-1: Fundamentals of Physical Geography	GEG-I. SC-2: Basic Cartographic Techniques				
II	GEG-II. SC-3: Oceanography	GEG-II. SC-4: Geography of Man and Environment				
III	GEG-III. SC-5: Fundamentals of GIS and Remote Sensing		GEG-III.E-1: Spatial Analysis	GEG-III.E-2: Open Source GIS	GEG-III.E-3: Participatory GIS	GEG-III.E-4: Applied GIS
IV	GEG-IV. SC-6: Geomorphology		GEG-IV.E-5: Coastal Geomorphology	GEG-IV.E-6: Fluvial Geomorphology	GEG-IV.E-7: Watershed Management	GEG-IV.E-8: Biogeography
V	GEG-V. SC-7: Atmospheric Sciences		GEG-V.E-9: Synoptic Climatology	GEG-V.E-10: Agro-Meteorology	GEG-V.E-11: Disaster Management	GEG-V.E-12: Applied Climatology
VI	GEG-VI. SC-8: Geography of Sustainability		GEG-VI.E-13: Cities and Sustainability	GEG-VI.E-14: Statistical Geography	GEG-VI.E-15: Population, Society and Sustainability	GEG-VI.E-16: Globalization and Sustainable Development

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER I & II

Paper Title: Fundamentals of Physical Geography
Paper Code: GEG-I.SC 1
Name of Faculty: Dr. Nandkumar Sawant
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each

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Course Objectives: The course provides the basic conceptual framework of physical geography. It focuses on developing basic geographical skills through understanding and analysis of the fundamental concepts.

Learning outcomes: At the end of this course, students are expected to have basic understanding of fundamental concepts of physical geography.

Unit	Title	Lecture	Marks
I	**i) Introduction to geomorphology**- Nature , scope and significance of geomorphology. Fundamental concepts in geomorphology. ii) Interior of the earth. Continental drift theory. Isostacy.	15	25
II	**Introduction to atmosphere**- Origin and composition of atmosphere. Layers of the atmosphere. Atmospheric elements, factors and their interrelationships. Insolation. Heat Budget .Temperature and its spatio-temporal distribution. Global Pressure and wind systems.	15	25
III	**Biosphere**: Introduction to biosphere. Components of biosphere. Major biomes of the world. Anthropogenic effects on biosphere and its consequences and remedial measures	15	25
		45	75

References:

1.Bloom, Arthur L., 2004: Geomorphology – A Systematic Analysis of Late Cenozoic Landforms, Prentice Hall, Engle Wood Cliff, N.J
2. Ahmed, E., 2005: Geomorphology, Kalyani Publishers, New Delhi
3. Sharma, V.K., 2006: Geomorphology, Earth Surface, Process and forms, Tata McGraw Hill, New York
5. Strahler, A.N.: Physical Geography, 3rd Ed., Wiley,2006
6. Singh, S. : Physical Geography, Pustak Bhawan, Allahabad,2005
7. Thornbury, W.D., 2001: Principles of Geomorphology, 2nd Ed., Wiley International Edition, Wiley Eastern Reprint, 2001
8. Wooldridge, S.W. and Morgan, R.S., 2000: The Physical Basis of Geography, Longman.
9. Worcestor, P.G., 2005: A Textbook of Geomorphology, Van Nostrand, 2nd Ed., East West Edition, New Delhi.
10. Chorley, Richard J., 2002: Spatial Analysis in Geomorphology, Harper and Row Publishers, New York, London.
11. Dayal, P. (2nd edition) 2006: A Textbook of Geomorphology, Shukla Book Depot, Patna

12. Sharma, H.S. (ed), 2002: Perspective in Geomorphology, Vol. I & IV, Concept, New Delhi.
13. Sharma, V.K., 2006: Geomorphology, Earth Surface Processes and Forms, Tata Mc. Graw Hill, New Delhi.
14. Sparks, B.W., 2000: Geomorphology, Longman, London, 2nd edition.

Paper Title: Practical in physical Geography
Paper Code: GEG-I. SC 1
Name of Faculty: Dr. Nandkumar Sawant
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each

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Course Objectives: The course aims to develop skills of relief representation and climate data analysis.

Le**arning outcome:** After the completion of this course, students are expected to be familiar with the basic cartographical skills in contour reading and climatic data representation.

Unit	Title	Practical sessions	Marks
I	Contour – Representation of relief features with the help of contours. Identification of relief features from Toposheet. Contour profiles. Longitudinal profile. Calculation of Vertical Exaggeration. Profiles: types. Drawing of profiles. a) Cross and longitudinal, b) Composite, projected and superimposed.	10	12
II	Calculation of RH, Min, Max and range of temperature, Climographs hythergraphs, Comfort Diagram, Interpolation techniques.	5	08
	Journal		5
		15	25

References

1. Chorley, Richard. J. (ed.), 2001: Water, Earth and Man, Methuen & Co., London
2. Goudie, Andrew, et al. (eds),2001: Geomorphological Technique, George Allen & Unwin, London
3. Gregory, K.J. and Walling, D.E., 2003: Drainage Basin – Form and Process, Edward Arnold, London
4. King, C.A.M., 2006: Techniques in Geomorphology, Edward Arnold, London
5. Leopold, L.B, Wolman, M.G. and Miller, J.P., 2004: Fluvial Processes in Geomorphology, Freeman, San Francisco
6. Misra, R.P. and Ramesh, A., 2009: Fundamentals of Cartography, Concept Publishing Co., New Delhi
7. Monkhouse, F.J. and Wilkinson, H.R., 2009: Maps and Diagrams, B.I. Publications Pvt. Ltd., New Delhi
8. Singh, R.L. and Singh Rana P.B., 2008, Elements of Practical Geography, Kalyani Publishers, New Delhi
9. Strahler, A.N., 2000: Physical Geography, 3rd Ed., Wiley.
10. Sarkar, Ashis, Practical Geography: A Systematic Approach, Orient Longman Pvt. Ltd., Kolkata.2000

Paper Title: Basic Cartographic Techniques (Theory)
Paper Code: GEG-I. SC2
Name of Faculty: Mrs. Anagha Bicholcar
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each

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Course Objectives: The course aims understand the elements of map**.**

Learning outcome: After the completion of this course, students will be familiar with the mapping techniques.

Unit	Topic	**Lectures**	**Marks**
I	**Introduction**: Cartography. Scope of Cartography. Cartography as a science and art. Growth of modern cartography. Major divisions in cartography. Spatial data – Data nature and data sources. **Mapping Organizations in india** – Survey of India, NATMO,NRSA, **Colors and Patterns** –color Systems in cartography. Identification. Use of colors in maps – use of patterns. **Map design**: Graphic design in map making. Map. Graphic presentation and maps. Graphic elements of map design .Planning a map design. **Map symbolization**: Mapping qualitative data and quantitative data- using point, line and area symbols. SOI Conventional signs and symbols.	**15**	**25**
II	**Scales**- types. Characteristics. **Latitude and longitudes**- characteristics. **Maps** and its types. Uses. Grid systems. Datum. Geoids. Spheroid. **Directions**- primary and secondary. **Concept of distance**- map distance, ground distance, temporal distance, angular distance, space distance.	**15**	**25**
III	**Map projections**: General Principles: Classification, properties and choice of map projections- merits and demerits.	**15**	**25**
		45	**75**

References

1. Campbell, J., 2004: Introductory Cartography, Prentice Hall Inc., Englewood Cliff
2. Misra, R.P. and Ramesh, A., 2005: Fundamentals of Cartography, Concept Publishing Company, New Delhi
3. Robinson, A.H., et al: Elements of Cartography, John Wiley & Sons, New York ,2000
4. Campbell, J., 2004: Introductory Cartography, Prentice Hall Inc., Englewood Cliff
5. Misra, R.P. and Ramesh, A., 2005: Fundamentals of Cartography, Concept Publishing Company, New Delhi
6. Robinson, A.H., et al: Elements of Cartography, John Wiley & Sons, New York,2003

7. Raisz, E. : Principles of Cartography, McGraw Hills, London ,2004Bygott, J., An Introduction to Map work and Practical Geography,2007 Talukder, S., 2008: Introduction to Map Projections, Eastern Book House, Guwahati.
8. Mahmood, A., 2009: Statistical Methods in Geographical Studies, Rajesh Publications, New Delhi.
9. Hammond, R. and Mc Cullagh, P. (2005): Quantitative Techniques in Geography, Clarendon Press, Oxford Sarkar, Ashis, Practical Geography: A Systematic Approach, Orient Longman Pvt. Ltd., Kolkata.
10. Elhance, D.N., 2002: Fundamentals of Statistics, Kitab Mahal, Allahabad
11. Monkhouse, F.J. & Wilkinson, H.R., 2009: Maps & Diagrams, B.I. Publications, New Delhi
12. Gregory, S., 2003: Statistical Methods and Geographers, Longman, London
13. Singh, R. & Singh, R.: Map Work & Practical Geography, Central Book Depot, Allahabad. 2001
14. Sarkar, Ashis, Practical Geography: A Systematic Approach, Orient Longman Pvt. Ltd., Kolkata. 2000

Paper Title: Practical in Cartographic Techniques
Paper Code: GEG-I. SC2
Name of Faculty: Mrs. Anagha Bicholcar
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
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Course Objectives: The course aims to develop skills of construction of scales, projections and preparation of map.

Le**arning outcome:** After the completion of this course students are expected to be familiar with map and its properties.

Unit	Topic	Practical	Marks
I	**Scales** – Construction of linear and Comparative. Scale conversion. Calculation of time based on longitude. Preparation of format of a map. Easting and northing. Calculation of distance. Identification of directions and Bearings. Drawing of grid system. Calculation of area by square method.	8	10
II	**Projections**- Zenithal Polar Gnomonic, Zenithal Polar Stereographic, Cylindrical Equal area, Mercator's projection, Conical Projection with two standard parallels, Bonne's Projection and Polyconic.	7	10
III	Journal		5
		15	25

1. Raisz, E. : Principles of Cartography, McGraw Hills, London,2000
2. Kellaway, G.P.: Map Projectio, Methuen & Co., London,2004
3. Steers, J.A., 2005: An Introduction to the Study of Map Projection, University of London, London
4. Bygott, J., An Introduction to Map work and Practical Geography,2002
5. Talukder, S., 2008: Introduction to Map Projections, EBS Publication, Guwahati
6. Ashish Sarkar: Practical Geography, A Systematic Approach. Orient Black Swan. Kolkata. 2008
7. Campbell, J., 2004: Introductory Cartography, Prentice Hall Inc., Englewood Cliff
8. Misra, R.P. and Ramesh, A., 2005: Fundamentals of Cartography, Concept Publishing Company, New Delhi
9. Robinson, A.H., et al: Elements of Cartography, John Wiley & Sons, New York,2000

Paper Title: OCEANOGRAPHY (Theory)
Paper Code: GEG- II. SC 3
Name of Faculty: Dr. Sanjay Gaikwad.
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each

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Course Objectives: The course provides the basic conceptual framework of oceanography, its dynamism and the contemporary issues associated with Oceans.

Learning outcomes: At the end of this course, students are expected to have an understanding of fundamental concepts of oceanography and issues.

Unit	Title	Lecture	Marks
I	**Introduction to oceanography**- Development of oceanography as a discipline, Significance and scope. Location, shape, size. Extent, average depth of major oceans. General bottom relief features. Study of Pacific, Atlantic and Indian oceans. Heat budget of oceans.	15	25
II	**Properties of ocean water**- Salinity, Temperature, Density, and relation among them. **Dynamics of ocean water:** Waves- types causes Tides –types and surface currents and their effects on coastal climate.	15	25
III	**Issues in Oceanography** - Sea level change, acidification, Ballast water Exclusive Economic Zones in oceans.	15	25
		45	75

References

1. K. Siddhartha Oceanography: A Brief Introduction, Kislaya publishers 2000
2. Defant, A., Physical Oceanography, Vol. I, Pergamon Press,2001

Paper Title: PRACTICAL IN OCEANOGRAPHY
Paper Code: GEG-II. SC 3
Name of Faculty: Dr. Sanjay Gaikwad
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
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Course Objectives: The course aims to develop skills of field sampling and analysis of ocean water and interpretation of hypsometric curves and bathymetric charts.

Le**arning outcome:** After the completion of this course, students will learn ocean water testing and reading of bathymetric and hydrographic charts.

Unit	Title	Practical sessions	Marks
1	Signs and symbols in hydrographic charts and reading of hydrographic chart. Reading of Bathymetric, reading of Naval Hydrographic Chart, and Maritime Bathymetric charts. Plotting of Bathymetric and Hypsometric curves.	10	15
2	Water analysis – salinity PH Conductivity and TDS.	05	05
3	Journal and Viva		05
		15	25

References
1. Bygot, J.: An Introduction to Map Work and Practical Geography,2001
2. Campbell, J., 2004: Introductory Cartography, Printice Hall, Inc Englewood
3. Misra, R.P. and Ramesh, A., 2005: Fundamentals of Cartography, Concept Pub. Co., New Delhi
4. Monkhouse, I.J. and Wilkinson, H.R., 2001: Maps and Diagram, B.I. Publication, New Delhi
5. Raisz, E.: General Cartography, McGraw Hills Co., London ,2005
6. Robinson, A.H., et al,: Elements of Cartography, John Wiley and Sons, New York,2003
7. Singh, R.L.: Elements of Practical Geography, Kalyani Publishers, New Delhi ,2000
8. Jackson, R.H. and Hudmar, L.E.: Regional Geography: Issues for today ,2001
9. Singh, R ; Singh L.R., Mapworks in Practical Geography,Central book Depot, Allahabad,2001

Paper Title: Geography of Man and Environment
Paper code: GEG-II. SC 4
Name of Faculty: Mr. Ashish Ashwini
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
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Course Objectives: The course aims to understand man environment and issues associated with human intervention.

Learning outcome: After the completion of this course, students will learn to appreciate the symbiotic relationship between man and his environment.

Unit	Title	Practical sessions	Marks
I	**Concept and Nature**: Meaning, Scope and Development of Human Geography, Man and Environment relationship-Determinism, Possibilism, Neo-determinism, Probabilism, Basic principles – Principle of Activity, Change, and Terrestrial Unity.	15	25
II	**Habitation (Population and Settlement)** Distribution of population and world pattern, concept of over population and under Population and its impact on resources. **Human Settlements** –Rural-Urban settlement. House types and their association with phsiography and climate distribution with special reference to India. Urbanization and weather modification	15	25
III	**Society and Culture:** Evolution of man – physical and cultural Climate health and diseases.	15	25
		45	75

REFERENCE

1) H.J De Blij, Alexander B.Murphy, Erin H. Fouberg. (2007) *Human Geography: people,place and culture.* John Wiley and sons. USA.
2) Panigrahi .P.K. (2011).*Human Geography-Landscape of Human Activities*. Murari Lala and sons. New Delhi.
3) Sharma Y.K. (2007) *Human Geography*. Lakshmi Narain Agrawal, Agra.
4) Rubenstein J M (2010) *Contemporary Human Geography*. PHI learning pvt, New Delhi.
5) Hussain, M. (2004) *Human Geography*. Rawat Publication. New Delhi.
6) Chandna, R.C. (2006) *Geography of Population*. Kalyani Publishers. New Delhi
7) Hagget, P.(2002) *Geography: A Modern Synthesis*. Harper & Row, New York
8) De Blij, H.J., Human Geography, Culture, Society and Space, John Wiley, New York, 2006
9) Fellman, J.L. Human Geography-Landscapes of Human Activities, Brown and Bench man, Pub. U.S.A. 2007.

Paper Title: Techniques in Demographic Analysis
Paper code: GEG-II. SC 4
Name of Faculty: Mr. Ashish Ashwini
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
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Course Objectives: The course provides the understanding of basic quantitative aspects of demography and man-resource relationship

Learning outcomes: At the end of this course, students will be able to interpret population and resource data.

Unit	Title	Practical sessions	Marks
I	**Fertility Measures**: crude birth rate, general fertility rate, total fertility rate, age specific fertility rate. Child women ratio. Net replacement rate. **Mortality measures**: crude death rate, Age and gender specific death rates. Cause specific death rate. Infant mortality rate. **Age data Analysis**: Age composition. Construction of population pyramid	10	12
II	Land carrying capacity, man – resource ratio, nutritional density, calculation of population pressure on land. Population concentration index.	05	08
III	Journal and viva		05
		15	25

References:

1. Bogue, D. J. Principles in Demography, John Wiley, New York 2009.
2. Bose, Ashish et. al.: Population in India's Development,Vikas Publishing House, New Delhi 2004.
3. Census of India, India : A State Profile, 2001.
4. Chandna, R.C. Geography of Population : Concept, Determinants and Patterns, Kalyani Publishers, New York 2000.
5. Crook, Nigel Principles of Population and Development. Pergmon Press, New York 2007.
6. Daugherty, Helen Gin, Kenneth C.W. Kammeryir, An Introduction to Population (Second Edition). The Guilford Press, New York, London 2008.
7. Mitra, Asok, India's Population. Aspects of quality and Control Vol. I & II. Abhinar Publication. New Delhi 2008.
8. Srinivsan, K. and M. Vlassoff. Population Development Nexus in India : Challenges for the New Millennium. Tata McGraw Hill, New Delhi 2001.
9. Srinivasan, K. Basic Demographic Techniques and Applications Sage Publications, New Delhi 2008.
10. UNDP: Human Development Report Oxford University Press, Oxford 2000.
11. United Nations, Methods for Projections of Urban and Rural Populations. No. VIII, New York 2004.
12. Woods, R. Population Analysis in Geography, Longman, London 2002.

Parvatibai Chowgule College of Arts and Science
(Autonomous)

DEPARTMENT OF GEOGRAPHY

COURSE STRUCTURE

THREE YEAR B.Sc. DEGREE COURSE IN GEOGRAPHY

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	GEG-I. SC-1: Fundamentals of Physical Geography	GEG-I. SC-2: Basic Cartographic Techniques				
	GEG-I. SC-1: Practicals in Physical Geography (Practicals)	GEG-I. SC-2: Practicals in Cartographic Techniques (Practicals)				
II	GEG-II. SC-3: Oceanography	GEG-II. SC-4: Geography of Man and Environment				
	GEG-II. SC-3: Practicals in Oceanography (Practicals)	GEG-II. SC-4: Techniques in Demographic Analysis (Practicals)				
III	GEG-III. SC-5: Fundamentals of Remote Sensing and GIS		GEG-III.E-1: Spatial Analysis	GEG-III.E-2: Raster and Vector Data Models in GIS	GEG-III.E-3: Participatory GIS	GEG-III.E-4: Applied GIS
IV	GEG-IV. SC-6: Geomorphology		GEG-IV.E-5: Coastal Geomorphology	GEG-IV.E-6: Fluvial Geomorphology	GEG-IV.E-7: Watershed Management	GEG-IV.E-8: Biogeography
V	GEG-V. SC-7: Atmospheric Sciences		GEG-V.E-9: Synoptic Climatology	GEG-V.E-10: Agro-Meteorology	GEG-V.E-11: Disaster Management	GEG-V.E-12: Applied Climatology
VI	GEG-VI. SC-8: Geography of Sustainability		GEG-VI.E-13: Cities and Sustainability	GEG-VI.E-14: Statistical Geography	GEG-VI.E-15: Population, Society and Sustainability	GEG-VI.E-16: Globalization and Sustainable Development

CORE COMPULSORY
Paper Title: Fundamentals of Remote Sensing and GIS (THEORY)
Paper Code: GEG-III. SC-5
Name of Faculty: A. Ashish
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
===
Course Objectives: The focus of this paper is to introduce key concepts of Remote Sensing and GIS**.**

Learning outcomes: On completion of this course students will able to appreciate the basic science of remote sensing and GIS as a tool of study and research in geography

Unit	Title	Lectures
I	**Concepts of Remote Sensing : Introduction to remote sensing,** Electromagnetic Radiation and its components:- Characteristics of Electromagnetic Spectrum Energy Interactions with Earth's atmosphere and surface features; Spectral response of Earth's natural surface. Introduction to Sensors and platforms Aerial Photography:- Types, Error In Flying, Geometry, Scale, Relief Displacement, Stereoscopes Parallax	15
II	**Visual Interpretation of Satellite Images and Aerial Photographs :** Elements of Image interpretation, Interpretation of Multi-Spectral Imagery, Identification of Earth Surface Features **Introduction to digital analysis**	15
III	**Concepts in GIS :** Content of GIS, objectives of GIS, Elements of GIS, Hardware & Software Requirements, Point Line and Polygon ,Layers and Coverage Raster and Vector Data, Components of GPS.	15
		45

REFERENCES

1. C.P.Lo and Albert K. W. Yeung,(2002) Concepts and Techniques of Geographic Information System, Prentice –Hall, India.
2. Heywood I, el. (2011) An Introduction to Geographical Information Systems , Pearson Education Pvt. Ltd., New Delhi.,
3. J.R. Jensen, (2003) Remote Sensing of Environment, An Earth Resource Perspective, , Pearson Education Pvt. Ltd., New Delhi.
4. Kang – tsung – Chang, (2002)Introduction to Geographical Information System, , McGraw Hill.
5. Lillesand T.M. and Kiefer R.W., (2002) Remote Sensing and Image Interpretation, John Wiley and Sons, New Delhi.
6. George Joseph (2005) Fundamentals of Remote Sensing, University press Private Ltd, Hyderabad.
7. P. A. Burrough and R. A. McDonnell, (2000)Principles of Geographical Information System, , Oxford University Press.
8. Paul A. Lonfley, et al.(2002), Introduction to Geographic Information Systems and Science, , John Wiley and Sons Ltd

CORE COMPULSORY
Paper Title: Fundamentals of Remote Sensing and GIS (Practical)
Paper Code: GEG-III. SC-5
Name of Faculty: A. Ashish
Marks: 25
Credits: 01
Duration: 15 sessions of 2 hours each
==

Course Objectives: The objective of this course is to provide hands-on training in in basic Remote Sensing, GIS and GPS techniques.

Le**arning outcome:** At the end of this course, students will be able interpret and analyze remotely sensed data.

Unit	Title	Practical sessions
I	Determination of scale, coverage, area, distance and height parallax. Interpretation of Satellite images and Aerial Photography. Identification of physical and cultural features constructing three dimensional view. Aerial photographs and their verification and ground truthing	07
II	Geo-referencing of scanned maps. Digitization of point, line and polygon layers. GPS survey on field and Identification of geographic feature on image and on actual ground	08
III	Journal	
		15

References

1. C.P.Lo and Albert K. W. Yeung, Concepts and Techniques of Geographic Information System, (2002) Prentice –Hall, India.
2. George Joseph, Fundamentals of Remote Sensing, (2004), Universities Press Pvt. Ltd., Hyderabad.
3. Heywood I, (el.) An Introduction to Geographical Information Systems , Pearson (2011)
4. J.R. Jensen, Remote Sensing of Environment, An Earth Resource Perspective, (2003), Pearson Education Pvt. Ltd., New Delhi.
5. Kang – tsung – Chang, Introduction to Geographical Information System, (2002), McGraw Hill.
6. Lillesand T.M. and Kiefer R.W., (2002), Remote Sensing and Image Interpretation, John Wiley and Sons, New Delhi.
7. P. A. Burrough and R. A. McDonnell, Principles of Geographical Information System, (2000), Oxford University Press.
8. Paul A. Lonfley, Michel F. Goodchild, D J. Maguire and D W. Rhind, Introduction to Geographic Information Systems and Science, (2002), John Wiley and Sons Ltd

CORE ELECTIVE
Paper Title: Spatial Analysis (Theory)
Paper Code: GEG-III.E-1
Name of Faculty: Mrs. Anagha Bicholcar
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
===

Course Objectives: The objectives of this course is to introduce the fundamentals of spatial analysis through pattern recognition, interpolation, locational and topographical analysis.

Learning outcome: At the end of this course, students will acquire the skills of spatial analysis, identification of suitable site, locational advantages and decision making.

Unit	Topic	Lectures
I	**Introduction to Spatial Analysis**: Criteria for spatial analysis, Homogeneity of input data. Characteristics, importance of geo-data base, Topology Concept of Non-Spatial Data, sources, Optimum spatial database generation guidelines, Attribute queries.	10
II	**Concept of Interpolation**, Inverse distance weighted method, Spline, Krigging **Basics of overlay**: weighted overlay analysis, Reclassification of data, Raster analysis: local, focal, zonal and global Spatial relationships, Location Analysis using multiple parameters.	15
III	**Topographic Analysis**: Digital Elevation Model, Slope, Aspect, Flow Accumulation, Flow Direction. Suitability analysis for new site and habitat, Guidelines for preparing data for suitability analysis, criteria selection, Multi criteria analysis. Application of Spatial Analysis in decision making	20
		45

Reference Books:

1. Alias A. Rahman and Morakot Pilouk (2008) Spatial Data Modeling for 3D GIS, Springer New York
2. Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W. (2005). Geographic Information Systems and Science. Chichester: Wiley. 2nd edition.
3. M Goodrich (2000). Data Structures and Algorithms in Java, 2nd Edition Wiley.
4. Malczewski, J. (1999). GIS and Multicriteria Decision Analysis. New York: John Wiley and Sons
5. Ott, T. and Swiaczny, F. (2001). Time-integrative GIS. Management and analysis of spatio-temporal data. Berlin / Heidelberg / New York: Springer.
6. Thurston, J., Poiker, T.K. and J. Patrick Moore. (2003). Integrated Geospatial Technologies: A Guide to GPS, GIS, and Data Logging. Hoboken, New Jersey: Wiley.

CORE ELECTIVE
Paper Title: Spatial Analysis (Practical)
Paper Code: GEG-III.E-1
Name of Faculty: Mrs. Anagha Bicholcar
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hour each
==

Course Objectives: The objectives of this course is to introduce the fundamentals of spatial analysis through pattern recognition, interpolation, locational and topographical analysis.

Learning outcome: At the end of this course, students will acquire the skills of spatial analysis, identification of suitable site, locational advantages and decision making.

Unit	Topic	Practical Sessions
I	**Vector Operations** (Single Layer): Dissolve, Buffer, Multi Ring Buffer. Vector Operations (Multi Layer): Clip, Erase, Merge, Intersect. **Raster Operations**: Zonal Calculations, Extract By Mask. Spatial Queries Based on Location. Non-Spatial Queries	**07**
II	**Interpolation**: Inverse Distance Weighted method, Krigging, Topo to Raster. Reclassification of vector data. **Overlay Operations** (point in Polygon, Line in Polygon, Polygon in polygon). Site Suitability using weighted overlay.	**08**
III	Journal	**-**
		15

Reference Books:

1. Alias A. Rahman and Morakot Pilouk (2008): Spatial Data Modeling for 3D GIS, Springer New York.
2. Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W. (2005). Geographic Information Systems and Science. Chichester: Wiley. 2nd edition.
3. Ott, T. and Swiaczny, F. (2001). Time-integrative GIS. Management and analysis of spatio-temporal data. Berlin / Heidelberg / New York: Springer.
4. Thurston, J., Poiker, T.K. and J. Patrick Moore. (2003). Integrated Geospatial Technologies: A Guide to GPS, GIS, and Data Logging. Hoboken, New Jersey: Wiley.
5. M Goodrich (2000). Data Structures and Algorithms in Java, 2nd Edition Wiley.
6. Malczewski, J. (1999). GIS and Multicriteria Decision Analysis. New York: John Wiley and Sons

CORE ELECTIVE
Paper Title: Raster and Vector Data Models in GIS (THEORY)
Paper Code: GEG-III.E-2
Name of Faculty: Dr. Sanjay D. Gaikwad
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
===

Course Objectives: This course introduces basic concepts and principles of GIS and emphases on the role of raster and vector data models. The students will ~~also be~~ introduced data processing, transformation and visualization of data using various models.

Learning outcomes: The students will be able to differentiate raster and vector data models and also appreciate the role of these models in visualizing ~~and~~ graphical outputs through GIS.

Unit	Title	Lectures
I	GIS Concepts, Principles, Geospatial Data Models, Organization of GIS Data and System Functionality, Map Projections, ~~and~~ Coordinate Systems and Transformations. Source of Data.	15
II	Fundamentals of Raster data models and data exchange 2D and 3D raster data models Fundamentals of Viewing and managing raster maps, Raster map algebra, Raster data transformation Basics of Graphical output and visualization.	15
III	Vector data Basics of Map viewing and metadata management Fundamentals of Vector map attribute management and SQL support, Generation of vector data, fundamentals of Vector map queries and statistics, Geometrical operations, Vector network analysis, data transformations Basics of Graphical output and visualization.	15
		45

Reference :

1. Markus Neteler and Helena Mitasova (2008) OPEN SOURCE GIS, A GRASS GIS Approach (Third Edition) Springer, USA
2. McCartney Taylor, Nik Freeman (2014) Getting Started With GIS Using QGIS (Kindle Edition) McCartney Taylor.

Sample Data source

1. https://grass.osgeo.org/download/sample-data/
2. http://grassbook.org/datasets/datasets-3rd-edition/
3. http://www.qgis.org/en/site/

CORE ELECTIVE

Paper Title: Raster and Vector Data Models in GIS (Practical)
Paper Code: GEG-III.E-2
Name of Faculty: Dr. Sanjay D. Gaikwad
Marks: 25
Credits: 1
Duration: 15 Sessions of 2 hour each

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Course Objectives:
This course introduces basic concepts and principles of GIS and emphasis on the role of raster and vector data models. The students will be also be introduced data processing, transformation and visualization of data using various models.

Learning outcomes: The students will be able to differentiate raster and vector data modes and also appreciate the role of these models in visualizing and graphical outputs through GIS.

Unit	Title	Practical sessions
I	Downloading and installing of software, Graphical User Interfaces for GRASS & QGIS, data display, Defining the coordinate system Import of raster data, Coordinate transformation, Viewing and managing raster maps Raster map algebra Raster data transformation and interpolation Spatial analysis with raster data Landscape process modeling Graphical output and visualization. .	8
II	Vector Data. Generation of Data Layer Map Viewing and Metadata Management Attribute Management and SQL Support Queries and Statistics Geometry Operations Network Analysis Transformations to Raster(vectorization - rasterization) Spatial Interpolation and Approximation Graphical Output and Visualization.	7
III	Journal	-

Reference :

1. Markus Neteler and Helena Mitasova (2008) OPEN SOURCE GIS, A GRASS GIS Approach (Third Edition) Springer, USA

2. McCartney Taylor, Nik Freeman (2014) Getting Started With GIS Using QGIS (Kindle Edition) McCartney Taylor.

Sample Data source

1. https://grass.osgeo.org/download/sample-data/
2. http://grassbook.org/datasets/datasets-3rd-edition/
3. http://www.qgis.org/en/site/

CORE ELECTIVE
Paper Title: Participatory GIS (Theory)
Paper Code: GEG-III.E-3
Name of Faculty: Dr. Sanjay D. Gaikwad
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==

Course Objectives: This is an introductory paper of Participatory GIS that aims to expose student to applications of GIS in the context of community and people's participation. This helps to enhance Geographical Information through shared knowledge and information.

Learning outcomes: At the end of this course, students will be able to understand and acknowledge the applications of GIS for benefit of society.

Unit	**Title**	**Lectures**
I	Participatory Geographic Information Systems Concepts and Methods, History (PRA, P-GIS pGIS Pgis) Ethics, Partnership, role and responsibility of the scientist. Methodology for Pgis., implementation and limitations of the participation Methods, Techniques, advantages of community mapping. Data management. Features of interest for socio-economic analysis and social development skills and training requirements. P-GIS and the livelihoods approach.	15
II	Contribution of P-GIS through Community Mapping in Water Resource Inventory. Urban and Peri-Urban Partnership and Community Empowerment Community Resource Mapping in Forest, Agriculture and Water Resources Management: Bridging the Divide between Community and Government Voluntary Information and PGIS (VI & PGIS)	15
III	Neo-geography and GIS/2 : value addition to P-GIS Needs of Participatory GIS. Perspectives on Participatory mapping and PGIS	15
		45

References

1. Michael K. Mccall (2004) Can Participatory-GIS Strengthen Local-Level Spatial Planning? Suggestions For Better Practice. Dept. Of Urban & Regional Planning and Geoinformation Management ITC. Paper Prepared For: GISDECO 2004 Skudai, Johor, Malaysia, 10-12 May 2004
2. Julian Quan, Nicoliene Oudwater, Judith Pender And Adrienne Martin (2001)GIS And Participatory Approaches In Natural Resources Research. SOCIO-ECONOMIC METHODOLOGIES FOR NATURAL RESOURCES RESEARCH BEST PRACTICE GUIDELINES. Published By Natural Resources Institute, The University Of Greenwich 2001
3. Abbot, J., Chambers, R., Dunn, C., Harris, T., Merode, E. D., Porter, G., Townsend, J.,Weiner, D., De Merode, E., (1998). ‘Participatory GIS: Opportunity Or Oxymoron?’ PLA Notes33. IIED: Londo
4. PETER A. MINANG And MICHAEL K. MCCALL (2006) Participatory GIS And Local Knowledge Enhancement For Community Carbon Forestry Planning: An Example From Cameroon. Participatory Learning And Action.
5. Sarah Elwood: Participatory GIS And Community Planning: Restructuring Technologies, Social Processes, And Future Research In PPGIS Collaborative Geographic Information Systems Edited By Shivanand Balram And Suzana Dragicevic © (2006), Idea Group Inc. University Of Arizona, USA
6. Sarah Elwood : Critical Issues In Participatory GIS: Deconstructions, Reconstructions, And New Research Directions Transactions In GIS, (2006), 10(5): 693–708

CORE ELECTIVE
Paper Title: Participatory GIS (Practical)
Paper Code: GEG-III.E-3
Name of Faculty: Dr. Sanjay D. Gaikwad
Marks: 25
Credits: 1
Duration: 15 Sessions of 2 hour each
===

Course Objectives: The basic objective of this practical course is to equip students with skills to calculate various indices and practically apply it in case studies.

Learning outcome: This practical course helps in developing skills by which students will practically carry on field studies.

Unit	Title	Practical Sessions
1	Data processing and computing indices Linear Model & Linear Combination Method (LCM) Assessment Index (AI) Employment index (M) Education index (E) Health index (S) Housing index (H) Infrastructure index The Principal Component Analysis Method (PCAM) Marginality Index (MI) Human Development Index	5
2	Case study of any one of the following (mini project) Water Resource Inventory Urban and Peri-Urban Agriculture Forest and Water Resources Management Using software like GRASS (Geographic Resources Analysis Support System) and ILWIS (Integrated Land and Water Information System)	10
3	Project report	-

References :

1. Françoise Orban-Ferauge V.Aguilar, E. Alarcon, A. Carmona, N. Daix, B. Denil, A. Ignacio, J. Martinez, M. McCall, G.Miscione, E. Olivarez, M. Pandan. G. Rambaldi, R. Teruel, J. Verplanke participatory geographic information systems and land planning life experiences for people empowerment and community transformation , Technical Centre for Agricultural and Rural Cooperation ACP-EU (CTA) Wageningen, The Netherlands

CORE ELECTIVE
Paper Title: Applied GIS (Theory)
Paper Code: GEG-III.E-4
Name of Faculty: Dr. Sanjay D. Gaikwad
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==

Course Objectives: This paper introduces various recent application of GIS in business, society, transportation and spatial planning.

Learning outcomes: At the end of this course students will be able to correlate acknowledge of GIS in the day to days life problems.

Unit	**Title**	**Lectures**
I	**Geobusiness** Retail Application of Spatial Modelling to Solve: Retail Location Problems, Location Based Services for Mobile Applications Mass Appraisal Model, Lifestyle Segmentation Profiles, Neighbourhood Model, Housing Price Mass Appraisal Model.	15
II	**Social Application**: Assessing Clusters of Deprivation in City Regions, GIS for Joined up Government Spatial Statistical Methods to the Detection of Geographical Patterns of Crime **Transport and Location**: Demand Responsive Passenger Transport Services, Strategic Land Use / Transportation Model, Relocation of Facilities. Probability Based GIS Model.	15
III	**Spatial Planning** Modelling Migration, Modeling Regional Economic Growth, Carrying Capacity, Planning Network of Site, Assessing Service Provision,	15
		45

References

1. John Stillwell and Graham Clarke (2004) Applied GIS and Spatial Analysis (Ed). John Willy and Sons LTD England
2. Michael K. McCall (2004) Can Participatory-GIS Strengthen Local-level Spatial Planning? Suggestions for Better Practice. Dept. of Urban & Regional Planning and GeoInformation Management ITC. Paper prepared for: GISDECO 2004 Skudai, Johor, Malaysia, 10-12 May (2004)
3. Julian Quan, Nicoliene Oudwater, Judith Pender and Adrienne Martin (2001)*GIS And Participatory Approaches In Natural Resources Research*. SOCIO-ECONOMIC METHODOLOGIES FOR NATURAL RESOURCES RESEARCH BEST PRACTICE GUIDELINES. Published by Natural Resources Institute, The University of Greenwich 2001
4. Abbot, J., Chambers, R., Dunn, C., Harris, T., Merode, E. d., Porter, G., Townsend, J.,Weiner, D., de Merode, E., (1998). 'Participatory GIS: opportunity or oxymoron?' PLA Notes33. IIED: Londo
5. PETER A. MINANG and MICHAEL K. MCCALL (2006) Participatory GIS and local knowledge enhancement for community carbon forestry planning: an example from Cameroon. Participatory Learning And Action.
6. Sarah Elwood: Participatory GIS and Community Planning: Restructuring Technologies, Social Processes, and Future Research in PPGIS Collaborative Geographic Information Systems edited by Shivanand Balram and Suzana Dragicevic © (2006), Idea Group Inc. University of Arizona, USA
7. Sarah Elwood : (2006), Critical Issues in Participatory GIS: Deconstructions, Reconstructions, and New Research Directions Transactions in GIS, 10(5): 693–708

CORE ELECTIVE
Paper Title: Applied GIS (practical)
Paper Code: GEG-III.E-4
Name of Faculty: Dr. Sanjay D. Gaikwad
Marks: 25
Credits: 1
Duration: 15 Sessions of 2 hour each
==

Course Objectives: The basic objective of this practical course is to equip students with skills to apply GIS skills various issues through spatial modeling and analytical tools.

Learning outcome: This practical course helps in developing skills by which students will be able to under undertake various local problems and suggest realistic spatial solution to it.

Unit	**Title**	**Practical Sessions**
1	Spatial Modelling: Retail Location Based Modeling, Land Use Transportation Model, Migration Modeling, Economic Growth Modeling, Neighboring Model	5
2	Spatial Statistic: Cluster Analysis, Crime Pattern Analysis, Mass Appraisal, Segmentation Profiling, Site Suitability Analysis Location Based Services for Mobile Application	10
3	Journal	-

References :

1. John Stillwell and Graham Clarke (2004) Applied GIS and Spatial Analysis (Ed). John Willy and Sons Ltd. England
2. Markus Neteler and Helena Mitasova (2008) OPEN SOURCE GIS, A GRASS GIS Approach (Third Edition) Springer, USA
3. McCartney Taylor, Nik Freeman (2014) Getting Started With GIS Using QGIS (Kindle Edition) McCartney Taylor.

Sample Data source

4. https://grass.osgeo.org/download/sample-data/
5. http://grassbook.org/datasets/datasets-3rd-edition/
6. http://www.qgis.org/en/site/

Pattern of Question paper for Semester End Examination

Q1 12 Marks	Q2 16 Marks	Q3 18 Marks	Q4 24 Marks	Max Marks	Total Marks
Any 3 of 4 3×3= 9 Marks	Any 3 of 4 3×4=12 Marks	Any 2 of 3 2×6=12 Marks	Any 1 of 2 12 Marks	45	70

Parvatibai Chowgule College of Arts and Science
(Autonomous)

DEPARTMENT OF GEOGRAPHY

COURSE STRUCTURE

THREE YEAR B.Sc. DEGREE COURSE IN GEOGRAPHY

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	GEG-I. SC-1: Fundamentals of Physical Geography	GEG-I. SC-2: Basic Cartographic Techniques				
	GEG-I. SC-1: Practicals in Physical Geography (Practicals)	GEG-I. SC-2: Practicals in Cartographic Techniques (Practicals)				
II	GEG-II. SC-3: Oceanography	GEG-II. SC-4: Geography of Man-Environment Interaction				
	GEG-II. SC-3: Practicals in Oceanography (Practicals)	GEG-II. SC-4: Techniques in Demographic Analysis (Practicals)				
III	GEG-III. SC-5: Fundamentals of Remote Sensing and GIS		GEG-III.E-1: Spatial Analysis	GEG-III.E-2: Raster and Vector Data Models in GIS	GEG-III.E-3: Participatory GIS	GEG-III.E-4: Applied GIS
IV	GEG-IV. SC-6: Fundamentals of Geomorphology		GEG-IV.E-5: Coastal Geomorphology	GEG-IV.E-6: Fluvial Geomorphology	GEG-IV.E-7: Watershed Management	GEG-IV.E-8: Biogeography
V	GEG-V. SC-7: Atmospheric Sciences		GEG-V.E-9: Synoptic Climatology	GEG-V.E-10: Agro-Meteorology	GEG-V.E-11: Disaster Management	GEG-V.E-12: Applied Climatology
VI	GEG-VI. SC-8: Geography of Sustainability		GEG-VI.E-13: Cities and Sustainability	GEG-VI.E-14: Statistical Geography	GEG-VI.E-15: Population, Society and Sustainability	GEG-VI.E-16: Globalization and Sustainable Development

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER IV

CORE COMPULSORY
Paper Title: Fundamentals of Geomorphology (Theory)
Paper Code: GEG-IV. SC-6
Name of Faculty: Anagha Bicholcar
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each

Course Objectives: The Course provides the fundamentals of geomorphology. It also focuses on application of geomorphological knowledge to resolve the challenging issues of man environment relationships.
Learning Outcomes: At the end of this course, students will be familiar with fundamentals of geomorphology and learn the techniques of application of geomorphological knowledge to solve the challenging issues of man environmental relationships.

Unit	Title	Lectures
I.	Interior of the Earth: Composition and Structure Endogenetic Processes : folds, faults, rift valleys, plate tectonics. Earthquakes, Volcanoes.	18
II.	Exogenetic processes: Weathering and erosion, cycle of erosion Slope development theory. Mass Movements: Concept and Types. Aeolian landscapes: Erosional & Depositional. Glacial Landscapes: Erosional and Depositions	10
III.	Application of Geomorphology: • Regional planning • Urban planning and transportation • Mining • Hazard management • Agriculture • Environmental management	17
		45

References:

1. Ahmed, E., 2005 : Geomorphology , Kalyan Publishers, New Delhi
2. Bloom, Arthur L., 2004: Geomorphology – A systematic Analysis of Late Cenozoic Landforms, Prentice Hall, engle Wood Cliff, N.J
3. Chorley, Richard J., 2002: Spatial Analysis in Geomorphology, Harper and Row Publishers, New York, London.
4. Cooke R. U. and Doornkamp J.C. (1989): Geomorphology in Environmental Management, 2nd Edition, Oxford : Clarendon Press
5. Dayal, P. (2nd edition) 2006 A Textbook of Geomorphology, Shukla Book Depot, Patna
6. Sharma, H.S. (ed), 2002: Perspective in Geomorphology, Vol. I & Vol. IV, Concept, New Delhi.
7. Sharma, V.K., 2006 : Geomorphology, Earth Surface Processes and Forms, Tata Mc. Graw Hill, New Delhi
8. Sharma, V.K., 2006 : Geomorphology, Earth Surface, Process and forms, Tata McGraw Hill, New York
9. Singh, S: Physical Geography, Pustak BHawan, Allahabad, 2005
10. Sparks, B.W., 2000: Geomorphology, Longman, London, 2nd edition.
11. Strahler, A.N .: Physical Geography, 3rd Ed., Wiley, 2006
12. Thornbury W.D, 2001: Principles of Geomorphology , 2nd Ed., Wiley International edition, Wiley Eastern Reprint, 2001
13. Wooldridge, S.W. and Morgan, R.S., 2000: The Physical Basis of Geography, Longman.
14. Worcestor, P.G., 2005: A textbook of Geomorphology, Van Nostrand, 2nd Ed., East west Edition, New Delhi

CORE COMPULSORY
Paper Title: Fundamentals of Geomorphology (Practical)
Paper Code: GEG-IV. SC-6
Name of Faculty: Anagha Bicholcar
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hour each

Course Objectives: The Course provides the skills in rock identification and their uses. strategies to the challenging issues of man environment relationships.
Learning Outcomes: At the end of this course, students will be familiar with the skills of identification and application of geomorphology and the techniques of application of geomorphological knowledge to solve the challenging issues of man environmental relationships.

Unit	Title	Practical sessions
I.	Identification of rocks, their properties and uses Soil profile, Soil testing and analysis and their application in crop cultivation(sample of any three soil types)	10
II.	Interpretation of geological map, identifications of faults, lineaments, dykes and sills, rock types	5
III.	Journal and viva voce	
		15

References:

1. Ahmed, E., 2005 : Geomorphology , Kalyan Publishers, New Delhi
2. Bloom, Arthur L., 2004: Geomorphology – A systematic Analysis of Late Cenozoic Landforms, Prentice Hall, engle Wood Cliff, N.J
3. Chorley, Richard J., 2002: Spatial Analysis in Geomorphology, Harper and Row Publishers, New York, London.
4. Dayal, P. (2nd edition) 2006 A Textbook of Geomorphology, Shukla Book Depot, Patna
5. Sharma, V.K., 2006 : Geomorphology, Earth Surface, Process and forms, Tata McGraw Hill, New York
6. Singh, S: Physical Geography, Pustak BHawan, Allahabad, 2005
7. Strahler, A.N .: Physical Geography, 3rd Ed., wiley, 2006
8. Thornbury W.D, 2001: Principles of Geomorphology , 2nd Ed., Wiley International edition, Wiley Eastern Reprint, 2001
9. Sharma, H.S. (ed), 2002: Perspective in Geomorphology, Vol. I & Vol. IV, Concept, New Delhi.
10. Sharma, V.K., 2006 : Geomorphology, Earth Surface Processes and Forms, Tata Mc. Graw Hill, New Delhi
11. Sparks, B.W., 2000: Geomorphology, Longman, London, 2nd edition.
12. Wooldridge, S.W. and Morgan, R.S., 2000: The Physical Basis of Geography, Longman.
13. Worcestor, P.G., 2005: A textbook of Geomorphology, Van Nostrand, 2nd Ed., East west Edition, New Delhi

CORE ELECTIVE
Paper Title: Coastal Geomorphology (Theory)
Paper Code: GEG-IV.E-5
Name of Faculty: Mr. A. Ashish
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each

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Course Objectives: The basic objective of this course is to familiarize students about the mechanism of landform development resulting from coastal processes.

Learning outcomes: At the end of this course, students are expected to have an understanding of the various processes and associated landforms in coastal regions. Besides learn the methods of coastal hazard management

Unit	Title	Lectures
I	Introduction to coastal Processes Waves: Formation, Drifts and Tides. Types of coastlines, Coastal erosion and deposition. Costal landforms.	15
II	Beach Geomorphology: Types and Configuration of beaches Coastal wetlands. Coral reefs and marine environment. Coasts of India.	15
III	Coastal Ecosystem Management. Coastal Hazard Management.	15
		45

References

1. Cooke R. U. and Doornkamp J.C. (1989): Geomorphology in Environmental Management, 2nd Edition, Oxford : Clarendon Press
2. Eric Bird: Coastal Geomorphology: An Introduction, John Wiley & Sons; 1 edition (November 7, 2000),
3. Gerhard Masselink , Michael Hughes :An Introduction to Coastal Processes and Geomorphology (Hodder Arnold Publication), ISBN-10: 0340764112 , ISBN-13: 978-0340764114
4. Kale, V. S. and Gupta, A. (Rep.2011): Introduction to Geomorphology, Orient Longman, Calcutta.
5. Karlekar, S. (2009): Coastal Processes and Landforms: Diamond Publications, Pune
6. Richard Davis Jr. , Duncan Fitzgerald : Beaches and Coasts, Wiley-Blackwell; 1st edition (July 15, 2004), ISBN-10: 0632043083 , ISBN-13: 978-0632043088
7. Timothy Beatley , Anna K. Schwab , David Brower (2002):An Introduction to Coastal Zone Management, Island Press; REV edition

CORE ELECTIVE

Paper Title: Practicals in Coastal Geomorphology
Paper Code: GEG-IV. E-5
Name of Faculty: Mr. A. Ashish
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each

Course Objectives: To develop the skills of identification and interpretation of coastal landforms and processes.

Learning outcome: At the end of the course students are expected to independently prepare geographic map and interpret coastal landscape. Besides they should be able to carry out beach profiling using instruments**.**

Unit	**Title**	**Practical sessions**
1	Identification of coastal features and processes on SOI toposheet.	05
2	Beach profiling & identification of major and minor coastal features on beach. Profile of various types of coast. Geomorphic mapping of Coastal Areas.	10
3	Journal and Viva	
		15

References

1. Bygot, J.: An Introduction to Map Work and Practical Geography, 2001
2. Campbell, J., 2004: Introductory Cartography, Printice Hall, Inc Englewood
3. Misra, R.P. and Ramesh, A., 2005: Fundamentals of Cartography, Concept Pub. Co., New Delhi
4. Monkhouse, I.J. and Wilkinson, H.R., 2001: Maps and Diagram, B.I. Publication, New Delhi
5. Raisz, E.: General Cartography, McGraw Hills Co., London ,2005
6. Robinson, A.H., et al,: Elements of Cartography, John Wiley and Sons, New York,2003
7. Singh, R.L.: Elements of Practical Geography, Kalyani Publishers, New Delhi ,2000
8. Jackson, R.H. and Hudmar, L.E.: Regional Geography: Issues for today ,2001
9. Singh, R ; Singh L.R., Mapworks in Practical Geography,Central book Depot, Allahabad,2001

CORE ELECTIVE
Paper Title: Fluvial Geomorphology (Theory)
Paper Code: GEG-IV. E-6
Name of Faculty: Mr. A.Ashish
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each

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Course Objectives: The Rivers being a major agent of erosion, the course assumes significance as it mainly deals with fluvial forms and processes.

Learning outcomes: At the end of this course, students are expected to have an understanding of the fundamental concepts of river and its processes.

Unit	Title	Lecture
I	River basin and Drainage Network: River and Stream, Drainage basin and network characteristics, River Dynamics, Classification, Phases of development, Patterns.	15
II	Fluvial processes: Erosion, Transportation and Deposition. Fluvial cycle and Fluvial landforms.	15
III	Applied fluvial geomorphology: Environmental changes and river metamorphosis. Flood and its impact (case studies)	15
		45

Reference Books:

1. Chorley, R. J., Schumm, S. A. and Sugden, D. E. (1984): Geomorphology, Methuen, London.
2. Fairbridge, R. W. (1968): Encyclopedia of Geomorphology, Reinholdts, New York.
3. Kale, V. S. and Gupta, A. (Rep.2011): Introduction to Geomorphology, Orient Longman, Calcutta.
4. Luna Bergere Leopold, Markley Gordon Wolman, John P. Miller (1995): Fluvial Processes in Geomorphology. Dover Publications Inc., New York
5. R.J. Small (1989)Geomorphology and Hydrology (Longman modular geography series), Longman Publication, Harlow, Essex, England
6. Savindra Singh (Rep. 2011): Geomorphology, Prayag Pustak Bhawan, Allahabad
7. Strahler A. H and Strahler, A. N. (1992) : Modern Physical Geography, John Wiley, New York
8. Thornbury, W. D. (Rep.2011): Principles of Geomorphology, John Wiley and Sons, New York.

CORE ELECTIVE
Paper Title: Practicals in Fluvial Geomorphology
Paper Code: GEG-IV. E-6
Name of Faculty: Mr. A. Ashish
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
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Course Objectives: To develop the skills of river morphometry analysis, river profiling, fluvial processes.

Learning outcome: At the end of the course student are expected to independently prepare drainage map and interpret fluvial landscape. Besides they should be able to carry out river profiling using instruments**.**

Unit	**Title**	**Practical sessions**
1	Preparation of drainage map. Identification and Interpretation of fluvial landforms, Patterns and processes from SOI toposheet. Slope analysis.	05
2	Drainage basin morphometry: Morphmetric analysis of drainage basin. Field visit : river Profiling and to observe fluvial processes	10
3	Journal and Viva	
		15

References

1. Bygot, J.: An Introduction to Map Work and Practical Geography,2001
2. Campbell, J., 2004: Introductory Cartography, Printice Hall, Inc Englewood
3. Misra, R.P. and Ramesh, A., 2005: Fundamentals of Cartography, Concept Pub. Co., New Delhi
4. Monkhouse, I.J. and Wilkinson, H.R., 2001: Maps and Diagram, B.I. Publication, New Delhi
5. Raisz, E.: General Cartography, McGraw Hills Co., London ,2005
6. Robinson, A.H., et al,: Elements of Cartography, John Wiley and Sons, New York,2003
7. Singh, R.L.: Elements of Practical Geography, Kalyani Publishers, New Delhi ,2000
9. Singh, R ; Singh L.R., Map works in Practical Geography, Central book Depot, Allahabad,2001

CORE ELECTIVE
Paper title: Watershed Management (Theory)
Paper Code: GEG-IV.E-7
Name of the Faculty: Adrian Ferro
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each

Course Objective: The objective of this course is to acquaint students with basic concepts and importance of Watershed Management. This course will also help students in understanding various processes that take place and that are involved in a watershed.

Learning outcomes: At the end of this course, students are expected to have a holistic understanding of Watershed Management. It will help them to develop a process-based understanding of how land surface characteristics will affect fluxes of mass and energy within a watershed.

UNIT NO.	COURSE CONTENT	TEACHING PERIODS
I	Introduction to Watershed Management : Definition, Principles, objectives, Need of Watershed Management, Identification of problems in Watershed Management	15
II	Characteristics of watershed : Delineation, Geomorphological Characteristics, linear aspects, aerial aspects and relief aspects, land use, runoff characteristics River discharge Sediment load	15
III	Hydrological Process in Watershed : Hydrological cycle, Water Budget, Ecological Characteristics of the river Soils in Watershed: Soil characteristics, Physical, Hydrological and Processes of Soil Erosion. Erosion due to water and wind. Watershed Conservation methods.	15
		45

REFERENCES:

- Manual of water and soil conservation: Government of India, ICAR
- Manuals of the USDA

1. DeBarry. A. Paul, 2004, Watersheds : Processes, Assessment, and Management, Hoboken, N.J. : John Wiley & Sons, New Jersey
2. Heathcote. W. Isobel , 2009, Integrated Watershed Management : Principles and Practice, 2nd Edition, Hoboken, N.J. : John Wiley & Sons, New Jersey
3. National Watershed Program Manual, The U.S. Department of Agriculture (USDA), Washington, D.C, December, 2009
4. Narayana, V.V. Dhruva, 2002, Soil and water conservation research in India, Published by ICAR, New Delhi
5. Singh Rajvir, 2003, Watershed Planning and Management, 2nd Edition, Yash Publishing House, Bikaner, India

CORE ELECTIVE
Paper title: Practicals in Watershed Management
Paper Code: GEG-IV.E-7
Name of the Faculty: Adrian Ferro
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each

Course Objective: The objective of this practical is to acquaint students with basic concepts and importance of Watershed Management. This practical will also help students in understanding various processes that take place and that are involved in a watershed.

Learning outcomes: At the end of this practical, students are expected to have a holistic understanding of Watershed Management as it will help them to develop a process-based understanding of how land surface characteristics will affect fluxes of mass and energy within a watershed, so that science-based management principles may be effectively applied to watershed systems.

UNIT NO.	COURSE CONTENT	Practical Sessions
I	Delineation of Watershed Area: Preparation of Contour map from Toposheet, Morphometric Analysis of drainage Basin. Relief Properties: Absolute Height, Relief Ratio, Ruggedness number. Areal Properties: Length, Width of Basin, Basin Perimeter, Drainage density; Linear. Properties: Stream Ordering, Bifurcation Ratio, Stream Length.	10
II	Measurement and Estimation of Soil Erosion – Revised Universal Soil Loss Equation (RUSLE), Field Visit and Report: Survey, Database Generation, Resource Mapping	5
III	Journal and Viva-voce	
		15

REFERENCES:

1. DeBarry. A. Paul, 2004, Watersheds : Processes, Assessment, and Management, Hoboken, N.J. : John Wiley & Sons, New Jersey
2. Heathcote. W. Isobel , 2009, Integrated Watershed Management : Principles and Practice, 2nd Edition, Hoboken, N.J. : John Wiley & Sons, New Jersey
3. National Watershed Program Manual, The U.S. Department of Agriculture (USDA), Washington, D.C, December, 2009
4. Narayana, V.V. Dhruva, 2002, Soil and water conservation research in India, Published by ICAR, New Delhi
5. Singh Rajvir, 2003, Watershed Planning and Management, 2nd Edition, Yash Publishing House, Bikaner, India

CORE ELECTIVE
Paper title: Biogeography (Theory)
Paper Code: GEG-IV.E-8
Name of the Faculty: Anagha Bicholcar
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each

Course Objectives: Biogeography deals with spatial and temporal patterns of biological diversity and the factors that govern the distribution and abundance .

Learning Outcomes: At the end of this course, students will be familiar with fundamentals of biogeography.

Unit	Title	TEACHING PERIODS
I.	Concept of Biogeography. Historical evolution of Biogeography. Global patterns of Biodiversity.	18
II.	Niche. Speciation and extinction. Accident and invasion. Endemism, vicariance and conservation. Island biogeography. Zoogeography and its Environmental Relationship. Palaeo botanical and Palaeo Climatological records of environmental change.	10
III.	Biodiversity hotspots. Forest communities and their distribution. Conservation- laws and practices. Social Movements of conservation.	17
		45

References:

1. Husain, M. (ed)., 1994: Biogeography(Part I & II), Anmol Publications, Pvt. Ltd., New Delhi.
2. Newbigin, M.I., 1939: Plants and Animal Geography.
3. Tiby, 1982: Biogeography, Longman, London.
4. Walts, D., 1971: The Principles of Biogeography, Mc. Graw Hill, London.
5. Bhattacharyya, N.N.: Biogeography, Rajesh Publications, New Delhi.
6. Singh, Savindra, 2010: Biogeography, Prayag Pustak Bhawan, Allahabad.

CORE ELECTIVE
Paper title: Practicals in Biogeography
Paper Code: GEG-IV.E-8
Name of the Faculty: Anagha Bicholcar
Marks: 25
Credits: 1
Duration: 15 Sessions of 2 hrs each

Course Objectives: Biogeography deals with spatial and temporal patterns of biological diversity and the factors that govern the distribution and abundance .

Learning Outcomes: At the end of this course, students will be familiar with fundamentals of biogeography .

Unit	Title	Sessions
I.	Vegetation Map interpretation Biodiversity indexing Biomass analysis Canopy structure Stock analysis	07
II.	NDVI Density of tree Plant tress analysis Disturbance analysis	08
III.	Journal and viva voce	
		15

References:

1. Husain, M. (ed)., 1994: Biogeography(Part I & II), Anmol Publications, Pvt. Ltd., New Delhi.
2. Newbigin, M.I., 1939: Plants and Animal Geography.
3. Tiby, 1982: Biogeography, Longman, London.
4. Walts, D., 1971: The Principles of Biogeography, Mc. Graw Hill, London.
5. Bhattacharya, N.N.: Biogeography, Rajesh Publications, New Delhi.
6. Singh, Savindra, 2010: Biogeography, Prayag Pustak Bhawan, Allahabad.

Parvatibai Chowgule College of Arts and Science
(Autonomous)
DEPARTMENT OF GEOGRAPHY
COURSE STRUCTURE
THREE YEAR B.Sc. DEGREE COURSE IN GEOGRAPHY

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	GEG-I. SC-1: Fundamentals of Physical Geography	GEG-I. SC-2: Basic Cartographic Techniques				
	GEG-I. SC-1: Practicals in Physical Geography (Practicals)	GEG-I. SC-2: Practicals in Cartographic Techniques (Practicals)				
II	GEG-II. SC-3: Oceanography	GEG-II. SC-4: Geography of Man-Environment Interaction				
	GEG-II. SC-3: Practicals in Oceanography (Practicals)	GEG-II. SC-4: Techniques in Demographic Analysis (Practicals)				
III	GEG-III. SC-5: Fundamentals of Remote Sensing and GIS		GEG-III.E-1: Spatial Analysis	GEG-III.E-2: Raster and Vector Data Models in GIS	GEG-III.E-3: Participatory GIS	GEG-III.E-4: Applied GIS
IV	GEG-IV. SC-6: Fundamentals of Geomorphology		GEG-IV.E-5: Coastal Geomorphology	GEG-IV.E-6: Fluvial Geomorphology	GEG-IV.E-7: Watershed Management	GEG-IV.E-8: Biogeography
V	GEG-V. SC-7: Fundamentals of Climatology		GEG-V.E-9: Geography of Soil Studies	GEG-V.E-10: Agro-Meteorology: Principles and Applications	GEG-V.E-11: Field Survey in Physical Geography	GEG-V.E-12: Quantitative Techniques in Geography
VI	GEG-VI. SC-8: Ecology and Terrestrial Environment		GEG-VI.E-13: Remote Sensing and Forest Ecology	GEG-VI.E-14: Applications of GIS in Coastal Processes	GEG-VI.E-15: Ecology of Marine Environment	GEG-VI.E-16: Landscape and Disaster Management

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER V

CORE COMPULSORY
Paper Title: Fundamentals of Climatology (THEORY)
Paper Code: GEG-V. SC-7
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
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Course Objectives: The focus of this paper is to introduce key concepts of climatology in general and Indian monsoon in details.

Learning outcomes: On completion of this course students will able to understand and apply the concepts in analyzing and applying climatological concepts.

Unit	Title	Lectures
I	**Fundamental of Atmospheric circulation** Basics of water cycle, Atmospheric Stability. Air Masses and its types. Fronts and types. El-Nino and La-Nina. **Atmospheric disturbances:** Thermodynamics Koppens Classification CAPE and CINE- cloud development and stability, thunderstorm Cyclogenesis – T number (basics of cyclones)	15
II	**Indian Climatology: Monsoons** **Pre monsoon:** Cyclone genesis, Cyclonic storms, frequency, intensity, landfall and associated weather. **South West monsoon :** Onset and advance of southwest monsoon, Semi-permanent features of monsoon, active and break in monsoon **Post monsoon:** withdrawal of southwest monsoon, Northeast monsoon, cyclonic storms in the Indian seas, trends in cyclonic disturbances, Easterly waves. **Winter:** western disturbances, fog, cold waves	15
III	**The Earth's Changing Climate** **Climate change and sea level rise:** Ocean in relation to long changes in Monsoon, tropical cyclones and climate, Land use change and climate. Cloud burst, clouds seeding and artificial rain. **Climate services:** Climate and application in agriculture, water, health and disaster risk reduction and urban planning.	15
		45

REFERENCES

1. Barry R.G. and Chorley, R. J., 2009: Atmosphere, Weather and Climate, Routledge
2. Bunnett R.B. , 1993: Physical geography in Diagrams, Longman
3. Critchfield, H.J, 1998 : General Climatology, Prentice-Hall
4. Lal, D.S., 2011: Climatology, Sharda Pustak Bhavan
5. Monkhouse, F.J., 1975 – Principles of Physical Geography , Hodder Murray Publishers
6. P. Birot, 1966: General Physical Geography, Longman, Green & Co
7. Strahler, A.H., 1983: Modern Physical Geography, John Wiley and Sons
8. Strahler A. M. and Strahler A.H., 1983: Elements of Physical Geography, John Wiley and Sons
9. Stringer, E.T., 1972: Foundation of Climatology: An Introduction to Physical, Dynamic, Synoptic, and Geographical Climatology, W.H. Freeman & Co. Ltd.
10. Tikka - R.N., 1998 - Physical Geography. Kedar Nath Ram Nath, Meerut
11. Trewartha, G.T., 1968: Introduction to Climate, McGraw-Hill

CORE COMPULSORY
Paper Title: Fundamentals of Climatology (Practical)
Paper Code: GEG-V. SC-7
Marks: 25
Credits: 01
Duration: 15 sessions of 2 hours each
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Course Objectives: The objective of this course is to provide basic practical tools in understanding weather and climate.
Learning outcome: At the end of this course, students will be able interpret and analyze weather and climatic phenomena.

Unit	Title	Practical sessions
I	Representation of weather phenomena using isolines Isohyets map Isotherm map Isobars Representation of wind data Evapotranspiration Determining atmospheric stability (Tephigram) Preparation of weather Station Model. Upper air chart, isotach (wind)	05
II	• Study of weather symbols and IMD weather charts. Interpretation of IMD weather charts (at least 1 map of three seasons) • Visit to IMD for hands- on- training: handling of weather instruments, taking readings, temperature, pressure, sunshine chart interpretation and forecasting. (seven Days Training in IMD)	10
III	Journal	
		15

References

1. Campbell, J. (2004), Introductory Cartography, Prentice Hall, Inc Englewood
2. Chorley, Richard. J. (ed.), 2001: Water, Earth and Man, Methuen & Co., London
3. Khullar.D.R. (2007), Essentials of Practical Geography, New Academic Publishing Co.,Jalandher
4. Misra, R.P. and Ramesh, A., 2009: Fundamentals of Cartography, Concept Publishing Co., New Delhi
5. Monkhouse, F.J. and Wilkinson, H.R., 2009: Maps and Diagrams, B.I. Publications Pvt. Ltd., New Delhi
6. Sarkar, Ashis (2000), Practical Geography: A Systematic Approach, Orient Longman Pvt. Ltd., Kolkata
7. Singh, R.L. and Singh Rana P.B., 2008, Elements of Practical Geography, Kalyani Publishers, New Delhi
8. Singh, R.L. and Singh Rana P.B.(2008), Elements of Practical Geography, Kalyani Publishers, New Delhi
9. Strahler, A.N., 2000: Physical Geography, 3rd Ed., Wiley.

CORE ELECTIVE
Paper Title: Geography of Soil Studies (THEORY)
Paper Code: GEG-V.E-9
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
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Course Objectives: This is a basic course that focuses on understanding of soil formation, development and distribution. They will also be equipped with basics of soil structure, composition, content and conservation practices.

Learning outcomes: On completion of this course, the students will be able to identify and differentiate between various soil~~s~~ profiles and types

This will develop understanding amongst students how different types of soil formations, characteristics and importance in agricultural practices.

Unit	TOPIC	Lectures
I	**Introduction to soil:** Concept , soil formation Soil water dynamic, Factors affecting soil formation. **Soil structure, composition and classification:** Soil profile, Soil taxonomy, Sub-orders, groups, families, series, Texture	15
II	**Soil and organisms** - Organic matter of soil, Sources of organic matter – Biomass, Termites, worms, ants, algae, fungi, bacteria…, Carbon cycle – simple decomposition, Agricultural importance of soils - Nitrogen fixation	15
III	**Soil Conservation and management** Soil erosion, degradation and pollution, its sources and impacts : industrial, agricultural, e-waste, nuclear, urban waste, mining, deforestation, irrigation projects. Soil conservation and management practices traditional and modern Case studies- global# and local examples.	15

#-different examples every year

References:

1. Brady Nyle. (2002). The nature and properties of soil. MacMillan Publishing company, USA
2. Foth Henry. (1984). Fundamentals of soil science. John Wiley & Sons, Inc. USA
3. Munns Donald and Singer Michael. (1996). Soils – An introduction. Prentice-Hall Inc, New Jersey, USA
4. Lal R and Stewart B.A. (1990). Advances in soil sciences. Springer-Verlag New York.
5. White Robert. (2005). Principles and Practice of Soil Science: The Soil as a Natural Resource, 4th Edition. Wiley & Sons, Inc – Blackwell. USA

CORE ELECTIVE
Paper Title: Geography of Soil Studies (PRACTICAL)
Paper Code: GEG-V.E-9
Marks: 25
Credits: 1
Duration: 15 Sessions of 2 hours each
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Course Objectives: This is a basic practical course in soil studies that give emphasis on lab analysis of soil sample to understand the various properties of soil sample.

Learning outcomes: On completion of this course, the students will be able test the soil properties and quality of collected soil samples using various instruments and prepare lab reports.

Unit	Topic	Lectures
I	Field visit component Sample preparation Moisture content Particle size analysis (density, porosity) Soil pH levels NPK level testing Carbonate testing	07
II	Spectro-photometric analysis of soil Quality control (trace element assessment) Permeability and erodibility tests Nutrient availability of soil Soil humus fraction	08
III	Journal	
		15

Reference:

1. Brady Nyle. (2002). The nature and properties of soil. MacMillan Publishing company, USA
2. Foth Henry. (1984). Fundamentals of soil science. John Wiley & Sons, Inc. USA
3. George Estefanm, Rolf Sommer, and John Ryan. (2013) Methods of Soil, Plant, and Water Analysis: A manual for the West Asia and North Africa region. Beirut, Lebanon
4. Head K.H. (1994). Manual of soil laboratory testing. John Wiley & Sons, Inc. USA
5. Munns Donald and Singer Michael. (1996). Soils – An introduction. Prentice-Hall Inc, New Jersey, USA

CORE ELECTIVE
Paper Title: Agrometeorology: Principles and Applications (THEORY)
Paper Code: GEG-V.E-10
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
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Course Objectives: This is a basic course that focuses on agrometeorology and its application in agriculture. This will help students to develop understanding of the physical and human interventions that affect agricultural systems and management practices.

Learning outcomes: On completion of this course, the students will be able to understand the role of climate in agricultural productivity. They will be exposed to use of geospatial technology in monitoring agricultural systems especially in the context of climate change.

Unit	Title	Lectures
I	**Agrometeorology:** Perspectives and Applications: Definition and scope and development. **Solar Radiation and Its Role in Plant Growth:** The Source of Energy, Laws of Radiation, Earth's Annual Global Mean Radiative Energy Budget, Solar Radiation and Crop Plants, Solar Radiation Interception by Plants, Photosynthetically Active Radiation (PAR), Solar Radiation Use Efficiency **Environmental Temperature and Crop Production:** Soil and Air Temperature, Plant Injury Due to Sudden Changes in Temperature, Frost: Damage and Control, Thermoperiodism, Temperature As a Measure of Plant Growth and Development.	15
II	**Climatological Methods for Managing Farm Water Resources-** Water for Crop Production, Making Effective Use of Rainfall, Evaporation and Evapotranspiration, Water Use and Loss in Irrigation. Climatological Information in Improving Water-Use Efficiency (WUE), Reducing Water Losses from Reservoirs, **Drought Monitoring and Planning for Mitigation:** water budgeting, irrigation scheduling, Drought Monitoring and Planning for Mitigation. **Climate, Crop Pests:** Role of Weather and Climate, Some Important Insect Pests of Crop Plant.	15
III	Remote-Sensing Applications in Agrometeorology. Computer Models in Managing Agricultural Systems, Agro-climatological Services, Using Climate Information to Improve Agricultural Systems, Climate Change and Its Impact on Agriculture.	15
		45

REFERENCES

1. Grigg, David (2005) An Introduction to Agricultural Geography (2nd Ed), Routeledge, London and New York
2. G. Kathiresan (2015) Agrometeorology: A Simplified Textbook. New India Publishing Agency
3. G.S. Mahi & P.K. Kingra (2014): Fundamentals of Agrometeorology. Kalyani Publishers
4. Harpal S. Mavi and Graeme J.,Tupper (2004), Agrometeorology Principles and Applications of Climate Studies in Agriculture. The Haworth Press, Inc., Binghamton, NY.
5. Mavi H S (2003): Introduction To Agrometeorology. Oxford & Ibh
6. Rao and Prasada (2008) Agricultural Meteorology. PHI Learning PVT. LTD., New Delhi
7. Seemann, Jochen, Chirkov, Y. I., Lomas, J., Primault, B. (2012): Agrometeorology. Springer-Verlag Berlin and Heidelberg GmbH & Co. KG
8. SR Reddy & D.S. Reddy (2014) Agrometeorology. Kalyani Publishers
9. S. Venkatraman (2015): Principles and Practice of Agricultural Meterology. BS Publications.
10. WMO (2011), Agricultural Meteorology Guide to Climatological Practices World Meteorological Organization, Geneva.

CORE ELECTIVE
Paper Title: Agrometeorology Principles and Applications (Practical)
Paper Code: GEG-V.E-10
Marks: 25
Credits: 01
Duration: 15 sessions of 2 hours each
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Course Objectives: This course enables student to understand the role of insolation, rainfall, evapotranspiration in crop growth and development. The students will learn techniques of measurement in agrometrology.

Learning outcomes: On completion of this course, the students will able to independently analyze the interaction of solar radiation, temperature, rainfall, evapotranspiration using metrological and remotely sensed data.

Unit	**Title**	**Practical sessions**
I	Green leaf response to Electro Magnetic Radiation Photosynthetically Active Radiation (PAR) Solar radiation use efficiency Temperature and crop growth	07
II	Measurement of effective rainfall(using Huggins and Kassam water balance approach) Water balance, Measurement of evaporation and calculation of evapotranspiration irrigation scheduling for crops Analyzing the water deficiency (drought) , drought index Use of thermal data in drought monitoring	08
III	Journal	
		15

References

1. Don Ankerman; Richard Large (2013) Agronomy Handbook. Midwest Laboratories Inc., OMAHA, NE
2. Harpal S. Mavi and Graeme J. Tupper (2004), Agrometeorology Principles and Applications of Climate Studies in Agriculture, The Haworth Press, Inc., Binghamton, NY.
3. Indian Council of Agricultural Research (2011) Handbook of Agriculture, Indian Council of Agricultural Research
4. Rao and Prasada (2008) Agricultural Meteorology. PHI Learning PVT. LTD., New Delhi
5. WMO (2011), Agricultural Meteorology Guide to Climatological Practices World Meteorological Organization, Geneva.

CORE ELECTIVE
Paper Title: Field Survey in Physical Geography (THEORY)
Paper Code: GEG-V.E-11
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
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Course Objectives: The primary aim of this paper to introduce various surveying instrument used in Physical Geography. Students will learn the operation and the application of the instruments and methods of surveying.
Learning outcomes: At the end of this course students will be able to understand functions and applications of dumpy level, Plane table and Global Positioning Systems (GPS) in field based studies.

Unit.	**Topic**	**Lectures**
I	Significance and Methods of Survey; Classification of Surveying; Fundamentals of Plane Table Survey: a) Radiation Method b) Intersection Method Pre survey work: Safety Measures, Field Book Preparation, Literature Survey, Sharing Responsibilities and Plan of Action Post field survey work: Data Processing Methods, Analysis, Mapping and Report Writing.	15
II	Dumpy level surveying : meaning, functioning elements, applications and Methods(Rise-fall and Collimation method) Profile drawing: Beach and River. Beach and River Morphology. Observation of slope, river and coastal morphology on toposheet. Pre survey and Post survey tasks.	15
III	GPS survey: Meaning, Space Segment, Ground Segment and GPS Receivers, Applications.	15
		45

REFERENCES

1. Campbell, J. (2004), Introductory Cartography, Prentice Hall, Inc Englewood
2. Khullar.D.R. (2007), Essentials of Practical Geography, New Academic Publishing Co.,Jalandher
3. Misra, R.P. and Ramesh, A. (2005), Fundamentals of Cartography, Concept Pub. Co., New Delhi
4. Monkhouse, I.J. and Wilkinson, H.R. (2009), Maps and Diagram, B.I. Publication, New Delhi
5. Sarkar, Ashis (2000), Practical Geography: A Systematic Approach, Orient Longman Pvt. Ltd., Kolkata
6. Singh, R.L. and Singh Rana P.B.(2008), Elements of Practical Geography, Kalyani Publishers, New Delhi

CORE ELECTIVE
Paper Title: Field Survey in Physical Geography (PRACTICAL)
Paper Code: GEG-V.E-11
Marks: 25
Credits:1
Duration: 15 Sessions of 2 hours each
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Course Objectives: The main objective of this course is to provide hands-on training in Plane Table, Dumpy Level and GPS survey.
Learning outcome: At the end of this course, students will be able to independently handle survey instruments and prepare maps and field reports.

Unit	Topic	Practical sessions
I	Plane table survey: a) Radiation Method :2 Exercises B) Intersection Method: 2 Exercises	07
II	Dumpy Level Survey: Rise-Fall and Collimation Method GPS Survey: Use of GPS in Mapping And Location Observation Of Slope, River and Coastal Morphology on Field	08
III	Journal /Field report	
		15

References

1. Campbell J. (2004), Introductory Cartography, Printice Hall, Inc Englewood
2. Khullar.D.R (2007), Essentials of Practical Geography, New Academic Publishing Co. Jalandher
3. Misra, R.P. and Ramesh, A. (2005), Fundamentals of Cartography, Concept Pub. Co., New Delhi
4. Monkhouse, I.J. and Wilkinson, H.R.(2009), Maps and Diagram, B.I. Publication, New Delhi
5. Singh, R.L. and Singh Rana P.B.(2008), Elements of Practical Geography, Kalyani Publishers, New Delhi
6. Sarkar, Ashis (2000), Practical Geography: A Systematic Approach, Orient Longman Pvt. Ltd., Kolkata.

CORE ELECTIVE
Paper Title: Quantitative Techniques in Geography (THEORY)
Paper Code: GEG-V.E-12
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
===

Course Objectives: The focus of this course is to expose students to basic and advance statistical methods in geography in general**.**

Learning outcomes: On completion of this course students will able to test various statistical tools applied in earth science. Further they will be able to understand various stochastic models and forecasting methods in the discipline of earth science.

Unit	Title	Lectures
I	Statistical Methods in Geography Basics of Sampling, Data Collection and Sample Design, Hypothesis Quantification and Prediction / projection, The Concept of Variable, Probability, Frequency Function.	15
II	Frequency Analysis and Simulation, Measure of Central tendency, Dispersion, Skewness and Kurtosis, Correlation and Regression, Chi Square(X^2)	15
III	Stochastic Modelling (Time Series Analysis) and Forecasting Processes, Autocorrelation, Moving Average. Spectral Analysis (Frequency Domain) Spectrum, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Maximum Entropy Method, Spectral Density and Entropy.	15
		45

REFERENCES

1. Pal S. K., 1998: Statistics for Geoscientists: Techniques and Application, Concept, New Delhi.
2. Sharma, D.D. (2008): Geostatistics with Application in Earth Sciences, Springer, with Capital Publishing Company, New Delhi, India.
3. Rogerson., P. A.(2001) : Statistical Methods for Geography. SAGE Pub. New Delhi
4. Spence, N. & Owens, A. (2011) :Methods of Geographical Analysis. University of London
5. Tomislav Hengl (2009): A Practical Guide to Geostatistical Mapping. The European Communities, Luxembourg

CORE ELCTIVE
Paper Title: Quantitative Techniques in Geography (Practical)
Paper Code: GEG-V.E-12
Marks: 25
Credits: 01
Duration: 15 sessions of 2 hours each
===

Course Objectives: The focus of this course is to enable students to learn and apply basic and advance statistical methods in geography**.**

Learning outcomes: On completion of this course students will able to test and analyze various statistical tools applied in geography. Further they will be able to formulate hypothesis and prove it applying various stochastic models and forecasting methods in the discipline of geography.

Unit	**Title**	**Practical sessions**
I	Measure of Central tendency and Dispersion Mean (Z) Estimates for the Mean, Confidence Limits for the Mean Skewness and Kurtosis Correlation and Regression, Correlation Coefficient Hypothesis testing :The Chi-square (X^2) Test, Time Series Analysis and Forecasting	07
II	Spectral Analysis (Frequency Domain) Spectrum, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) Maximum Entropy Method, Spectral Density and Entropy Stationarity and Intrinsic Hypothesis Variogram and Estimation Variance	08
III	Journal	
		15

Note : Only physical geography data should be used.

References

1. A. Stewart Fotheringham, Chris Brunsdon and Martin Charlton. (2000): Quantitative Geography Perspectives on Spatial Data Analysis. SAGE Publications Ltd
2. Rogerson, Peter A. (2015) Statistical Methods for Geography. (4th Ed) SAGE Publications Ltd
3. Sharma, D.D. (2008): Geostatistics with Application in Earth Sciences, Springer, with Capital Publishing Company, New Delhi, India.
4. Spence, N. & Owens, A. (2011) Methods of Geographical Analysis. University of London
5. Robert Hammond, Patrick McCullagh; (1974): Quantitative techniques in geography: an introduction. Clarendon Press,

Parvatibai Chowgule College of Arts and Science
(Autonomous)

DEPARTMENT OF GEOGRAPHY

COURSE STRUCTURE

THREE YEAR B.Sc. DEGREE COURSE IN GEOGRAPHY

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	GEG-I. SC-1: Fundamentals of Physical Geography	GEG-I. SC-2: Basic Cartographic Techniques				
	GEG-I. SC-1: Practicals in Physical Geography (Practicals)	GEG-I. SC-2: Practicals in Cartographic Techniques (Practicals)				
II	GEG-II. SC-3: Oceanography	GEG-II. SC-4: Geography of Man-Environment Interaction				
	GEG-II. SC-3: Practicals in Oceanography (Practicals)	GEG-II. SC-4: Techniques in Demographic Analysis (Practicals)				
III	GEG-III. SC-5: Fundamentals of Remote Sensing and GIS		GEG-III.SE-1: Spatial Analysis	GEG-III.SE-2: Raster and Vector Data Models in GIS	GEG-III.SE-3: Participatory GIS	GEG-III.SE-4: Applied GIS
IV	GEG-IV. SC-6: Fundamentals of Geomorphology		GEG-IV.SE-5: Coastal Geomorphology	GEG-IV.SE-6: Fluvial Geomorphology	GEG-IV.SE-7: Watershed Management	GEG-IV.SE-8: Biogeography
V	GEG-V. SC-7: Fundamentals of Climatology		GEG-V.SE-9: Geography of Soil Studies	GEG-V.SE-10: Agro-Meteorology: Principles and Applications	GEG-V.SE-11: Field Survey in Physical Geography	GEG-V.SE-12: Quantitative Techniques in Geography
VI	GEG-VI. SC-8: Ecology and Terrestrial Environment		GEG-VI.SE-13: Remote Sensing and Forest Ecology	GEG-VI.SE-14: Advanced Coastal Geomorphology	GEG-VI.SE-15: Ecology of Estuarine Environment	GEG-VI.SE-16: Disaster Management: Urban and Coastal

CORE
Course Code: GEG-VI.SC-8
Course Title: Ecology and Terrestrial Environment (THEORY)
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
===

Course Objectives: The basic objective of this course is to introduce the concepts of terrestrial ecology which will help in sustainable management of the same.

Learning outcomes: At the end of this course, students are expected to have an understanding of Biomes, ecological factors and applications. They will be familiar with sustainable strategies for conservation of terrestrial ecology.

Unit	Title	Lectures
I	**Biomes of the world:** • Biogeography: Species distribution, Historic effect of plate tectonics-past and present pattern of Biogeography • Meaning and Types of Biomes • Terrestrial Biomes : Tropical Rain Forest, Temperate Deciduous Forest, Savannah, Tundra, Desert •	15
II	**Factors controlling terrestrial ecosystem** • Soil : soil as an ecological factor, formation, profile, texture, • Water: Classification, properties of water as ecological factors: properties, composition, effect of rainfall and moisture on growth and distribution of plants and animals. • Temperature: ecological factor, range of temperature tolerance, effects on plants and animals, morphological and physiological adaptation in organism to change in temperature	15
III	**Threats to terrestrial environment and ecosystem** Population growth, Urbanization, Industrial growth, Military conflicts and Nuclear war, Natural hazard Mining, dams, land use changes	15
		45

References:

1. Dhaliwal GS, Sangha GS, Ralhan PK, 1996: Fundamentals of Environment Science, Kalyani Publishers New Delhi,
2. J.L Chapman and MJ Reiss, 1999: Ecology: Principles and Application, Second Edition, Cambridge University Press, UK
3. Kotpal RL, Bali NP, 1998: Concepts Of Ecology, Vishal Publication, Jalendhar
4. Purphit SS, Ranjan R, 2003: Ecology, Environment and Pollution, Agrobios (India) Publication, Jodhpur

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER VI

CORE
Course Code: GEG-VI.SC-8
Course Title: Ecology and Terrestrial Environment (PRACTICAL)
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
==

Course Objectives: The course aims to develop skills of field sampling, testing and analysis of water and soil and interpretation .
Le**arning outcome:** After the completion of this course, students will learn water and soil testing

Unit	Title	Practical sessions
1	• Soil sampling (Field work) • Soil Testing o Grain size analysis o Soil chemistry – pH **Organic matter and organic carbon:** Methods(Titration and Loss & ignition)	07
2	• Soil chemistry • pH testing • **organic matter and organic carbon:** Methods(Titration and Loss & ignition)	08
3	Journal and Viva	
		15

References :

1. Handbook of Applied Hydrology, Ven Te Chow, Ed., Section 4-II, McGraw-Hill Book Company, New York
2. King, C. A. M. (1966): Techniques in Geomorphology, Edward Arnold Ltd., London
3. Miller, A. A. (1953): The Skin of the Earth, Methuen and Co. Ltd., London
4. Monkhouse, F. J. and Wilkinson, H. R. (1971): Maps and Diagrams, Methuen and Co., London
5. Strahler, A. N. (1964): Quantitative Geomorphology of Drainage Basins and Channel Networks,

ELECTIVE
Course Code: GEG-VI .SE-13
Course Title: Remote Sensing of Forest Ecology
Marks: 75
Credits: 3
Duration: 45 sessions of 1 hours each
===

Course Objectives: The objective of this course is to introduce the fundamental application of remote sensing in the forest ecology.

Learning outcome: Student will be able to appreciate the use of remotely sensed data in forest applications.

Unit	Title	Lectures
1	**Remote Sensing of Forest Environments** Spectral Response of Vegetation. Measuring and monitoring: General Methods of Measuring Vegetation. Selecting a Measurement Method: Indirect Measurement of Forest Canopy Structure.	15
2	Measurement of Vegetation: Biophysical Measure, Timing of Measurements, Forest Structure and Composition, Species richness and composition	15
3	Modeling Forest Productivity Using Data Acquired Through Remote Sensing, Forest Information Extraction from coarse and medium Resolution Satellite Data. Selection of Remotely Sensed Data, Understanding Forest Dynamics	15
	Total	45

References

1. Adrian Newton (2007) Forest Ecology and Conservation, A Handbook of Techniques Techniques in Ecology & Conservation. Oxford New York
2. Hamlyn G Jones and Robin A Vaughan (2010) Remote Sensing of Vegetation Principles, Techniques, and Applications. Oxford University Press, Oxford.
3. Michael Wulder and Steven E. Franklin (2003) Remote Sensing of Forest. Environments, Concepts and Case Studies. (Ed) Springer, US.
4. Ned Horning, Julie A. Robinson, Eleanor J. Sterling, Woody Turner, and Sacha Spector (2010)
5. Remote Sensing for Ecology and Conservation, A Handbook of Techniques. Oxford University Press, Oxford.
6. Roger M. McCoy (2005) Field Methods in Remote Sensing. The Guilford Press, New York London.
7. Van Der Valk, Arnold (2009) Forest Ecology Recent Advances in Plant Ecology. Springer.

ELECTIVE
Course Code: GEG-VI .SE-13
Course Title: Practical in Remote Sensing of Forest Ecology (PRACTICAL)
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
==

Course Objectives: To develop the skills of assessing forests using remotely sensed data products.

Learning outcome: At the end of the course student are expected to independently prepare forest map and interpret the forest dynamics.

Unit	Title	Practical sessions
1	**Measurement of Forest Canopy** Accuracy Assessment of forest map Per-Pixel Analysis of Forest Structure Extracting Individual Tree Information Tree Canopy structure Fragmentation metrics, Fragmentation Analysis	10
2	**Vegetation indices** • NDVI • Principal Component Analysis (method specify) • Mapping forest disturbances	5
		15

References

1. Adrian Newton (2007) Forest Ecology and Conservation, A Handbook of Techniques Techniques in Ecology & Conservation. Oxford New York
2. Hamlyn G Jones and Robin A Vaughan (2010) Remote Sensing of Vegetation Principles, Techniques, and Applications. Oxford University Press, Oxford.
3. Michael Wulder and Steven E. Franklin (2003) Remote Sensing of Forest. Environments, Concepts and Case Studies. (Ed) Springer, US.
4. Ned Horning, Julie A. Robinson, Eleanor J. Sterling, Woody Turner, and Sacha Spector (2010)
5. Remote Sensing for Ecology and Conservation, A Handbook of Techniques. Oxford University Press, Oxford.
6. Roger M. McCoy (2005) Field Methods in Remote Sensing. The Guilford Press, New York London.
7. Van Der Valk, Arnold (2009) Forest Ecology Recent Advances in Plant Ecology. Springer.

ELECTIVE
Course Code: GEG-VI.SE-14
Course Title: Advanced Coastal Geomorphology (THEORY)
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==

Course Objectives: The basic objective of this course is to introduce the process of coastal foration and coastal geomorphology of India. It's also introduces application of geo-spatial data which will help in understanding coastal processes.

Learning outcomes: At the end of this course, students are expected to develop the skill of understanding coastal processes by using GIS tools and methods.

Unit	Title	Lectures
I	**Tectonic and coast** • Structural factors -Tectonic Coasts, Orientation of coastal tectonic movement, rates of coastal tectonic movement • Formation of coast • Structurally controlled coasts- Bold and Low coast • Coastal Process and sea-level fluctuations • Climatic factors	15
II	**Coastal Geomorphology of India:** • Indian coast- Extent & Topography Geology & structure of coastal zone, Evidence of emergence and submergence, • Shore features-Beach, Bar, Lagoons-lake, Delta, Estuaries, Coral reefs and islands • Classification of Indian coast	15
III	**Application of R.S in Coastal Studies:** Interpretation of coastal area: • Using SOI toposheet • Satellite images • Study of coastal problems: A case study	15
		45

References

1. Bloom. L. Arthur (2012):Geomorphology, Rawat Publication Delhi.
2. Ahamad.E (1972) Coastal geomorphology of India, Orient Longman Delhi.
3. Cooke R. U. and Doornkamp J.C. (1989): Geomorphology in Environmental Management, 2nd Edition, Oxford : Clarendon Press
4. Eric Bird (2000): Coastal Geomorphology: An Introduction, 1 edition, John Wiley & Sons
5. Gerhard Masselink , Michael Hughes :An Introduction to Coastal Processes and Geomorphology (Hodder Arnold Publication), ISBN-10: 0340764112 , ISBN-13: 978-0340764114
6. Kale, V. S. and Gupta, A. (Rep.2011): Introduction to Geomorphology, Orient Longman, Calcutta.
7. Karlekar, S. (2009): Coastal Processes and Landforms: Diamond Publications, Pune
8. Pethick J. (1995): Introduction to Coastal Geomorphology, John Wiley & Sons Inc.

9. Richard Davis Jr. , Duncan Fitzgerald : Beaches and Coasts, Wiley-Blackwell; 1st edition (July 15, 2004), ISBN-10: 0632043083 , ISBN-13: 978-0632043088
10. Timothy Beatley , Anna K. Schwab , David Brower (2002):An Introduction to Coastal Zone Management, Island Press; REV edition

ELECTIVE
Course Code: GEG-VI.SE-14
Course Title: Advanced Coastal Geomorphology (PRACTICAL)
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
===

Course Objectives: The basic objective of this course is to introduce the GIS techniques which will help in understanding and evaluating coastal processes.

Learning outcomes: At the end of this course, students are expected to develop the skill of understanding coastal processes by using GIS tools and methods.

Unit	**Title**	**Practical sessions**
1	Demarcation of shoreline and tide level and coastal features using GIS software from satellite and SOI toposheet.	05
2	Case study of any coastal problems: Field work and use of GIS software	10
3	Journal and Viva	
		15

References:

1. Ahamad. E (1972) Coastal Geomorphology of India, Orient Longman Delhi.
2. Bloom. L. Arthur (2012):Geomorphology,Rawat Publication Delhi.
3. Cooke R. U. and Doornkamp J.C. (1989): Geomorphology in Environmental Management, 2nd Edition, Oxford : Clarendon Press
4. Eric Bird (2000): Coastal Geomorphology: An Introduction, John Wiley & Sons; 1 edition

ELECTIVE
Course Code: GEG-VI.SE-15
Course Title: Ecology of Estuarine Environment (THEORY)
Marks: 75
Credit: 03
Duration: 45 lectures of 1 hour each

Course objectives: This paper enables the study of estuaries and their unique ecosystems. It explores the features of estuarine ecosystem and analyzes the effects of anthropogenic activities on estuaries.

Learning outcomes: After the completion of this course, students will be able to understand the estuarine processes. They will be aware about anthropogenic effects on estuaries.

Unit No	Contents	Lectures
1	**Physical attributes of Estuaries** • Concept and Significance. • Physical characteristics of estuaries • Classification of estuaries. • Environment in estuaries: mudflats, salt marsh, mangroves, salt pans • Sediment source, transportation and deposition in estuaries.	15
2	**Estuarine dynamics** • Tides and tidal currents in estuaries • Estuarine circulation and mixing. • Estuaries as sources of food for marine organisms and nurseries for marine organisms.	15
3	**Anthropogenic Effects on estuaries and mitigation** • Agricultural runoff. • Fishing • Urban development and Reclamation of land for development. • Recreational activities. • Ports and harbors	15
		45

References:

1. Dronker J and Leussen W.V (1988) Physical Processes In Estuaries, Springer Verlag Publishers. London
2. Dyer. K.R (1997) Estuaries- Physical Introduction, 2nd edition John Wiley and Sons, New York
3. Gade, Edward and Svendson(1982) Coastal Oceanography, Plenum Press London.
4. Nair N. B. and Thampy, D.M.: (1989), Textbook of Marine Ecology. Macmillan Publishers
5. Tait, R.V- (1982), Elements of Marine Ecology: An Introductory Course, 3rd Edition, Butterworth-Heinemann

ELECTIVE
Course Code: GEG-VI.SE-15
Course Title: : Ecology of Estuarine Environment (PRACTICAL)
Marks: 25
Credit: 01
Duration: 15 sessions of 2 hours each

Course objectives: this paper helps in developing the practical skills of studying estuarine ecology.

Learning outcomes: after the completion of this course, students will be able to independently test and analyze various parameters associated with estuarine ecology and suggest remedial measures for the protection f the same.

Unit No	Contents	Practical sessions
1	Mapping of estuaries from Indian coasts using SOI toposheets(any 3)	6
2	**Mapping of estuaries in Goa:** • LULC • Drivers for change	9
3	Journal and Viva	

References:

1. Dronker J and Leussen W.V (1988) Physical Processes In Estuaries, Springer Verlag Publishers. London
2. Dyer. K.R (1997) Estuaries- Physical Introduction, 2nd edition John Wiley and Sons, New York
3. Gade, Edward and Svendson(1982) Coastal Oceanography, Plenum Press London.
4. Nair N. B. and Thampy, D.M.: (1989), Textbook of Marine Ecology. Macmillan Publishers
5. Tait, R.V- (1982), Elements of Marine Ecology: An Introductory Course, 3rd Edition, Butterworth-Heinemann

ELECTIVE
Course Code: GEG-VI.SE-16
Course Title: Disaster Management: Urban and Coastal (THEORY)
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==

Course Objectives: The course aims give insights of basics and applications of landscape and disaster management.

Learning outcomes: This course will enable the students to understand the role of landscape in Urban and Coastal disaster management.

Prerequisite:
Students must have completed the course of Basics of remote sensing and GIS in SEM III.

Unit	Title	Lectures
I	**Introduction to Disaster Management:** • Definition, Types, Concepts of Disaster Management • Importance of Disaster Management • Introduction to mitigation methods • Disaster Management Cycle • Indian Scenario **Natural Hazards & Landscapes:** • Types of landscapes & natural hazards • Distribution Pattern • Consequences • Mitigation measures	15
II	**Urban Landscape & Disaster Management:** • Understanding Risk of Urban hazard • Case study	15
III	**Coastal Landscape & Disaster Management:** • Understanding Risk of coastal hazards • Coastal risk, mitigation and planning. • Case study	15
		45

References:

1. Asian Development Bank, (2016), Reducing Disaster Risk by managing Urban Landuse-Guidance notes for planners, Metro Manila, Philippines
2. Ban Wisner, (2005), At Risk: Natural Hazards, People's Vulnerability and Disasters, Routledge
3. Chowdhury Emdadul. Haque, (2005), Mitigation of Natural Hazards And Disasters: International Perspectives, Springer
4. FitzGerald. M. Duncan, (2003), Beaches and Coasts, Blackwell Publishing
5. Natural Hazards and Disaster Management, (2006), A Supplementary Textbook in Geography for Class XI on Unit 11: Natural Hazards and Disasters, Published by: The Secretary, Central Board of Secondary Education, 2, Community Centre, Preet Vihar, Delhi-110092
6. Vernberg. F. John, Vernberg. Winona B, (2001), The Coastal Zone: Past, Present, and Future, University of South Carolina Press

ELECTIVE
Course Code: GEG-VI.SE-16
Course Title: Practical in Disaster Management: Urban and Coastal (PRACTICAL)
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
==

Course Objectives: This practical course aims to equip student with the techniques of vulnerable hazard zone delineation in local and regional landscape.

Learning outcomes: Student will be able to demarcate the risk prone sites and potential disasters in local and regional landscape.

Prerequisite:
Students must have completed the course of Basics of remote sensing and GIS in SEM III.

Unit	Title	Practical sessions
I	1. Mapping Flood risk area 2. Mapping Landslide and Erosion prone sites 3. Mapping Rock fall prone sites	07
II	4. Mapping the urban land surface temperature (Urban Heat Islands) 5. Risk sensitive land use map 6. Calculating permissible density of hazards.	8
	Journal	
		15

References

1. Asian Development Bank, (2016), Reducing Disaster Risk by managing Urban Landuse-Guidance notes for planners, Metro Manila, Philippines
2. Ban Wisner, (2005), At Risk: Natural Hazards, People's Vulnerability and Disasters, Routledge
3. Chowdhury Emdadul. Haque, (2005), Mitigation of Natural Hazards And Disasters: International Perspectives, Springer
4. FitzGerald. M. Duncan, (2003), Beaches and Coasts, Blackwell Publishing
5. Natural Hazards and Disaster Management, (2006), A Supplementary Textbook in Geography for Class XI on Unit 11: Natural Hazards and Disasters, Published by: The Secretary, Central Board of Secondary Education, 2, Community Centre, Preet Vihar, Delhi-110092
6. Vernberg. F. John, Vernberg. Winona B, (2001), The Coastal Zone: Past, Present, and Future, University of South Carolina Press

INTERDSCIPLINARY
Course Title: Geography of Social Wellbeing
Course code:
Marks: 100
Credits: 4
Duration: 60 lectures of 1 hour each
==

Course Description: Development, in a narrow sense, was supposed to be the ultimate objective of every society across space and time. While development continues to be the buzz-word today, the understanding of what exactly constitutes the term 'development' has undergone crucial changes. Development is being taken out of an exclusivist financial economics view-point, and being given a wider perspective, involving but not limited to, good governance, health, education, environment, culture, community bonding and living standards.

Course Organization: The focus of the course would be a detailed introduction to the students about an emerging contrarian paradigm of Gross National Happiness (GNH), as an alternative to the Gross Domestic Product (GDP) based measurement of the net worth of a country. The shift is primarily necessitated by the fact that neither is the material wealth of any country equitable, and nor does it cover the wider well-being, or "happiness" in the society.

Course Objectives: In this course, the focus is on the Geographical entity of Bhutan, whose government proposed a radically different take on how to measure the sense of well-being in that country. The concept has since been pushing the frontiers of research as well as practice in social well-being beyond the confines of Bhutan. The students in the course are expected to imbibe the varied notions of well-being, critically evaluate, widen their horizons, and think out of-the-box. While the Kingdom of Bhutan, which propounded the concept of GNH will hold a central focus, the focus is more of the conceptual notions of development, the possibility of its wider replications, relevance, tests of implementation, challenges of quantification a rather abstract notion, and most importantly, its wide array of criticism.

Course Topics: The course will be interdisciplinary in nature, in that that it is designed to provoke the postgraduate students of Geography to think holistically, and to appreciate different facets of a complex, real-life social issue. This would go towards building critical thinking skills. Some of the specific modules would be:

Unit	**Title**	**Lectures**
I	**Fundamental Concepts** • Meaning of Social Well-being • Definition, Nature and Scope • Social Well-being and Geography	**15**
II	**The traditional ideas of development and its criticism** • Development as natural resource exploitation • Secondary sector, Industrialization and consumerism • Economic output as the sole evaluation criteria for development, and the GDP based scale of ranking development	15
III	**The Bhutanese concept of Gross National Happiness as a new paradigm** • Bhutan: The land, society, culture and values • Gross National Happiness (GNH): A radical departure from established norms of understanding and measuring development • Attempts in adaptations of GNH across sectors and cultures	15

IV	**Assessing Gross National Happiness (Any four from the following)** • Issues of measurement • Role of cultural aspects • Community coherence and vitality • Ecological diversity and resilience • Good governance • Health • Education • Living Standards • Criticism of GNH and the way ahead	15
Total		60

The above modules would have single or multiple readings, which may be related to the abstract notion of Happiness, spatial incorporation of the ideas, as well as relevant case-studies from Bhutan and other countries from around the world.

Course Grading Plans: The course is designed for students who are at a level to appreciate and incorporate different perspectives, as well as to learn to read, question and critically analyze academic literature on the topic. Most of the classes will have pre-requisite reading (identified academic articles previously provided to students), which the students are expected to complete before attending the lecture, and the contact class would then consist of a short presentation by the instructor, followed by group discussions, debate and critical questioning. Traditional as well and newer methods of grading including written exams and continuous assessments in the form of presentations, group discussions etc would be used for grading. In short, the course will be learning oriented, and not teaching oriented. Attempt would be to introduce a different academic approach, which would have the potential to go beyond the specific course.

Readings:

1. 2015 Gross National Happiness Survey Report: A compass towards just and harmonious society: (Centre for Bhutan Studies and GNH Research)
2. Measuring Progress towards Gross National Happiness: From GNH indicators to GNH national accounts: (Ronald Colman)
3. The Analysis of Results of Research into 'the Ideal Society' in Japan, Sweden and Bhutan - Using the indicator of Human Satisfaction Measure (HSM): (Terue Ohashi)
4. The Global Project on Measuring the Progress of Societies: A global movement for a global challenge: (Jon Hall)
5. Creating National Accounts of Well-Being: A parallel process to GNH: (Nic Marks)
6. Gross Natural Happiness: Can we have both psychological and ecological wellbeing?: (George W. Burns)
7. Time Use and Happiness: (Karma Galay)
8. Internalizing the Other: A cross cultural understanding in arts and education: (Sharon Lowen)
9. Role of Meditation in Achieving Gross National Happiness: (Khenpo Phuntsok Tashi)
10. The Semantic Structure of Gross National Happiness: A view from conceptual metaphor theory: (Carl Polley)
11. Development and (Un)happiness: A case study from rural Ethiopia (Dena Freeman)
12. Religious Institution-based Community-hood and Identity of a 'Muslim Community' in a 'Remote' Rural Village in Bangladesh: (Mohammed Kamruzzaman)
13. To Think Like an Island: Three-capital model in pursuing GNH in Taiwan: (Juju Chin Shou Wang)
14. Institutional Challenges to 'Patience' in the Collective Management of Public Goods: (Mukul Ram Fishman)

15. Status Symbols, Ecosystems and Sustainability: (Arthur Fishman)
16. Good Organisational Practice and Gross National Happiness: (Anne-Marie Schreven)
17. Between Earth and Sky: Formal Organizations as Instruments in Creating Gross National Happiness: (John Nirenberg)
18. Do Information and Communication Technologies Further or Hinder Gross National Happiness?: (Kezang and Jason Whalley)
19. Lessons from ICT Pilot Projects in Rural Haïti for Sustainable Economy with Four Inferred Coefficients for the GNH Index: (Serge Miranda, Frantz Verella and Tahar Saiah)
20. Bhutanese Health Care Reform: A Paradigm Shift in Health Care to Increase Gross National Happiness: (Dr. Chencho Dorji)
21. Nature Affinity and the Human Conditions: (Dave M. Augeri)
22. Conceptualising Education for Constitutional Monarchy System: Meiji Japan's View and Approach: (Masanori Kakutani)
23. Schools in Rural Areas and Gross National Happiness: Endogenous Actions Of Small Communities In Japan And Sweden: (Michiyo Kiwako Okuma-Nyström)
24. Shift in the Measures of Quality of Life viz-a-viz Happiness: A Study of Phongmey Gewog and Trashigang Town in Eastern Bhutan: (Vijay Kumar Shrotryia)
25. Japan's Paradigm Shift From Growth To Happiness: Slowing Down to Advance Wellbeing: (Junko Edahiro and Riichiro Oda)
26. Food Security and Gross National Happiness: (Akiko Ueda)
27. Optimal Condition of Happiness: Application of Taguchi Robust Parameter Design on Evidences from India: (Prabhat Pankaj and Roma Mitra Debnath)
28. The Future of Gross National Happiness: (Ross McDonald)
29. Critical Holism: A New Development Paradigm Inspired by Gross National Happiness?: (Hans van Willenswaard)

INTERDSCIPLINARY
Course Title: Geography of Sustainable Development
Course code:
Marks: 100
Credits: 4
Duration: 60 lectures of 1 hour each
==

Course Objectives: The basic objective of this course is to introduce the concept of sustainable development considering Norway as benchmark which has been consistently topping the Human Development Index. This course focuses on introducing the concept of resource management and maintain a balance between economic profit and environmental implications which is based on Model followed by Norway.

Learning outcomes: At the end of this course, students are expected to understand the concept of development in its holistic term. They would be encouraged to appreciate the Norwegian Model of Development and the possibilities and challenges of replicating such approaches.

Unit	Title	Lectures
I	**Development to Sustainable Development:** • What is development • Concept of sustainable development • Distinction between development and sustainable development • Key concepts in sustainable development •	15
II	**The Norwegian Model of Sustainable Development** • The post-war development model and its limits • Norwegian Model of Sustainable Development	15
III	**Environment and sustainable development (Teach Any Five)** • Conservation of nature • Encouragement of indigenous way of life • Gender equality • Social equity • Immigration policy • Renewable sources of energy and conservation • Marine resources	15
IV	**Local Issues and Challenges in attaining Sustainable Development (Any two case studies)**	15
Total		60

References:

1. Our Common Future: The Brundtland Commission Report
2. Sustainable Development in Norway on the example of government pension fund global: (Julita Fiedorczuk)
3. Norway´s Strategy for Sustainable Development: (Norwegian ministry of finance)
4. The Norwegian Model of Sustainable Development: A Policy Oriented Capital Framework for Measurement and Policies: (Thorvald Moe)
5. The Global Goals for Sustainable Development: Challenges and possible implications for Norway (Arne Backer Grønningsæter and Svein Erik Stave)

6. A comprehensive resource development strategy: Norway's path to inclusive and sustainable development (Francis Dennig)
7. Sustainable Development Goals and children in Norway: A discussion paper on the SDGs indicators (Lars B. Kristofersen)
8. Norwegian development cooperation for sustainable fisheries and aquaculture: (Asmund Bjordal)

ANNEXURE - II

Parvatibai Chowgule College of Arts and Science

(Autonomous)

DEPARTMENT OF GEOGRAPHY

COURSE STRUCTURE

THREE YEAR B.Sc. DEGREE COURSE IN GEOGRAPHY

SEMESTER	CORE		ELECTIVE			
I	GEG-I.SC1: Introduction to Geography	GEG-I.SC2: Fundamentals of Physical Geography				
	GEG-I.SC1: Measurement Systems in Geography (Practical)	GEG-I.SC2: Practicals in Physical Geography (Practical)				
II	GEG-II.SC3: Basics of Human Geography	GEG-II.SC4: Basics of Regional Geography				
	GEG-II.SC3: Practicals in Human Geography (Practicals)	GEG-II.SC4: Practicals in Regional Geography (Practicals)				

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER I

REVISED AS ON 11TH OCTOBER 2017

Course Title: Introduction to Geography (THEORY)
Course Code: GEG-I.SC1
Marks: 75
Credits: 3
Duration:45 lectures of 1 hour each
==

Course Objectives: This introductory Course is intended to acquaint the students with distinctiveness of Geography as a field of learning. The philosophy of the subject is to be taught in order to develop a keen interest in the subject and to pursue it for higher studies.

Learning outcomes: At the end of this course students are expected to have a holistic understanding of fundamental concepts of geography and thereby be able to analyze the interrelationships among them.

Unit No.	Course Content	No. of Hours
I	**Introduction of Geography** Definition, Meaning, nature and scope of geography; Major divisions of geography Major themes in Geography – location, region, process, spatial interaction and time.	15
II	**Introduction to Geosphere: I** **Atmosphere:** Meaning &Definitions-Composition& Structure of Atmosphere, Elements of Weather & Climate and their inter-relation. **Biosphere &Nanosphere** Major Natural regions of world	15
III	**Introduction to Geosphere: II** **Lithosphere:**Evolution of Earth, Geological Time scale. Orders of Relief (I, II, III), oceans and continents, classification of mountains, plateau and plains **Hydrosphere**: Hydrological Cycle Spatial distribution of water on earth.	15

REFERENCES

1. Dikshit R.D (2004): The Arts, Science of Geography, Integrated Readings Prentice Hall of India, New Delhi
2. Lal . D. S. (2007) : Climatology, Pushtakmahal, Allahabad
3. Goh Cheng Leong (2003): Certificate Physical and Human Geography, Oxford university press, New Delhi
4. Das Gupta and Kapoor (2013): Principles of Physical Geography, S. Chand & Company Pvt. Ltd.
5. SinghSavindra (2005) : Environmental Geography, PrayagPustakBhavan, Allahabad

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER I

Course Title: Measurement Systems in Geography (Practical)
Course Code: GEG-I.SC1
Marks: 25
Credits: 01
Duration: 15 sessions of 2 hours each
===

Course Objectives: The course aims to develop skills of map reading and understanding. It also encourages students to understand and correlate the different measurement systems which are essential to understand the geographical concepts.

Learning outcome: After the completion of this course students are expected to be familiar with the basic cartographical skills such as basic elements of map and map reading. Besides, they will be acquainted with the cartographic techniques such as area measurements, time calculation, which will help in learning advanced techniques as they progress.

Unit	Title	Practical sessions
I	1. Scales and its types: a. Verbal Statement. b. Representative Fraction. 2. Linear scale- a. Simple and comparative- b. time and distance 3. Identification of location and extension based on latitude and longitudes. 4. Grid reference system. 5. Finding directions. 6. Calculation of time based on longitude 7. Calculation of area by square method	10
II	8. Preparation of map – Title, Scale, Legend, Direction, Signs and symbols, lettering and colour scheme.	05
III	Journal	
		15

References

1. Campbell, J.(2004) Introductory Cartography, Prentice Hall, Inc Englewood
2. Misra, R.P. and Ramesh, A., (2005): Fundamentals of Cartography, Concept Pub. Co., New Delhi
3. Monkhouse, I.J. and Wilkinson, H.R., (2009): Maps and Diagram, B.I. Publication, New Delhi
4. R. P Mishra. (2014) Fundamentals of Cartography, Concept Pub. Co., New Delhi
5. Gopal Singh. (2014), : Map Work and Practical Geography, 4th Edition, Sterling Book House Mumbai

Course Title: Fundamentals of Physical Geography (THEORY)

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER I

Course Code: GEG-I.SC2
Marks: 75
Credits: 3
Duration:45 lectures of 1 hour each
==
Course Objectives: The course aims to introduce fundamental concepts of physical geography. The course focuses of various spheres of the earth and their related concepts.
Le**arning outcome:** After the completion of this course students are expected to be familiar with the different spheres of the earth and the interrelation amongst them.

Unit No.	Course Content	No. of hours
I	**Concept and Nature**: Introduction to physical geography Recent developments in physical geography. **Layers of the Earth**: Lithospheric system: Interior of the earth. Layering of the earth- Mechanical layering and chemical layering. Weathering and mass movement, Rocksand its types. Soil- definition and profile.	15
II	**Basic concepts of climatology**: Definition and scope of climatology Insolation, factors affecting Insolation and Heat budget. Temperature, atmospheric pressure, wind, and humidity	15
III	**Dynamics of ocean water**: -Waves, Tides, and surface currents of Indian and Atlantic Ocean.	15
		45

References:

1. Bloom, Arthur L., 2008: Geomorphology – A Systematic Analysis of Late Cenozoic Landforms, Prentice Hall, Engle Wood Cliff, New.Jersey.
2. Ahmed, E., 2005: Geomorphology, Kalyani Publishers, New Delhi
3. Sharma, V.K., 2006: Geomorphology, Earth Surface, Process and forms, Tata McGraw Hill, New York
4. Lal.D.S , 2004: Oceanography,PrayagPustakBhavan,Allahabad
5. Strahler, A.N., 2005: Physical Geography, 3rd Ed., Wiley Publications
6. Singh, S. 2005: Physical Geography,PrayagPustakBhawan, Allahabad
7. Thornbury, W.D., 1969: Principles of Geomorphology, 2nd Ed., Wiley International Edition, Wiley Eastern Reprint, 2004
8. Wooldridge, S.W. and Morgan, R.S., 2008: The Physical Basis of Geography, Longman (First published in 1937)
9. Worcestor, P.G., 2005: A Textbook of Geomorphology, Van Nostrand, 2nd Ed., East West Edition, New Delhi.
10. Chorley, Richard J., 2002: Spatial Analysis in Geomorphology, Harper and Row Publishers, New York, London.
11. Dayal, P. (2nd edition) 2006: A Textbook of Geomorphology, Shukla Book Depot, Patna
12. Sharma, H.S. (ed), 2002: Perspective in Geomorphology, Vol. I & IV, Concept, New Delhi.
13. Sharma, V.K., 2006: Geomorphology, Earth Surface Processes and Forms, Tata Mc. Graw Hill, New Delhi.
14. Sparks, B.W., 2000: Geomorphology, Longman, London, 2nd edition.

Course Title: Practical in Physical Geography

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER I

Course Code: GEG-I.SC2
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
==

Course Objectives: The course aims to develop skills of relief representation and Toposheet reading, climate data analysis and interpretation. This exercise demands a higher order skill of converting signs and symbols into words.

Le**arning outcome:** After the completion of this course students are expected to be familiar with techniques of representing different relief features and interpretation of the characteristics and association with other relief features. Student will be able to analyze, interpret and represent climate data through graphs.

Unit	**Title**	**Practical Sessions**
I	1. Methods of Representation of Relief features a. Spot Heights, b. Bench Marks. c. Triangulation mark 2. Contours diagrams for slopes with cross sections- gentle slope, steep slope, concave and convex slope, 3. Contours diagrams for hills, plateaus, cliff, 4. Contours diagrams for V-shaped valley, waterfall, rapids, river terraces 5. Profile Drawing from contour diagram. a. Serial b. Superimposed c. composite	10
II	6. Calculation of mean, average, range of temperature. 7. Calculation of lapse rate and Relative Humidity.	5
	Journal	

References

1. Chorley, Richard. J. (ed.), 2009: Water, Earth and Man, Methuen & Co., London
2. Goudie, Andrew, et al. (eds), 2001: Geomorphological Technique, George Allen & Unwin, London
3. Gregory, K.J. and Walling, D.E., 2003: Drainage Basin – Form and Process, Edward Arnold, London
4. King, C.A.M., 2006: Techniques in Geomorphology, Edward Arnold, London
5. Leopold, L.B, Wolman, M.G. and Miller, J.P., 2004: Fluvial Processes in Geomorphology, Freeman, San Francisco
6. Misra, R.P. and Ramesh, A., 2009: Fundamentals of Cartography, Concept Publishing Co., New Delhi
7. Monkhouse, F.J. and Wilkinson, H.R., 2009: Maps and Diagrams, B.I. Publications Pvt. Ltd., New Delhi
8. Singh, R.L. and Singh Rana P.B., 2008, Elements of Practical Geography, Kalyani Publishers, New Delhi

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER II

REVISED AS ON 11TH OCTOBER 2017

Course Title: Basics of Human Geography (Theory)
Course Code: GEG-II. SC3
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
===

Course Objectives: The course provides the basic conceptual framework of Human Geography. It focuses on cultivating basic knowledge through understanding and analysis of the fundamental concepts in Human geography.

Learning outcomes: At the end of this course students are expected to have a holistic understanding of fundamental concepts of Human Geography and thereby be able to understand human related issues.

Unit	Topic	No. of hours
I	**Concept and Nature :** Meaning, Scope and Development of Human Geography. Basic principles-Principle of Activity or Change, Principle of Terrestrial Unity or whole. Approaches in human geography (humanistic, scientific, welfare and behavioral)	15
II	**Society and Culture** Evolution of man (Australopithecus, Homo Erectus, Homo sapiens. Man's spread over the earth during the Pleistocene). Culture- meaning and components. Language and religion. (Classification, distribution, issues and challenges.) Contemporary social problems: Gender disparity and related issues Ethnicity and the related issues. (Case study of India).	15
III	**Indicators of Development:** L.D.C. and M.D.C.-social, economic and demographic. (Distribution and Density. Concepts of under population, over population, age and gender composition. Fertility, mortality, migration, Ageing population.) Demographic transition.	15
		45

Note : The course should focus on basic conceptual aspects.

Reference

1) H.J De Blij,Alexander B.Murphy,Erin H. Fouberg.(2007) *Human Geography:people,place and culture*.John Wiley and sons. USA.
2) Panigrahi .P.K. (2011).*Human Geography-Landscape of Human Activities*. MurariLala and sons. New Delhi.
3) Sharma Y.K. (2007) *Human Geography*.Lakshmi Narain Agrawal, Agra.
4) Rubenstein J M (2010) *Contemporary Human Geography*. PHI learning pvt, New Delhi.
5) Hussain, M.(2004)*Human Geography*. Rawat Publication. New Delhi.
6) Chandna, R.C. (2006)*Geography of Population*.Kalyani Publishers. New Delhi
7) Hagget, P.(2002)*Geography: A Modern Synthesis*. Harper & Row, New York
8) De Blij, H.J., Human Geography, Culture, Society and Space, John Wiley, New York, 2006
9) Fellman, J.L. Human Geography-Landscapes of Human Activities, Brown and Bench man, Pub. U.S.A. 2007.
10) Arun Kumar Sharma, 2012: Principles of Human Geography, Rastogi Publications, Meerut

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER II

Course Title: Practicals in Human Geography
Course Code: GEG-II.SC3
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
===

Course Objectives: The course provides the basic quantitative aspects of Human Geography. It focuses on cultivating quantification and diagrammatic representation of population data. This enables students to understand, quantify and precisely represent population data.

Learning outcomes: At the end of this course students are expected to have a holistic understanding of basic quantitative techniques used in Human geography. They should be able to diagrammatically represent population data and diagrams.

Unit.	Title	Practical sessions
1	Calculation and interpretation of: **1. Fertility measures**: Crude Birth Rate, General Fertility Rate **2. Mortality measures**: Crude Death Rate, Infant Mortality Rate. **3. Age data Analysis**: Age and gender composition **4.** Construction of Population Pyramid	8
2	**5. Literacy measures**: Crude Literacy Rate. Gross Enrolment Ratio. **6.** Work Participation Ratio. **7.** Per capita income **8.** GDP	7
3	Journal and viva	
		15

References:

1. Bogue, D. J., 2001: Principles in Demography, John Wiley, New York
2. Bose, Ashish et. al., 2004: Population in India's Development,Vikas Publishing House, New Delhi
3. Census of India, India : A State Profile, 2001.
4. Chandna, R.C. Geography of Population : Concept, Determinants and Patterns, Kalyani Publishers, New York 2000.
5. Crook, Nigel Principles of Population and Development. Pergmon Press, New York 2007.
6. Daugherty, Helen Gin, Kenneth C.W. Kammeryir, An Introduction to Population (Second Edition). The Guilford Press, New York, London 2008.
7. Mitra, Asok, India's Population. Aspects of quality and Control Vol. I & II. Abhinar Publication. New Delhi 2008.
8. Srinivsan, K. and M. Vlassoff. Population Development Nexus in India : Challenges for the New Millennium. Tata McGraw Hill, New Delhi 2001.
9. Srinivasan, K. Basic Demographic Techniques and Applications Sage Publications, New Delhi 2008.
10. UNDP: Human Development Report Oxford University Press, Oxford 2000.
11. United Nations, Methods for Projections of Urban and Rural Populations. No. VIII, New York 2004.
12. Woods, R. Population Analysis in Geography, Longman, London 2009.
13. Sawant & Athavale: Population Geography, Mehta Publishing House, Pune.2005

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER II

Course Title: Basics of Regional Geography
Course Code: GEG-II.SC4
Marks: 75
Credits: 3
Duration:45 lectures of 1 hour each
==

Course Objectives: The course aims to develop a basic understanding of the regions and recognizing the significance of geography in shaping region. It helps students to appreciate regional unique dimensions of regions.

Learning outcome: At the end of this course, student will gain sense of spatial organization and areal variation in human activities.

Unit	Title	No. of hours
I	Concept of Region in Geography: Definition and characteristic The Regional Approach - area, region, space. ii) Methods of Regionalization- methods of delineation of region, types of regions,	15
II	i.) Foundations of Region - Ecological, Economic, Social and Cultural Dimensions ii.) Federalism-center – state relationships. iii.) Core – Periphery iv.) Hierarchy of regions, v.) Regional Consciousness and Identity. vi.) The Regional issues. (Two case studies)	15
III	Study of Regional Organization: Their evolution, functions and inter-linkages. Globalization and the New Territorial Order.	15

References

1. Singh, R.L.2001 (ed):India – A Regional Geography, National Geographical Society, India
2. Cole, J. : *A Geography of the World's Major Regions*, Routledge, London,2000
3. Israel, S. Johnson, D.I. and Wood, D.: *World Geography* Today,2005
4. Jackson, R.H. and Hudman, L.E.: *Regional Geography: Issues for Today*.,2007
5. *An Introduction to Regional Geography*, Paul Claval, Rawat Publication, Jaipur & Delhi,2003
6. Wheeler, J.H. Jr. and Kostbade, J.T., (1990): *World Regional Geography*, Holt Rinshort and Winston, Inc
7. Holier, G.P., 2008: Regional Development in Michael Pacione (ed), *The Geography of the 3rd World: Progress & Prospects*, Rutledge, London, New York.
8. Jackson, R.H. and Hudmar, L.E.: Regional Geography: Issues for Today ,2004
9. Paul Claval (2008) An Introduction to Regional Geography, Wiley-Blackwell, ISBN 155786733X.

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER II

Course Title: Practical in Regional Geography
Course Code: GEG-II.SC4
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each

==

Course objectives: The course provides the basic quantitative aspects of regional Geography. It focuses on cultivating quantification and diagrammatic representation of regional data. This enables students to understand, quantify, compare of unique characteristic of different regions.

Learning outcomes: At the end of this course students are expected to have a holistic understanding of basic quantitative techniques used in regional geography. They should be able to diagrammatically represent interpret regional data and diagrams.

Unit	Topic	Practical Sessions
I	Methods of Regional Demarcation: 1. Demarcation of agricultural regions (crop combination and diversification) 2. Gravity model, 3. Breaking point Analysis, 4. Sphere of Urban Influence 5. Population potential surfaces	08
II	6. Network Analysis 7. Nearest Neighbor index, 8. Centro graphic analysis	07
III	**Journal and viva**	
		15

References

1. Hegget Peter, Cliff A.D. et. al. (2001) Locational Methods, Locational Analysis in Human Geography, Vol.II Arnold – Heinemann Pub. (India)
2. Hegget Peter, Cliff A.D. et. al. (2000) Locational Meodels, Locational Analysis in Human Geography. Vol. I Arnold – Heinemann Pub. (India)
3. Chandna R.C. (2003): Regional Planning: A Comprehensive Text, Kalyani Publishers, Ludhiana

ANNEXURE - II

Parvatibai Chowgule College of Arts and Science

(Autonomous)

DEPARTMENT OF GEOGRAPHY

COURSE STRUCTURE

THREE YEAR B.Sc. DEGREE COURSE IN GEOGRAPHY

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	GEG-I.SC1: Introduction to Geography	GEG-I.SC2: Fundamentals of Physical Geography				
	GEG-I.SC1: Measurement Systems in Geography (Practical)	GEG-I.SC-2: Practicals in Physical Geography (Practical)				
II	GEG-II.SC3: Basics of Human Geography	GEG-II.SC4: Basics of Regional Geography				
	GEG-II.SC3: Practicals in Human Geography (Practicals)	GEG-II.SC4: Practicals in Regional Geography (Practicals)				
III	GEG-III.SC5: Fundamentals of Remote Sensing and GIS		GEG-SE1: Spatial Analysis	GEG-SE2: Raster and Vector Data Models in GIS	GEG-SE3: Participatory GIS	GEG-SE4: Applied GIS
IV	GEG-IV.SC6: Fundamentals of Geomorphology		GEG-SE5: Coastal Geomorphology	GEG-SE6: Fluvial Geomorphology	GEG-SE7: Watershed Management	GEG-SE8: Biogeography
V	GEG-V.SC7: Fundamentals of Climatology		GEG-SE9: Geography of Soil Studies	GEG-SE10: Agro-Meteorology: Principles and Applications	GEG-SE-11: Field Survey in Physical Geography	GEG-SE12: Quantitative Techniques in Geography
VI	GEG-VI.SC8: Ecology and Terrestrial Environment		GEG-SE13: Remote Sensing and Forest Ecology	GEG-SE14: Advanced Coastal Geomorphology	GEG-SE15: Ecology of Estuarine Environment	GEG-SE16: Disaster Management: Urban and Coastal

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER III

REVISED AS ON 7TH APRIL 2018

CORE
Course Title: Fundamentals of Remote Sensing and GIS (THEORY)
Course Code: GEG-III.SC5
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==

Course Objectives: The focus of this Course is to introduce key concepts of Remote Sensing and GIS**.**

Learning outcomes: On completion of this course students will able to appreciate the basic science of remote sensing and GIS as a tool of study and research in geography

Unit	Title	No. of hours
I	**Concepts of Remote Sensing : Introduction to remote sensing,** Electromagnetic Radiation and its components:- Characteristics of Electromagnetic Spectrum Energy Interactions with Earth's atmosphere and surface features; Spectral response of Earth's natural surface. Introduction to Sensors and platforms Aerial Photography:- Types, Error In Flying, Geometry, Scale, Relief Displacement, Stereoscopes Parallax	15
II	**Visual Interpretation of Satellite Images and Aerial Photographs :** Elements of Image interpretation, Interpretation of Multi-Spectral Imagery, Identification of Earth Surface Features **Introduction to digital analysis**	15
III	**Concepts in GIS :** Content of GIS, objectives of GIS, Elements of GIS, Hardware & Software Requirements, Point Line and Polygon, Layers and Coverage Raster and Vector Data, Components of GPS.	15
		45

REFERENCES

1. C.P.Lo and Albert K. W. Yeung,(2002) Concepts and Techniques of Geographic Information System, Prentice –Hall, India.
2. Heywood I, el. (2011) An Introduction to Geographical Information Systems , Pearson Education Pvt. Ltd., New Delhi.,
3. J.R. Jensen, (2003) Remote Sensing of Environment, An Earth Resource Perspective, , Pearson Education Pvt. Ltd., New Delhi.
4. Kang – tsung – Chang, (2002)Introduction to Geographical Information System, , McGraw Hill.
5. Lillesand T.M. and Kiefer R.W., (2002) Remote Sensing and Image Interpretation, John Wiley and Sons, New Delhi.
6. George Joseph (2005) Fundamentals of Remote Sensing, University press Private Ltd, Hyderabad.
7. P. A. Burrough and R. A. McDonnell, (2000)Principles of Geographical Information System, , Oxford University Press.
8. Paul A. Lonfley, et al.(2002), Introduction to Geographic Information Systems and Science, , John Wiley and Sons Ltd

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER III

CORE
Course Title: Fundamentals of Remote Sensing and GIS (Practical)
Course Code: GEG-III.SC5
Marks: 25
Credits: 01
Duration: 15 sessions of 2 hours each
===

Course Objectives: The objective of this course is to provide hands-on training in basic Remote Sensing, GIS and GPS techniques.

Le**arning outcome:** At the end of this course, students will be able interpret and analyze remotely sensed data.

Unit	Title	Practical sessions
I	Determination of scale, coverage, area, distance and height. Determination of parallax using mirror stereoscope. Interpretation of Aerial Photographs & Satellite images Identification of physical and cultural features using elements of interpretation Aerial photographs and their verification and ground truthing	07
II	Geo-referencing of scanned maps. Digitization of point, line and polygon layers. GPS survey on field and Identification of geographic feature on image and on actual ground	08
III	Journal	
		15

References

1. C.P. Lo and Albert K. W. Yeung, Concepts and Techniques of Geographic Information System, (2002) Prentice –Hall, India.
2. George Joseph, Fundamentals of Remote Sensing, (2004), Universities Press Pvt. Ltd., Hyderabad.
3. Heywood I, (el.) An Introduction to Geographical Information Systems , Pearson (2011)
4. J.R. Jensen, Remote Sensing of Environment, An Earth Resource Perspective, (2003), Pearson Education Pvt. Ltd., New Delhi.
5. Kang – Tsung – Chang, Introduction to Geographical Information System, (2002), McGraw Hill.
6. Lillesand T.M. and Kiefer R.W., (2002), Remote Sensing and Image Interpretation, John Wiley and Sons, New Delhi.
7. P. A. Burrough and R. A. McDonnell, Principles of Geographical Information System, (2000), Oxford University Press.
8. Paul A. Lonfley, Michel F. Goodchild, D J. Maguire and D W. Rhind, Introduction to Geographic Information Systems and Science, (2002), John Wiley and Sons Ltd

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER III

ELECTIVE
Course Title: Spatial Analysis (Theory)
Course Code: GEG- SE1
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
===

Course Objectives: The objectives of this course is to introduce the fundamentals of spatial analysis through pattern recognition, interpolation, locational and topographical analysis.

Learning outcome: At the end of this course, students will acquire the skills of spatial analysis, identification of suitable site, locational advantages and decision making.

Unit	Topic	No. of hours
I	**Introduction to Spatial Analysis**: concepts, functions of spatial analysis Characteristics, importance of geo-data base Topology and types Concept and sources of Spatial and Non-Spatial Data	15
II	Concept and methods of spatial Interpolation. Raster analysis. Overlay analysis.	20
III	**Topographic Analysis**: Digital Elevation Model, Slope, Aspect, Flow Accumulation, Flow Direction etc.	10
		45

Reference Books:

1. Alias A. Rahman and Morakot Pilouk (2008) Spatial Data Modeling for 3D GIS, Springer New York
2. Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W. (2005). Geographic Information Systems and Science. Chichester: Wiley. 2nd edition.
3. M Goodrich (2000). Data Structures and Algorithms in Java, 2nd Edition Wiley.
4. Malczewski, J. (1999). GIS and Multicriteria Decision Analysis. New York: John Wiley and Sons
5. Ott, T. and Swiaczny, F. (2001). Time-integrative GIS. Management and analysis of spatio-temporal data. Berlin / Heidelberg / New York: Springer.
6. Thurston, J., Poiker, T.K. and J. Patrick Moore. (2003). Integrated Geospatial Technologies: A Guide to GPS, GIS, and Data Logging. Hoboken, New Jersey: Wiley.

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER III

ELECTIVE
Course Title: Spatial Analysis (Practical)
Course Code: GEG-SE1
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hour each
==

Course Objectives: The objectives of this course is to introduce the fundamentals of spatial analysis through pattern recognition, interpolation, locational and topographical analysis.

Learning outcome: At the end of this course, students will acquire the skills of spatial analysis, identification of suitable site, locational advantages and decision making.

Unit	Topic	Practical Sessions
I	**Vector Operations** (Single Layer): Dissolve, Buffer, Multi Ring Buffer. Vector Operations (Multi Layer): Clip, Erase, Merge, Intersect. **Raster Operations**: clip and mosaic (Extract By Mask). Spatial Queries and Non-Spatial Queries based on locations	**10**
II	**Interpolation**: Inverse Distance Weighted method Topo to Raster. **Overlay Operations** (Point in Polygon, Line in Polygon, Polygon in polygon).	**05**
III	Journal	**-**
		15

Reference Books:

1. Alias A. Rahman and Morakot Pilouk (2008): Spatial Data Modeling for 3D GIS, Springer New York.
2. Goodrich, M (2000). Data Structures and Algorithms in Java, 2nd Edition Wiley Longley, P.A.,
3. Goodchild, M.F., Maguire, D.J. and Rhind, D.W. (2005). Geographic Information Systems and Science. Chichester: Wiley. 2nd edition.
4. Malczewski, J. (1999). GIS and Multicriteria Decision Analysis. New York: John Wiley and Sons
5. Ott, T. and Swiaczny, F. (2001). Time-integrative GIS. Management and analysis of spatio-temporal data. Berlin / Heidelberg / New York: Springer.
6. Thurston, J., Poiker, T.K. and J. Patrick Moore. (2003). Integrated Geospatial Technologies: A Guide to GPS, GIS, and Data Logging. Hoboken, New Jersey: Wiley.

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER III

ELECTIVE
Course Title: Raster and Vector Data Models in GIS (THEORY)
Course Code: GEG-SE2
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
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Course Objectives: This course introduces basic concepts and principles of GIS and emphases on the role of raster and vector data models. The students will introduced data processing, transformation and visualization of data using various models.

Learning outcomes: The students will be able to differentiate raster and vector data models and also appreciate the role of these models in visualizing graphical outputs through GIS.

Unit	Title	No. of hours
I	GIS Concepts, Principles, Geospatial Data Models, Organization of GIS Data and System Functionality, Map Projections, Coordinate Systems and Transformations.	15
II	Fundamentals of Raster data models, metadata and data exchange 2D and 3D raster data models Fundamentals of raster maps, Raster data transformation	15
III	Vector data Basics of vector data and Generation of vector data, fundamentals of Vector map queries and statistics, Basics of Point analysis Basics of Network analysis	15
		45

Reference :

1. Markus Neteler and Helena Mitasova (2008) OPEN SOURCE GIS, A GRASS GIS Approach (Third Edition) Springer, USA
2. McCartney Taylor, Nik Freeman (2014) Getting Started With GIS Using QGIS (Kindle Edition) McCartney Taylor.

Sample Data source
1. https://grass.osgeo.org/download/sample-data/
2. http://grassbook.org/datasets/datasets-3rd-edition/
3. http://www.qgis.org/en/site/

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER III

ELECTIVE
Course Title: Raster and Vector Data Models in GIS (Practical)
Course Code: GEG-SE2
Marks: 25
Credits: 1
Duration: 15 Sessions of 2 hour each
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Course Objectives:
This course introduces basic concepts and principles of GIS and emphasis on the role of raster and vector data models. The students will be also be introduced data processing, transformation and visualization of data using various models.

Learning outcomes: The students will be able to differentiate raster and vector data modes and also appreciate the role of these models in visualizing and graphical outputs through GIS.

Unit	Title	Practical sessions
I	Import of raster data, Coordinate transformation, Raster map algebra Raster data transformation and interpolation Spatial analysis with raster data	8
II	Vector Datageneration Network Analysis Cluster analysis Transformations to Raster(vectorization - rasterization) Spatial Interpolation.	7
III	Journal	-

Reference :

1. Markus Neteler and Helena Mitasova (2008) OPEN SOURCE GIS, A GRASS GIS Approach (Third Edition) Springer, USA
2. McCartney Taylor, Nik Freeman (2014) Getting Started With GIS Using QGIS (Kindle Edition) McCartney Taylor.

Sample Data source
1. https://grass.osgeo.org/download/sample-data/
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3. http://www.qgis.org/en/site/

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER III

ELECTIVE
Course Title: Participatory GIS (Theory)
Course Code: GEG-SE3
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
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Course Objectives: This is an introductory Course of Participatory GIS that aims to expose student to applications of GIS in the context of community and people's participation. This helps to enhance Geographical Information through shared knowledge and information.

Learning outcomes: At the end of this course, students will be able to understand and acknowledge the applications of GIS for benefit of society.

Unit	Title	No. of hours
I	Participatory Geographic Information Systems Concepts and Methods, History (PRA, P-GIS pGIS Pgis) Ethics, Partnership, role and responsibility of the scientist. Methodology for Pgis., implementation and limitations of the participation Methods, Techniques, advantages of community mapping. Data management. Features of interest for socio-economic analysis and social development skills and training requirements. P-GIS and the livelihoods approach.	15
II	Contribution of P-GIS through Community Mapping in Water Resource Inventory. Urban and Peri-Urban Partnership and Community Empowerment Community Resource Mapping in Forest, Agriculture and Water Resources Management: Bridging the Divide between Community and Government Voluntary Information and PGIS (VI & PGIS)	15
III	Neo-geography and GIS/2 : value addition to P-GIS Needs of Participatory GIS. Perspectives on Participatory mapping and PGIS	15
		45

References

1. Abbot, J., Chambers, R., Dunn, C., Harris, T., Merode, E. d., Porter, G., Townsend, J.,Weiner, D., de Merode, E., (1998). 'Participatory GIS: opportunity or oxymoron?' PLA Notes33. IIED: Londo
2. Elwood, Sarah (2006) Participatory GIS and Community Planning: Restructuring Technologies, Social Processes, and Future Research in PPGIS Collaborative Geographic Information Systems edited by Shivanand Balram and Suzana Dragicevic, Idea Group Inc. University of Arizona, USA
3. Elwood, Sarah (2006), Critical Issues in Participatory GIS: Deconstructions, Reconstructions, and New Research Directions Transactions in GIS, 10(5): 693–708
4. McCall, Michael K. (2004) Can Participatory-GIS Strengthen Local-level Spatial Planning? Suggestions for Better Practice. Dept. of Urban & Regional Planning and GeoInformation Management ITC. Course prepared for: GISDECO 2004 Skudai, Johor, Malaysia, 10-12 May (2004)
5. Quan, Julian, Oudwater, Nicoliene, Pender, Judith and Martin, Adrienne (2001)*GIS And Participatory Approaches In Natural Resources Research*. SOCIO-ECONOMIC METHODOLOGIES FOR NATURAL RESOURCES RESEARCH BEST PRACTICE GUIDELINES. Published by Natural Resources Institute, The University of Greenwich 2001
6. Minang, Peter A. and McCall, Michael K. (2006) Participatory GIS and local knowledge enhancement for community carbon forestry planning: an example from Cameroon. Participatory Learning And Action.

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER III

ELECTIVE
Course Title: Participatory GIS (Practical)
Course Code: GEG-SE3
Marks: 25
Credits: 1
Duration: 15 Sessions of 2 hour each
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Course Objectives: The basic objective of this practical course is to equip students with skills to calculate various indices and practically apply it in case studies.
Learning outcome: This practical course helps in developing skills by which students will practically carry on field studies.

Unit	Title	Practical Sessions
1	Data processing and computing indices Linear Model & Linear Combination Method (LCM) Assessment Index (AI) Employment index (M) Education index (E) Health index (S) Housing index (H) Infrastructure index The Principal Component Analysis Method (PCAM) Marginality Index (MI) Human Development Index	5
2	Case study of any one of the following (mini project) Water Resource Inventory Urban and Peri-Urban Agriculture Forest and Water Resources Management Using software like GRASS (Geographic Resources Analysis Support System) and ILWIS (Integrated Land and Water Information System)	10
3	Project report	-

References:

1. Françoise Orban-Ferauge V.Aguilar, E. Alarcon, A. Carmona, N. Daix, B. Denil, A. Ignacio, J. Martinez, M. McCall, G.Miscione, E. Olivarez, M. Pandan. G. Rambaldi, R. Teruel, J. Verplanke participatory geographic information systems and land planning life experiences for people empowerment and community transformation , Technical Centre for Agricultural and Rural Cooperation ACP-EU (CTA) Wageningen, The Netherlands

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER III

ELECTIVE
Course Title: Applied GIS (Theory)
Course Code: GEG-SE4
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
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Course Objectives: This Course introduces various recent application of GIS in business, society, transportation and spatial planning.

Learning outcomes: At the end of this course students will be able to correlate acknowledge of GIS in the day to days life problems.

Unit	Title	No. of hours
I	**Geobusiness** Retail Application of Spatial Modelling to Solve: Retail Location Problems, Location Based Services for Mobile Applications Mass Appraisal Model, Lifestyle Segmentation Profiles, Neighbourhood Model, Housing Price Mass Appraisal Model.	15
II	**Social Application**: Assessing Clusters of Deprivation in City Regions, GIS for Joined up Government Spatial Statistical Methods to the Detection of Geographical Patterns of Crime **Transport and Location**: Demand Responsive Passenger Transport Services, Strategic Land Use / Transportation Model, Relocation of Facilities. Probability Based GIS Model.	15
III	**Spatial Planning** Modelling Migration, Modeling Regional Economic Growth, Carrying Capacity, Planning Network of Site, Assessing Service Provision,	15
		45

References

1. Abbot, J., Chambers, R., Dunn, C., Harris, T., Merode, E. d., Porter, G., Townsend, J.,Weiner, D., de Merode, E., (1998). 'Participatory GIS: opportunity or oxymoron?' PLA Notes33. IIED: Londo
2. Elwood, Sarah (2006) Participatory GIS and Community Planning: Restructuring Technologies, Social Processes, and Future Research in PPGIS Collaborative Geographic Information Systems edited by Shivanand Balram and Suzana Dragicevic, Idea Group Inc. University of Arizona, USA
3. Elwood, Sarah (2006), Critical Issues in Participatory GIS: Deconstructions, Reconstructions, and New Research Directions Transactions in GIS, 10(5): 693–708
4. McCall, Michael K. (2004) Can Participatory-GIS Strengthen Local-level Spatial Planning? Suggestions for Better Practice. Dept. of Urban & Regional Planning and GeoInformation Management ITC. Course prepared for: GISDECO 2004 Skudai, Johor, Malaysia, 10-12 May (2004)
5. Quan, Julian, Oudwater, Nicoliene, Pender, Judith and Martin, Adrienne (2001)*GIS And Participatory Approaches In Natural Resources Research*. SOCIO-ECONOMIC METHODOLOGIES FOR NATURAL RESOURCES RESEARCH BEST PRACTICE GUIDELINES. Published by Natural Resources Institute, The University of Greenwich 2001
6. Minang, Peter A. and McCall, Michael K. (2006) Participatory GIS and local knowledge enhancement for community carbon forestry planning: an example from Cameroon. Participatory Learning And Action.
7. Stillwell, John and Clarke, Graham (2004) Applied GIS and Spatial Analysis (Ed). John Willy and Sons LTD England

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER III

ELECTIVE
Course Title: Applied GIS (practical)
Course Code: GEG-SE4
Marks: 25
Credits: 1
Duration: 15 Sessions of 2 hour each
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Course Objectives: The basic objective of this practical course is to equip students with skills to apply GIS skills various issues through spatial modeling and analytical tools.
Learning outcome: This practical course helps in developing skills by which students will be able to under undertake various local problems and suggest realistic spatial solution to it.

Unit	Title	Practical Sessions
1	Spatial Modelling: Land Use transformation model and Transportation Model, Neighboring Model (NNI)	8
2	Spatial Statistic: Cluster Analysis, Crime Pattern Analysis, Mass Appraisal	7
3	Journal	-

References :

1. John Stillwell and Graham Clarke (2004) Applied GIS and Spatial Analysis (Ed). John Willy and Sons Ltd. England
2. Markus Neteler and Helena Mitasova (2008) OPEN SOURCE GIS, A GRASS GIS Approach (Third Edition) Springer, USA
3. McCartney Taylor, Nik Freeman (2014) Getting Started With GIS Using QGIS (Kindle Edition) McCartney Taylor.

Sample Data source
1. https://grass.osgeo.org/download/sample-data/
2. http://grassbook.org/datasets/datasets-3rd-edition/
3. http://www.qgis.org/en/site/

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER IV
REVISED AS ON 7TH APRIL 2018

CORE
Course Title: Fundamentals of Geomorphology (Theory)
Course Code: GEG-IV.SC6
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each

Course Objectives: The Course provides the fundamentals of geomorphology. It also focuses on application of geomorphological knowledge to resolve the challenging issues of man environment relationships.

Learning Outcomes: At the end of this course, students will be familiar with fundamentals of geomorphology and learn the techniques of application of geomorphological knowledge to solve the challenging issues of man environmental relationships.

Unit	Title	No. of hours
I.	Geomorphic concept : major geomorphic concept	18
II.	Slope development theory. Davis and Penck. Aeolian landforms: Erosional & Depositional. Glacial Landforms: Erosional and Depositions	12
III.	Application of Geomorphology: • Mining • Hazard management • Agriculture • Environmental management	15
		45

References:

1. Ahmed, E., 2005 : Geomorphology , Kalyan Publishers, New Delhi
2. Bloom, Arthur L., 2004: Geomorphology – A systematic Analysis of Late Cenozoic Landforms, Prentice Hall, engle Wood Cliff, N.J
3. Chorley, Richard J., 2002: Spatial Analysis in Geomorphology, Harper and Row Publishers, New York, London.
4. Cooke R. U. and Doornkamp J.C. (1989): Geomorphology in Environmental Management, 2nd Edition, Oxford : Clarendon Press
5. Dayal, P. (2nd edition) 2006 A Textbook of Geomorphology, Shukla Book Depot, Patna
6. Sharma, H.S. (ed), 2002: Perspective in Geomorphology, Vol. I & Vol. IV, Concept, New Delhi.
7. Sharma, V.K., 2006 : Geomorphology, Earth Surface Processes and Forms, Tata Mc. Graw Hill, New Delhi
8. Sharma, V.K., 2006 : Geomorphology, Earth Surface, Process and forms, Tata McGraw Hill, New York
9. Singh, S: Physical Geography, Pustak BHawan, Allahabad, 2005
10. Sparks, B.W., 2000: Geomorphology, Longman, London, 2nd edition.
11. Strahler, A.N .: Physical Geography, 3rd Ed., Wiley, 2006
12. Thornbury W.D, 2001: Principles of Geomorphology , 2nd Ed., Wiley International edition, Wiley Eastern Reprint, 2001
13. Wooldridge, S.W. and Morgan, R.S., 2000: The Physical Basis of Geography, Longman.
14. Worcestor, P.G., 2005: A textbook of Geomorphology, Van Nostrand, 2nd Ed., East west Edition, New Delhi

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER IV

CORE
Course Title: Fundamentals of Geomorphology (Practical)
Course Code: GEG-IV.SC6
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hour each

Course Objectives: The Course provides the skills in rock identification and their uses. strategies to the challenging issues of man environment relationships.

Learning Outcomes: At the end of this course, students will be familiar with the skills of identification and application of geomorphology and the techniques of application of geomorphological knowledge to solve the challenging issues of man environmental relationships.

Unit	Title	Practical sessions
I.	Identification of rocks and their properties Soil profile, Soil analysis and their application	9
II.	Interpretation of geological map, identifications of faults, lineaments, dykes and sills, rock types Identification of Aeolian and Glacial Landforms	6
III.	Journal and viva voce	
		15

References:

1. Ahmed, E., 2005 : Geomorphology , Kalyan Publishers, New Delhi
2. Bloom, Arthur L., 2004: Geomorphology – A systematic Analysis of Late Cenozoic Landforms, Prentice Hall, engle Wood Cliff, N.J
3. Chorley, Richard J., 2002: Spatial Analysis in Geomorphology, Harper and Row Publishers, New York, London.
4. Dayal, P. (2nd edition) 2006 A Textbook of Geomorphology, Shukla Book Depot, Patna
5. Sharma, V.K., 2006 : Geomorphology, Earth Surface, Process and forms, Tata McGraw Hill, New York
6. Singh, S: Physical Geography, Pustak BHawan, Allahabad, 2005
7. Strahler, A.N .: Physical Geography, 3rd Ed., wiley, 2006
8. Thornbury W.D, 2001: Principles of Geomorphology , 2nd Ed., Wiley International edition, Wiley Eastern Reprint, 2001
9. Sharma, H.S. (ed), 2002: Perspective in Geomorphology, Vol. I & Vol. IV, Concept, New Delhi.
10. Sharma, V.K., 2006 : Geomorphology, Earth Surface Processes and Forms, Tata Mc. Graw Hill, New Delhi
11. Sparks, B.W., 2000: Geomorphology, Longman, London, 2nd edition.
12. Wooldridge, S.W. and Morgan, R.S., 2000: The Physical Basis of Geography, Longman.
13. Worcestor, P.G., 2005: A textbook of Geomorphology, Van Nostrand, 2nd Ed., East west Edition, New Delhi

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER IV

ELECTIVE
Course Title: Coastal Geomorphology (Theory)
Course Code: GEG-SE5
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each

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Course Objectives: The basic objective of this course is to familiarize students about the mechanism of landform development resulting from coastal processes.

Learning outcomes: At the end of this course, students are expected to have an understanding of the various processes and associated landforms in coastal regions. Besides learn the methods of coastal hazard management

Unit	Title	No. of hours
I	Introduction to coastal Processes Waves: Formation, Drifts and Tides. Types of coastlines, Coastal erosion and deposition. Costal landforms.	15
II	Beach Geomorphology: Types and Configuration of beaches Coastal wetlands. Coral reefs and marine environment.	15
III	Coastal Ecosystem Management. Coastal Hazard Management.	15
		45

References

1. Cooke R. U. and Doornkamp J.C. (1989): Geomorphology in Environmental Management, 2nd Edition, Oxford : Clarendon Press
2. Eric Bird: Coastal Geomorphology: An Introduction, John Wiley & Sons; 1 edition (November 7, 2000),
3. Gerhard Masselink , Michael Hughes :An Introduction to Coastal Processes and Geomorphology (Hodder Arnold Publication), ISBN-10: 0340764112 , ISBN-13: 978-0340764114
4. Kale, V. S. and Gupta, A. (Rep.2011): Introduction to Geomorphology, Orient Longman, Calcutta.
5. Karlekar, S. (2009): Coastal Processes and Landforms: Diamond Publications, Pune
6. Richard Davis Jr. , Duncan Fitzgerald : Beaches and Coasts, Wiley-Blackwell; 1st edition (July 15, 2004), ISBN-10: 0632043083 , ISBN-13: 978-0632043088
7. Timothy Beatley , Anna K. Schwab , David Brower (2002):An Introduction to Coastal Zone Management, Island Press; REV edition

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER IV

ELECTIVE
Course Title: Practicals in Coastal Geomorphology
Course Code: GEG-SE5
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each

Course Objectives: To develop the skills of identification and interpretation of coastal landforms and processes.

Learning outcome: At the end of the course students are expected to independently prepare geographic map and interpret coastal landscape. Besides they should be able to carry out beach profiling using instruments**.**

Unit	Title	Practical sessions
1	Identification of coastal features and processes on SOI toposheet.	05
2	Beach profiling & identification of major and minor coastal features on beach. Profile of various types of coast. Geomorphic mapping of Coastal Areas.	10
3	Journal and Viva	
		15

References

1. Bygot, J.: An Introduction to Map Work and Practical Geography, 2001
2. Campbell, J., 2004: Introductory Cartography, Printice Hall, Inc Englewood
4. Jackson, R.H. and Hudmar, L.E.: Regional Geography: Issues for today ,2001
5. Misra, R.P. and Ramesh, A., 2005: Fundamentals of Cartography, Concept Pub. Co., New Delhi
6. Monkhouse, I.J. and Wilkinson, H.R., 2001: Maps and Diagram, B.I. Publication, New Delhi
7. Raisz, E.: General Cartography, McGraw Hills Co., London ,2005
8. Robinson, A.H., et al,: Elements of Cartography, John Wiley and Sons, New York,2003
9. Singh, R.L.: Elements of Practical Geography, Kalyani Publishers, New Delhi ,2000
10. Singh, R ; Singh L.R., Mapworks in Practical Geography,Central book Depot, Allahabad,2001

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER IV

ELECTIVE
Course Title: Fluvial Geomorphology (Theory)
Course Code: GEG-SE6
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each

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Course Objectives: The Rivers being a major agent of erosion, the course assumes significance as it mainly deals with fluvial forms and processes.

Learning outcomes: At the end of this course, students are expected to have an understanding of the fundamental concepts of river and its processes.

Unit	Title	No. of hours
I	River basin and Drainage Network: River and Stream, Drainage basin and network characteristics, River Dynamics, Classification, Phases of development, Patterns.	15
II	Fluvial processes: Erosion, Transportation and Deposition. Fluvial cycle and Fluvial landforms.	15
III	Applied fluvial geomorphology: Environmental changes and river metamorphosis. Flood and its impact(case studies)	15
		45

Reference Books:

1. Chorley, R. J., Schumm, S. A. and Sugden, D. E. (1984): Geomorphology, Methuen, London.
2. Fairbridge, R. W. (1968): Encyclopedia of Geomorphology, Reinholdts, New York.
3. Goudie, Andrew, S. (2004), Encyclopedia of Geomorphology, 1& 2, Routledge, Taylor & Francis, New York
4. Kale, V. S. and Gupta, A. (Rep.2011): Introduction to Geomorphology, Orient Longman, Calcutta.
5. Luna Bergere Leopold, Markley Gordon Wolman, John P. Miller (1995): Fluvial Processes in Geomorphology. Dover Publications Inc., New York
6. R.J. Small (1989)Geomorphology and Hydrology (Longman modular geography series), Longman Publication, Harlow, Essex, England
7. Singh, Savindra (Rep. 2011): Geomorphology, Prayag Pustak Bhawan, Allahabad
8. Strahler A. H and Strahler, A. N. (1992) : Modern Physical Geography, John Wiley, New York
9. Thomas, S.G. David, (2016) The Dictionary of Physical Geography, 4th Edition, Wiley-Blackwell, New Jersey, USA
10. Thornbury, W. D. (Rep.2011): Principles of Geomorphology, John Wiley and Sons, New York.

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER IV

ELECTIVE
Course Title: Practicals in Fluvial Geomorphology
Course Code: GEG-SE6
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
==

Course Objectives: To develop the skills of river morphometry analysis, river profiling, fluvial processes.

Learning outcome: At the end of the course student are expected to independently prepare drainage map and interpret fluvial landscape. Besides they should be able to carry out river profiling using instruments**.**

Unit	Title	Practical sessions
1	Preparation of drainage map. Identification and Interpretation of fluvial landforms, Patterns and processes from SOI toposheet. Slope analysis.	05
2	Drainage basin morphometry: Morphometric analysis of drainage basin. Field visit : river Profiling and to observe fluvial processes	10
3	Journal and Viva	
		15

References

1. Bygot, J.: An Introduction to Map Work and Practical Geography,2001
2. Campbell, J., 2004: Introductory Cartography, Printice Hall, Inc Englewood
3. Misra, R.P. and Ramesh, A., 2005: Fundamentals of Cartography, Concept Pub. Co., New Delhi
4. Monkhouse, I.J. and Wilkinson, H.R., 2001: Maps and Diagram, B.I. Publication, New Delhi
5. Raisz, E.: General Cartography, McGraw Hills Co., London ,2005
6. Robinson, A.H., et al,: Elements of Cartography, John Wiley and Sons, New York,2003
7. Singh, R.L.: Elements of Practical Geography, Kalyani Publishers, New Delhi ,2000
8. Singh, R ; Singh L.R., Mapworks in Practical Geography,Central book Depot, Allahabad,2001

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER IV

ELECTIVE
Course title: Watershed Management (Theory)
Course Code: GEG-SE7
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each

Course Objective: The objective of this course is to acquaint students with basic concepts and importance of Watershed Management. This course will also help students in understanding various processes that take place and that are involved in a watershed.

Learning outcomes: At the end of this course, students are expected to have a holistic understanding of Watershed Management. It will help them to develop a process-based understanding of how land surface characteristics will affect fluxes of mass and energy within a watershed.

Unit	Title	No. of hours
I	Introduction to Watershed Management : Definition, Principles, objectives, Need of Watershed Management, Identification of problems in Watershed Management	15
II	Characteristics of watershed Runoff, River discharge Sediment load	15
III	Hydrological Process in Watershed : Ecological Characteristics of the river Soil management techniques in watershed Watershed Conservation methods.	15
		45

REFERENCES:

- Manual of water and soil conservation: Government of India, ICAR
- Manuals of the USDA

1. DeBarry. A. Paul, 2004, Watersheds : Processes, Assessment, and Management, Hoboken, N.J. : John Wiley & Sons, New Jersey
2. Heathcote. W. Isobel , 2009, Integrated Watershed Management : Principles and Practice, 2nd Edition, Hoboken, N.J. : John Wiley & Sons, New Jersey
3. National Watershed Program Manual, The U.S. Department of Agriculture (USDA), Washington, D.C, December, 2009
4. Narayana, V.V. Dhruva, 2002, Soil and water conservation research in India, Published by ICAR, New Delhi
5. Singh Rajvir, 2003, Watershed Planning and Management, 2nd Edition, Yash Publishing House, Bikaner, India

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER IV

ELECTIVE
Course title: Practicals in Watershed Management
Course Code: GEG-SE7
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each

Course Objective: The objective of this practical is to acquaint students with basic concepts and importance of Watershed Management. This practical will also help students in understanding various processes that take place and that are involved in a watershed.

Learning outcomes: At the end of this practical, students are expected to have a holistic understanding of Watershed Management as it will help them to develop a process-based understanding of how land surface characteristics will affect fluxes of mass and energy within a watershed, so that science-based management principles may be effectively applied to watershed systems.

Unit	Title	Practical Sessions
I	Sediment load analysis	5
II	Measurement and Estimation of Soil Erosion – Revised Universal Soil Loss Equation (RUSLE). Field Visit and Report: visit to watershed (Identification of problems of watershed, soil and water management) Survey, Database Generation.	10
III	Journal and Viva-voce	
		15

REFERENCES:

1. DeBarry. A. Paul, 2004, Watersheds : Processes, Assessment, and Management, Hoboken, N.J. : John Wiley & Sons, New Jersey
2. Heathcote. W. Isobel , 2009, Integrated Watershed Management : Principles and Practice, 2nd Edition, Hoboken, N.J. : John Wiley & Sons, New Jersey
3. National Watershed Program Manual, The U.S. Department of Agriculture (USDA), Washington, D.C, December, 2009
4. Narayana, V.V. Dhruva, 2002, Soil and water conservation research in India, Published by ICAR, New Delhi
5. Singh Rajvir, 2003, Watershed Planning and Management, 2nd Edition, Yash Publishing House, Bikaner, India

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER IV

ELECTIVE
Course title: Biogeography (Theory)
Course Code: GEG-SE8
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each

Course Objectives: Biogeography deals with spatial and temporal patterns of biological diversity and the factors that govern the distribution and abundance .

Learning Outcomes: At the end of this course, students will be familiar with fundamentals of biogeography.

Unit	Title	No. of hours
I.	Concept of Biogeography. Historical evolution of Biogeography. Global patterns of Biodiversity.	18
II.	Niche. Speciation and extinction. Accident and invasion. Endemism, vicariance and conservation. Island biogeography. Zoogeography and its Environmental Relationship. Palaeo botanical and Palaeo Climatological records of environmental change.	10
III.	Biodiversity hotspots. Forest communities and their distribution. Conservation- laws and practices. Social Movements of conservation.	17
		45

References:

1. Bhattacharyya, N.N.: Biogeography, Rajesh Publications, New Delhi.
2. Husain, M. (ed)., 1994: Biogeography(Part I & II), Anmol Publications, Pvt. Ltd., New Delhi.
3. Newbigin, M.I., 1939: Plants and Animal Geography.
4. Singh, Savindra, 2010: Biogeography, Prayag Pustak Bhawan, Allahabad.
5. Tiby, 1982: Biogeography, Longman, London.
6. Walts, D., 1971: The Principles of Biogeography, Mc. Graw Hill, London.

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER IV

ELECTIVE
Course title: Practicals in Biogeography
Course Code: GEG-SE8
Marks: 25
Credits: 1
Duration: 15 Sessions of 2 hrs each

Course Objectives: Biogeography deals with spatial and temporal patterns of biological diversity and the factors that govern the distribution and abundance .

Learning Outcomes: At the end of this course, students will be familiar with fundamentals of biogeography .

Unit	Title	Practical Sessions
I.	Vegetation Map interpretation Biodiversity indexing Biomass analysis Canopy structure Stock analysis	07
II.	NDVI Density of tree Plant tress analysis Disturbance analysis	08
III.	Journal and viva voce	
		15

References:

1. Bhattacharya, N.N.: Biogeography, Rajesh Publications, New Delhi Husain, M. (ed)., 1994: Biogeography(Part I & II), Anmol Publications, Pvt. Ltd., New Delhi.
2. Newbigin, M.I., 1939: Plants and Animal Geography.
3. Singh, Savindra, 2010: Biogeography, Prayag Pustak Bhawan, Allahabad.
4. Tiby, 1982: Biogeography, Longman, London.
5. Walts, D., 1971: The Principles of Biogeography, Mc. Graw Hill, London.

Parvatibai Chowgule College of Arts and Science
(Autonomous)
DEPARTMENT OF GEOGRAPHY
COURSE STRUCTURE
THREE YEAR B.Sc. DEGREE COURSE IN GEOGRAPHY

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	GEG-I.SC1: Introduction to Geography	GEG-I.SC2: Fundamentals of Physical Geography				
	GEG-I.SC1: Measurement Systems in Geography (Practical)	GEG-I.SC-2: Practicals in Physical Geography (Practical)				
II	GEG-II.SC3: Basics of Human Geography	GEG-II.SC4: Basics of Regional Geography				
	GEG-II.SC3: Practicals in Human Geography (Practicals)	GEG-II.SC4: Practicals in Regional Geography (Practicals)				
III	GEG-III.SC5: Fundamentals of Remote Sensing and GIS		GEG-SE1: Spatial Analysis	GEG-SE2: Raster and Vector Data Models in GIS	GEG-SE3: Participatory GIS	GEG-SE4: Applied GIS
IV	GEG-IV.SC6: Fundamentals of Geomorphology		GEG-SE5: Coastal Geomorphology	GEG-SE6: Fluvial Geomorphology	GEG-SE7: Watershed Management	GEG-SE8: Biogeography
V	GEG-V.SC7: Introduction to Climatology		GEG-SE9: Geography of Soil Studies	GEG-SE10: Agro-Meteorology: Principles and Applications	GEG-SE-11: Field Survey in Physical Geography	GEG-SE12: Quantitative Techniques in Geography
VI	GEG-VI.SC8: Ecology and Terrestrial Environment		GEG-SE13: Remote Sensing and Forest Ecology	GEG-SE14: Advanced Coastal Geomorphology	GEG-SE15: Ecology of Estuarine Environment	GEG-SE16: Disaster Management: Urban and Coastal

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER V

CORE
Course Title: Introduction to Climatology (THEORY)
Course Code: GEG-V. SC-7
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
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Course Objectives: The focus of this Course is to introduce key concepts of climatology in general and Indian monsoon in details.

Learning outcomes: On completion of this course students will able to understand and apply the concepts in analyzing and applying climatological concepts.

Unit	Title	No. of hours
I	**Fundamental of Atmospheric circulation** Primary, secondary and tertiary circulation	15
II	**Atmospheric disturbances:** Thermodynamics CAPE and CINE- cloud development and stability, thunderstorm Cyclogenesis – T number (basics of cyclones) Western disturbances, fog, cold waves **Koppens Classification of climate**	15
III	**Indian Climatology: Monsoons** **Pre monsoon:** Cyclone genesis, Cyclonic storms, frequency, intensity, landfall and associated weather. **South West monsoon:** Onset and advance of southwest monsoon, Semi-permanent features of monsoon, active and break in monsoon. El-Nino and La-Nina. **Post monsoon:** withdrawal of southwest monsoon, Northeast monsoon, cyclonic storms in the Indian seas, trends in cyclonic disturbances, Easterly waves.	15
		45

REFERENCES

1. Barry R.G. and Chorley, R. J., 2009: Atmosphere, Weather and Climate, Routledge
2. Bunnett R.B. , 1993: Physical geography in Diagrams, Longman
3. Critchfield, H.J, 1998 : General Climatology, Prentice-Hall
4. Lal, D.S., 2011: Climatology, Sharda Pustak Bhavan
5. Monkhouse, F.J., 1975 – Principles of Physical Geography , Hodder Murray Publishers
6. P. Birot, 1966: General Physical Geography, Longman, Green & Co
7. Strahler, A.H., 1983: Modern Physical Geography, John Wiley and Sons
8. Strahler A. M. and Strahler A.H., 1983: Elements of Physical Geography, John Wiley and Sons
9. Stringer, E.T., 1972: Foundation of Climatology: An Introduction to Physical, Dynamic, Synoptic, and Geographical Climatology, W.H. Freeman & Co. Ltd.
10. Tikka - R.N., 1998 - Physical Geography. Kedar Nath Ram Nath, Meerut
11. Trewartha, G.T., 1968: Introduction to Climate, McGraw-Hill

CORE
Course Title: Introduction to Climatology (PRACTICAL)
Course Code: GEG-V. SC-7
Marks: 25
Credits: 01
Duration: 15 sessions of 2 hours each
==

Course Objectives: The objective of this course is to provide basic practical tools in understanding weather and climate.

Learning outcome: At the end of this course, students will be able interpret and analyze weather and climatic phenomena.

Unit	Title	Practical sessions
I	Representation of weather phenomena using isolines Isohyets map Isotherm map Isobars Representation of wind data Evapotranspiration Determining atmospheric stability (Tephigram) Preparation of weather Station Model. Upper air chart, isotach (wind)	05
II	• Study of weather symbols and IMD weather charts. Interpretation of IMD weather charts (at least 1 map of three seasons) • Visit to IMD for hands- on- training: handling of weather instruments, taking readings, temperature, pressure, sunshine chart interpretation and forecasting.	10
	Journal and Viva	
		15

References

1. Campbell, J. (2004), Introductory Cartography, Prentice Hall, Inc Englewood
2. Chorley, Richard. J. (ed.), 2001: Water, Earth and Man, Methuen & Co., London
3. Khullar.D.R. (2007), Essentials of Practical Geography, New Academic Publishing Co.,Jalandher
4. Misra, R.P. and Ramesh, A., 2009: Fundamentals of Cartography, Concept Publishing Co., New Delhi
5. Monkhouse, F.J. and Wilkinson, H.R., 2009: Maps and Diagrams, B.I. Publications Pvt. Ltd., New Delhi
6. Sarkar, Ashis (2000), Practical Geography: A Systematic Approach, Orient Longman Pvt. Ltd., Kolkata
7. Singh, R.L. and Singh Rana P.B., 2008, Elements of Practical Geography, Kalyani Publishers, New Delhi
8. Singh, R.L. and Singh Rana P.B.(2008), Elements of Practical Geography, Kalyani Publishers, New Delhi
9. Strahler, A.N., 2000: Physical Geography, 3rd Ed., Wiley.

ELECTIVE
Course Title: Geography of Soil Studies (THEORY)
Course Code: GEG-V.SE-9
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each

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Course Objectives: This is a basic course that focuses on understanding of soil formation, development and distribution. They will also be equipped with basics of soil structure, composition, content and conservation practices.

Learning outcomes: On completion of this course, the students will be able to identify and differentiate between various soil~~s~~ profiles and types

This will develop understanding amongst students how different types of soil formations, characteristics and importance in agricultural practices.

Unit	Topic	No. of hours
I	**Introduction to soil:** Concept , soil formation Soil water dynamic, Factors affecting soil formation. Soil structure, composition Soil profile, Texture	15
II	**Soil and organisms** - Organic matter of soil, Sources of organic matter – Biomass, Termites, worms, ants, algae, fungi, bacteria…, Carbon cycle – simple decomposition, Agricultural importance of soils - Nitrogen fixation	15
III	**Soil Conservation and management** Soil erosion, degradation and pollution, its sources and impacts : Soil conservation and management practices traditional and modern Case studies	15

References:

1. Brady Nyle. (2002). The nature and properties of soil. MacMillan Publishing company, USA
2. Foth Henry. (1984). Fundamentals of soil science. John Wiley & Sons, Inc. USA
3. Munns Donald and Singer Michael. (1996). Soils – An introduction. Prentice-Hall Inc, New Jersey, USA
4. Lal R and Stewart B.A. (1990). Advances in soil sciences. Springer-Verlag New York.
5. White Robert. (2005). Principles and Practice of Soil Science: The Soil as a Natural Resource, 4th Edition. Wiley & Sons, Inc – Blackwell. USA

ELECTIVE
Course Title: Geography of Soil Studies (PRACTICAL)
Course Code: GEG-V.SE-9
Marks: 25
Credits: 1
Duration: 15 Sessions of 2 hours each
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Course Objectives: This is a basic practical course in soil studies that give emphasis on lab analysis of soil sample to understand the various properties of soil sample.

Learning outcomes: On completion of this course, the students will be able test the soil properties and quality of collected soil samples using various instruments and prepare lab reports.

Unit	Topic	Practical sessions
I	Field visit: pre field, fieldwork and post fieldwork Sample preparation **Soil Test (physical)** 1. Moisture content calculation 2. Texture analysis 3. EC	10
II	**Soil Test (chemical)** 1. Soil pH levels 2. NPK level testing **3.** Carbon testing	05
	Journal and Viva	
		15

Reference:

1. Brady Nyle. (2002). The nature and properties of soil. MacMillan Publishing company, USA
2. Foth Henry. (1984). Fundamentals of soil science. John Wiley & Sons, Inc. USA
3. George Estefanm, Rolf Sommer, and John Ryan. (2013) Methods of Soil, Plant, and Water Analysis: A manual for the West Asia and North Africa region. Beirut, Lebanon
4. Head K.H. (1994). Manual of soil laboratory testing. John Wiley & Sons, Inc. USA
5. Munns Donald and Singer Michael. (1996). Soils – An introduction. Prentice-Hall Inc, New Jersey, USA

ELECTIVE
Course Title: Agrometeorology: Principles and Applications (THEORY)
Course Code: GEG-V.SE-10
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
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Course Objectives: This is a basic course that focuses on agrometeorology and its application in agriculture. This will help students to develop understanding of the physical and human interventions that affect agricultural systems and management practices.

Learning outcomes: On completion of this course, the students will be able to understand the role of climate in agricultural productivity. They will be exposed to use of geospatial technology in monitoring agricultural systems especially in the context of climate change.

Unit	Title	No. of hours
I	**Agrometeorology:** Perspectives and Applications: Definition and scope and development. **Solar Radiation and Its Role in Plant Growth:** The Source of Energy, Laws of Radiation, Earth's Annual Global Mean Radiative Energy Budget, Solar Radiation and Crop Plants, Solar Radiation Interception by Plants, Photosynthetically Active Radiation (PAR), Solar Radiation Use Efficiency **Environmental Temperature and Crop Production:** Soil and Air Temperature, Plant Injury Due to Sudden Changes in Temperature, Frost: Damage and Control, Thermoperiodism, Temperature As a Measure of Plant Growth and Development.	15
II	**Climatological Methods for Managing Farm Water Resources**- Water for Crop Production, Making Effective Use of Rainfall, Evaporation and Evapotranspiration, Water Use and Loss in Irrigation. Climatological Information in Improving Water-Use Efficiency (WUE), Reducing Water Losses from Reservoirs, **Drought Monitoring and Planning for Mitigation:** water budgeting, irrigation scheduling, Drought Monitoring and Planning for Mitigation. **Climate, Crop Pests:** Role of Weather and Climate, Some Important Insect Pests of Crop Plant.	15
III	Remote-Sensing Applications in Agrometeorology**.** Computer Models in Managing Agricultural Systems, Agro-climatological Services, Using Climate Information to Improve Agricultural Systems, Climate Change and Its Impact on Agriculture.	15
		45

REFERENCES

1. Grigg, David (2005) An Introduction to Agricultural Geography (2nd Ed), Routeledge, London and New York
2. G. Kathiresan (2015) Agrometeorology: A Simplified Textbook. New India Publishing Agency
3. G.S. Mahi & P.K. Kingra (2014): Fundamentals of Agrometeorology. Kalyani Publishers
4. Harpal S. Mavi and Graeme J.,Tupper (2004), Agrometeorology Principles and Applications of Climate Studies in Agriculture. The Haworth Press, Inc., Binghamton, NY.
5. Mavi H S (2003): Introduction To Agrometeorology. Oxford & Ibh
6. Rao and Prasada (2008) Agricultural Meteorology. PHI Learning PVT. LTD., New Delhi
7. Seemann, Jochen, Chirkov, Y. I., Lomas, J., Primault, B. (2012): Agrometeorology. Springer-Verlag Berlin and Heidelberg GmbH & Co. KG
8. SR Reddy & D.S. Reddy (2014) Agrometeorology. Kalyani Publishers
9. S. Venkatraman (2015): Principles and Practice of Agricultural Meterology. BS Publications.
10. WMO (2011), Agricultural Meteorology Guide to Climatological Practices World Meteorological Organization, Geneva.

ELECTIVE
Course Title: Agrometeorology: Principles and Applications (PRACTICAL)
Course Code: GEG-V.SE-10
Marks: 25
Credits: 01
Duration: 15 sessions of 2 hours each
==

Course Objectives: This course enables student to understand the role of insolation, rainfall, evapotranspiration in crop growth and development. The students will learn techniques of measurement in agrometrology.

Learning outcomes: On completion of this course, the students will able to independently analyze the interaction of solar radiation, temperature, rainfall, evapotranspiration using metrological and remotely sensed data.

Unit	Title	Practical sessions
I	Green leaf response to Electro Magnetic Radiation Photosynthetically Active Radiation (PAR) Solar radiation use efficiency Temperature and crop growth	07
II	Measurement of effective rainfall(using Huggins and Kassam water balance approach) Water balance, Measurement of evaporation and calculation of evapotranspiration irrigation scheduling for crops Analyzing the water deficiency (drought) , drought index Use of thermal data in drought monitoring	08
	Journal and Viva	
		15

References

1. Don Ankerman; Richard Large (2013) Agronomy Handbook. Midwest Laboratories Inc., OMAHA, NE
2. Harpal S. Mavi and Graeme J. Tupper (2004), Agrometeorology Principles and Applications of Climate Studies in Agriculture, The Haworth Press, Inc., Binghamton, NY.
3. Indian Council of Agricultural Research (2011) Handbook of Agriculture, Indian Council of Agricultural Research
4. Rao and Prasada (2008) Agricultural Meteorology. PHI Learning PVT. LTD., New Delhi
5. WMO (2011), Agricultural Meteorology Guide to Climatological Practices World Meteorological Organization, Geneva.

ELECTIVE
Course Title: Field Survey in Physical Geography (THEORY)
Course Code: GEG-V.SE-11
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==

Course Objectives: The primary aim of this Course to introduce various surveying instrument used in Physical Geography. Students will learn the operation and the application of the instruments and methods of surveying.

Learning outcomes: At the end of this course students will be able to understand functions and applications of dumpy level, Plane table and Global Positioning Systems (GPS) in field based studies.

Unit.	Topic	No. of hours
I	Significance and Methods of Survey; Classification of Surveying; Fundamentals of Plane Table Survey: a) Radiation Method b) Intersection Method Pre survey work: Safety Measures, Field Book Preparation, Literature Survey, Sharing Responsibilities and Plan of Action Post field survey work: Data Processing Methods, Analysis, Mapping and Report Writing.	15
II	Dumpy level surveying : meaning, functioning elements, applications and Methods(Rise-fall and Collimation method) Profile drawing: Beach and River. Beach and River Morphology. Observation of slope, river and coastal morphology on toposheet. Pre survey and Post survey tasks.	15
III	GPS survey: Meaning, Space Segment, Ground Segment and GPS Receivers, Applications.	15
		45

REFERENCES

1. Campbell, J. (2004), Introductory Cartography, Prentice Hall, Inc Englewood
2. Khullar.D.R. (2007), Essentials of Practical Geography, New Academic Publishing Co.,Jalandher
3. Misra, R.P. and Ramesh, A. (2005), Fundamentals of Cartography, Concept Pub. Co., New Delhi
4. Monkhouse, I.J. and Wilkinson, H.R. (2009), Maps and Diagram, B.I. Publication, New Delhi
5. Sarkar, Ashis (2000), Practical Geography: A Systematic Approach, Orient Longman Pvt. Ltd., Kolkata
6. Singh, R.L. and Singh Rana P.B.(2008), Elements of Practical Geography, Kalyani Publishers, New Delhi

ELECTIVE
Course Title: Field Survey in Physical Geography (PRACTICAL)
Course Code: GEG-V.SE-11
Marks: 25
Credits:1
Duration: 15 Sessions of 2 hours each
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Course Objectives: The main objective of this course is to provide hands-on training in Plane Table, Dumpy Level and GPS survey.
Learning outcome: At the end of this course, students will be able to independently handle survey instruments and prepare maps and field reports.

Unit	Topic	Practical sessions
I	Plane table survey: a) Radiation Method :2 Exercises B) Intersection Method: 2 Exercises	07
II	Dumpy Level Survey: Rise-Fall and Collimation Method GPS Survey: Use of GPS in Mapping And Location Observation Of Slope, River and Coastal Morphology on Field	08
	Journal /Field report	
		15

References

1. Campbell J. (2004), Introductory Cartography, Printice Hall, Inc Englewood
2. Khullar.D.R (2007), Essentials of Practical Geography, New Academic Publishing Co. Jalandher
3. Misra, R.P. and Ramesh, A. (2005), Fundamentals of Cartography, Concept Pub. Co., New Delhi
4. Monkhouse, I.J. and Wilkinson, H.R.(2009), Maps and Diagram, B.I. Publication, New Delhi
5. Singh, R.L. and Singh Rana P.B.(2008), Elements of Practical Geography, Kalyani Publishers, New Delhi
6. Sarkar, Ashis (2000), Practical Geography: A Systematic Approach, Orient Longman Pvt. Ltd., Kolkata.

ELECTIVE
Course Title: Quantitative Techniques in Geography (THEORY)
Course Code: GEG-V.SE-12
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==

Course Objectives: The focus of this course is to expose students to basic and advance statistical methods in geography in general**.**

Learning outcomes: On completion of this course students will able to test various statistical tools applied in earth science. Further they will be able to understand various stochastic models and forecasting methods in the discipline of earth science.

Unit	Title	No. of hours
I	Statistical Methods in Geography Basics of Sampling, Data Collection and Sample Design, Hypothesis Quantification and Prediction / projection, The Concept of Variable, Probability, Frequency Function.	15
II	Frequency Analysis and Simulation, Measure of Central tendency, Dispersion, Skewness and Kurtosis, Correlation and Regression, Chi Square(X^2)	15
III	Stochastic Modelling (Time Series Analysis) and Forecasting Processes, Autocorrelation, Moving Average.Maximum Entropy Method	15
		45

REFERENCES

1. Pal S. K., 1998: Statistics for Geoscientists: Techniques and Application, Concept, New Delhi.
2. Sharma, D.D. (2008): Geostatistics with Application in Earth Sciences, Springer, with Capital Publishing Company, New Delhi, India.
3. Rogerson., P. A.(2001) : Statistical Methods for Geography. SAGE Pub. New Delhi
4. Spence, N. & Owens, A. (2011) :Methods of Geographical Analysis. University of London
5. Tomislav Hengl (2009): A Practical Guide to Geostatistical Mapping. The European Communities, Luxembourg

ELECTIVE
Course Title: Quantitative Techniques in Geography (PRACTICAL)
Course Code: GEG-V.SE-12
Marks: 25
Credits: 01
Duration: 15 sessions of 2 hours each
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Course Objectives: The focus of this course is to enable students to learn and apply basic and advance statistical methods in geography**.**

Learning outcomes: On completion of this course students will able to test and analyze various statistical tools applied in geography. Further they will be able to formulate hypothesis and prove it applying various stochastic models and forecasting methods in the discipline of geography.

Unit	Title	Practical sessions
I	Measure of Central tendency and Dispersion Mean (Z) Estimates for the Mean, Confidence Limits for the Mean Skewness and Kurtosis Correlation and Regression, Correlation Coefficient Hypothesis testing :The Chi-square (X^2) Test, Time Series Analysis and Forecasting	07
II	Variogram and Estimation Variance Entropy Method,	08
	Journal and Viva	
		15

Note : Only physical geography data should be used.

References

1. A. Stewart Fotheringham, Chris Brunsdon and Martin Charlton. (2000): Quantitative Geography Perspectives on Spatial Data Analysis. SAGE Publications Ltd
2. Rogerson, Peter A. (2015) Statistical Methods for Geography. (4th Ed) SAGE Publications Ltd
3. Sharma, D.D. (2008): Geostatistics with Application in Earth Sciences, Springer, with Capital Publishing Company, New Delhi, India.
4. Spence, N. & Owens, A. (2011) Methods of Geographical Analysis. University of London
5. Robert Hammond, Patrick McCullagh; (1974): Quantitative techniques in geography: an introduction. Clarendon Press,

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER VI

CORE
Course Title: Ecology and Terrestrial Environment (THEORY)
Course Code: GEG-VI.SC-8
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
===

Course Objectives: The basic objective of this course is to introduce the concepts of terrestrial ecology which will help in sustainable management of the same.

Learning outcomes: At the end of this course, students are expected to have an understanding of Biomes, ecological factors and applications. They will be familiar with sustainable strategies for conservation of terrestrial ecology.

Unit	Title	No. of hours
I	**Biomes of the world:** • Biogeography: Species distribution, Historic effect of plate tectonics-past and present pattern of Biogeography • Terrestrial Biomes : Tropical Rain Forest, Savannah, Tundra, Desert	15
II	**Physical factors controlling terrestrial ecosystem** • Soil : soil as an ecological factor, texture, • Water: Classification, properties of water as ecological factors: properties, composition, effect of rainfall and moisture on growth and distribution of plants and animals.	15
III	**Climatic factors controlling terrestrial ecosystem** Temperature: ecological factor, range of temperature tolerance, effects on plants and animals, Precipitating : Distribution , effects on plants and animal	15
		45

References:

1. Dhaliwal GS, Sangha GS, Ralhan PK, 1996: Fundamentals of Environment Science, Kalyani Publishers New Delhi,
2. J.L Chapman and MJ Reiss, 1999: Ecology: Principles and Application, Second Edition, Cambridge University Press, UK
3. Kotpal RL, Bali NP, 1998: Concepts Of Ecology, Vishal Publication, Jalendhar
4. Purphit SS, Ranjan R, 2003: Ecology, Environment and Pollution, Agrobios (India) Publication, Jodhpur

CORE
Course Title: Ecology and Terrestrial Environment (PRACTICAL)
Course Code: GEG-VI.SC-8
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
===
Course Objectives: The course aims to develop skills of field sampling, testing and analysis of water and soil and interpretation .
Le**arning outcome:** After the completion of this course, students will learn water and soil testing

Unit	Title	Practical sessions
I	**Field Visit** : visit to a forest ecosystem mapping of biodiversity using quadrant method testing relationship of soil and water with forest ecology.	07
II	Field report writing and Viva	08
		15

References :

1. Handbook of Applied Hydrology, Ven Te Chow, Ed., Section 4-II, McGraw-Hill Book Company, New York
2. King, C. A. M. (1966): Techniques in Geomorphology, Edward Arnold Ltd., London
3. Miller, A. A. (1953): The Skin of the Earth, Methuen and Co. Ltd., London
4. Monkhouse, F. J. and Wilkinson, H. R. (1971): Maps and Diagrams, Methuen and Co., London
5. Strahler, A. N. (1964): Quantitative Geomorphology of Drainage Basins and Channel Networks,

ELECTIVE
Course Title: Remote Sensing of Forest Ecology (THEORY)
Course Code: GEG-VI .SE-13
Marks: 75
Credits: 3
Duration: 45 sessions of 1 hours each
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Course Objectives: The objective of this course is to introduce the fundamental application of remote sensing in the forest ecology.

Learning outcome: Student will be able to appreciate the use of remotely sensed data in forest applications.

Unit	Title	No. of hours
I	**Remote Sensing of Forest Environments** Spectral Response of Vegetation. Measuring and monitoring: General Methods of Measuring Vegetation.	15
II	• Measurement of Vegetation: Biophysical Measure, Timing of Measurements, • Forest Structure and Composition, Species richness and composition	15
III	• Modeling Forest Productivity Using Data Acquired Through Remote Sensing Understanding Forest Dynamics: spatial and temporal changes	15
	Total	45

References

1. Adrian Newton (2007) Forest Ecology and Conservation, A Handbook of Techniques Techniques in Ecology & Conservation. Oxford New York
2. Hamlyn G Jones and Robin A Vaughan (2010) Remote Sensing of Vegetation Principles, Techniques, and Applications. Oxford University Press, Oxford.
3. Michael Wulder and Steven E. Franklin (2003) Remote Sensing of Forest. Environments, Concepts and Case Studies. (Ed) Springer, US.
4. Ned Horning, Julie A. Robinson, Eleanor J. Sterling, Woody Turner, and Sacha Spector (2010)
5. Remote Sensing for Ecology and Conservation, A Handbook of Techniques. Oxford University Press, Oxford.
6. Roger M. McCoy (2005) Field Methods in Remote Sensing. The Guilford Press, New York London.
7. Van Der Valk, Arnold (2009) Forest Ecology Recent Advances in Plant Ecology. Springer.

ELECTIVE
Course Title: Practical in Remote Sensing of Forest Ecology (PRACTICAL)
Course Code: GEG-VI .SE-13
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
==
Course Objectives: To develop the skills of assessing forests using remotely sensed data products.

Learning outcome: At the end of the course student are expected to independently prepare forest map and interpret the forest dynamics.

Unit	Title	Practical sessions
I	**Measurement of Forest Canopy** • Accuracy Assessment of forest map • Sub-Pixel Analysis of Forest Structure • Extracting Individual Tree Information • Tree Canopy structure • Fragmentation Analysis using Entropy approach	10
II	**Vegetation indices** • NDVI • Principal Component Analysis (method specify) • Mapping forest disturbances	5
		15

References

1. Adrian Newton (2007) Forest Ecology and Conservation, A Handbook of Techniques Techniques in Ecology & Conservation. Oxford New York
2. Hamlyn G Jones and Robin A Vaughan (2010) Remote Sensing of Vegetation Principles, Techniques, and Applications. Oxford University Press, Oxford.
3. Michael Wulder and Steven E. Franklin (2003) Remote Sensing of Forest. Environments, Concepts and Case Studies. (Ed) Springer, US.
4. Ned Horning, Julie A. Robinson, Eleanor J. Sterling, Woody Turner, and Sacha Spector (2010)
5. Remote Sensing for Ecology and Conservation, A Handbook of Techniques. Oxford University Press, Oxford.
6. Roger M. McCoy (2005) Field Methods in Remote Sensing. The Guilford Press, New York London.
7. Van Der Valk, Arnold (2009) Forest Ecology Recent Advances in Plant Ecology. Springer.

ELECTIVE
Course Title: Advanced Coastal Geomorphology (THEORY)
Course Code: GEG-VI.SE-14
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
===

Course Objectives: The basic objective of this course is to introduce the process of coastal foration and coastal geomorphology of India. It's also introduces application of geo-spatial data which will help in understanding coastal processes.

Learning outcomes: At the end of this course, students are expected to develop the skill of understanding coastal processes by using GIS tools and methods.

Unit	Title	No. of hours
I	**Tectonic and coast** • Structural factors -Tectonic Coasts, Orientation of coastal tectonic movement, rates of coastal tectonic movement • Formation of coast • Structurally controlled coasts- Bold and Low coast • Coastal Process and sea-level fluctuations	15
II	**Coastal Geomorphology of India:** • Indian coast- Extent & Topography Geology & structure of coastal zone, Evidence of emergence and submergence, • Shore features-Beach, Bar, Lagoons-lake, Delta, Estuaries, Coral reefs and islands • Classification of Indian coast	15
III	**CRZ** CRZ : Meaning, zones and provision Case study of Goa	15
		45

References

1. Bloom. L. Arthur (2012):Geomorphology, Rawat Publication Delhi.
2. Ahamad.E (1972) Coastal geomorphology of India, Orient Longman Delhi.
3. Cooke R. U. and Doornkamp J.C. (1989): Geomorphology in Environmental Management, 2nd Edition, Oxford : Clarendon Press
4. Eric Bird (2000): Coastal Geomorphology: An Introduction, 1 edition, John Wiley & Sons
5. Gerhard Masselink , Michael Hughes :An Introduction to Coastal Processes and Geomorphology (Hodder Arnold Publication), ISBN-10: 0340764112 , ISBN-13: 978-0340764114
6. Kale, V. S. and Gupta, A. (Rep.2011): Introduction to Geomorphology, Orient Longman, Calcutta.
7. Karlekar, S. (2009): Coastal Processes and Landforms: Diamond Publications, Pune
8. Pethick J. (1995): Introduction to Coastal Geomorphology, John Wiley & Sons Inc.
9. Richard Davis Jr. , Duncan Fitzgerald : Beaches and Coasts, Wiley-Blackwell; 1st edition (July 15, 2004), ISBN-10: 0632043083 , ISBN-13: 978-0632043088
10. Timothy Beatley , Anna K. Schwab , David Brower (2002):An Introduction to Coastal Zone Management, Island Press; REV edition

ELECTIVE
Course Title: Advanced Coastal Geomorphology (PRACTICAL)
Course Code: GEG-VI.SE-14
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
===
Course Objectives: The basic objective of this course is to introduce the GIS techniques which will help in understanding and evaluating coastal processes.

Learning outcomes: At the end of this course, students are expected to develop the skill of understanding coastal processes by using GIS tools and methods.

Unit	Title	Practical sessions
I	Demarcation of shoreline and tide level and coastal features using GIS software from satellite and SOI toposheet.	05
II	Case study of any coastal problems: Field work and use of GIS software	10
	Journal and Viva	
		15

References:

1. Ahamad. E (1972) Coastal Geomorphology of India, Orient Longman Delhi.
2. Bloom. L. Arthur (2012):Geomorphology, Rawat Publication Delhi.
3. Cooke R. U. and Doornkamp J.C. (1989): Geomorphology in Environmental Management, 2nd Edition, Oxford : Clarendon Press
4. Eric Bird (2000): Coastal Geomorphology: An Introduction, John Wiley & Sons; 1 edition

ELECTIVE
Course Title: Ecology of Estuarine Environment (THEORY)
Course Code: GEG-VI.SE-15
Marks: 75
Credit: 03
Duration: 45 lectures of 1 hour each

Course objectives: This Course enables the study of estuaries and their unique ecosystems. It explores the features of estuarine ecosystem and analyzes the effects of anthropogenic activities on estuaries.

Learning outcomes: After the completion of this course, students will be able to understand the estuarine processes. They will be aware about anthropogenic effects on estuaries.

Unit No	Contents	No. of hours
1	**Physical attributes of Estuaries** • Concept and Significance. • Physical characteristics of estuaries • Classification of estuaries. • Environment in estuaries: mudflats, salt marsh, mangroves, salt pans • Sediment source, transportation and deposition in estuaries.	15
2	**Estuarine dynamics** • Tides and tidal currents in estuaries • Estuarine circulation and mixing. • Estuaries as sources of food for marine organisms and nurseries for marine organisms.	15
3	**Anthropogenic Effects on estuaries and mitigation** • Agricultural runoff. • Fishing • Urban development and Reclamation of land for development. • Recreational activities. • Ports and harbors	15
		45

References:

1. Dronker J and Leussen W.V (1988) Physical Processes In Estuaries, Springer Verlag Publishers. London
2. Dyer. K.R (1997) Estuaries- Physical Introduction, 2nd edition John Wiley and Sons, New York
3. Gade, Edward and Svendson(1982) Coastal Oceanography, Plenum Press London.
4. Nair N. B. and Thampy, D.M.: (1989), Textbook of Marine Ecology. Macmillan Publishers
5. Tait, R.V- (1982), Elements of Marine Ecology: An Introductory Course, 3rd Edition, Butterworth-Heinemann

ELECTIVE
Course Title: Ecology of Estuarine Environment (PRACTICAL)
Course Code: GEG-VI.SE-15
Marks: 25
Credit: 01
Duration: 15 sessions of 2 hours each

Course objectives: this Course helps in developing the practical skills of studying estuarine ecology.

Learning outcomes: after the completion of this course, students will be able to independently test and analyze various parameters associated with estuarine ecology and suggest remedial measures for the protection f the same.

Unit No	Contents	Practical sessions
I	Mapping of estuaries from Indian coasts using SOI toposheets (any 3)	6
II	**Mapping of estuaries in Goa:** • Change detection using satellite data and topographical sheet • Estuarine channel profiling, bank erosion, associated landforms (using GPS, current meter and depth analyzer)s • Mini project	9
	Journal and Viva	

References:

1. Dronker J and Leussen W.V (1988) Physical Processes In Estuaries, Springer Verlag Publishers. London
2. Dyer. K.R (1997) Estuaries- Physical Introduction, 2nd edition John Wiley and Sons, New York
3. Gade, Edward and Svendson(1982) Coastal Oceanography, Plenum Press London.
4. Nair N. B. and Thampy, D.M.: (1989), Textbook of Marine Ecology. Macmillan Publishers
5. Tait, R.V- (1982), Elements of Marine Ecology: An Introductory Course, 3rd Edition, Butterworth-Heinemann

ELECTIVE
Course Title: Disaster Management: Urban and Coastal (THEORY)
Course Code: GEG-VI.SE-16
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
===

Course Objectives: The course aims give insights of basics and applications of landscape and disaster management.

Learning outcomes: This course will enable the students to understand the role of landscape in Urban and Coastal disaster management.

Prerequisite:
Students must have completed the course of Basics of remote sensing and GIS in SEM III.

Unit	Title	No. of hours
I	**Introduction to Disaster Management:** • Definition, Types, Concepts of Disaster Management • Importance of Disaster Management • Introduction to mitigation methods • Disaster Management Cycle • Indian Scenario **Natural Hazards & Landscapes:** • Types of landscapes & natural hazards • Distribution Pattern • Consequences • Mitigation measures	15
II	**Urban Landscape & Disaster Management:** • Understanding Risk of Urban hazard • Case study	15
III	**Coastal Landscape & Disaster Management:** • Understanding Risk of coastal hazards • Coastal risk, mitigation and planning. • Case study	15
		45

References:

1. Asian Development Bank, (2016), Reducing Disaster Risk by managing Urban Landuse-Guidance notes for planners, Metro Manila, Philippines
2. Ban Wisner, (2005), At Risk: Natural Hazards, People's Vulnerability and Disasters, Routledge
3. Chowdhury Emdadul. Haque, (2005), Mitigation of Natural Hazards And Disasters: International Perspectives, Springer
4. FitzGerald. M. Duncan, (2003), Beaches and Coasts, Blackwell Publishing
5. Natural Hazards and Disaster Management, (2006), A Supplementary Textbook in Geography for Class XI on Unit 11: Natural Hazards and Disasters, Published by: The Secretary, Central Board of Secondary Education, 2, Community Centre, Preet Vihar, Delhi-110092
6. Vernberg. F. John, Vernberg. Winona B, (2001), The Coastal Zone: Past, Present, and Future, University of South Carolina Press

ELECTIVE
Course Title: Practical in Disaster Management: Urban and Coastal (PRACTICAL)
Course Code: GEG-VI.SE-16
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
==

Course Objectives: This practical course aims to equip student with the techniques of vulnerable hazard zone delineation in local and regional landscape.

Learning outcomes: Student will be able to demarcate the risk prone sites and potential disasters in local and regional landscape.

Prerequisite:
Students must have completed the course of Basics of remote sensing and GIS in SEM III.

Unit	Title	Practical sessions
I	1. Mapping Flood risk area 2. Mapping Landslide and Erosion prone sites 3. Mapping Rock fall prone sites	07
II	4. Mapping the urban land surface temperature (Urban Heat Islands) 5. Risk sensitive land use map 6. Calculating permissible density of hazards.	8
	Journal	
		15

References

1. Asian Development Bank, (2016), Reducing Disaster Risk by managing Urban Landuse-Guidance notes for planners, Metro Manila, Philippines
2. Ban Wisner, (2005), At Risk: Natural Hazards, People's Vulnerability and Disasters, Routledge
3. Chowdhury Emdadul. Haque, (2005), Mitigation of Natural Hazards And Disasters: International Perspectives, Springer
4. FitzGerald. M. Duncan, (2003), Beaches and Coasts, Blackwell Publishing
5. Natural Hazards and Disaster Management, (2006), A Supplementary Textbook in Geography for Class XI on Unit 11: Natural Hazards and Disasters, Published by: The Secretary, Central Board of Secondary Education, 2, Community Centre, Preet Vihar, Delhi-110092
6. Vernberg. F. John, Vernberg. Winona B, (2001), The Coastal Zone: Past, Present, and Future, University of South Carolina Press

<u>ANNEXURE A</u>

<u>(Summary of changes incorporated in the syllabus)</u>

Semester	Course Title	Existing (Indicate only the unit where the change is proposed)	Changes Proposed	Specify the reason for the change
V	Fundamentals of Climatology	NA	Course Title changed to Introduction to Climatology	Earlier title did not justify the contents
V	Fundamentals of Climatology (Introduction to Climatology)	I	Addition: • Primary, secondary and tertiary circulation (essential) Deletion: • Basics of water cycle, • Atmospheric Stability. Air Masses and its types. Fronts and types. • El-Nino and La-Nina. • Atmospheric disturbances: • Thermodynamics • CAPE and CINE- cloud development and stability, thunderstorm Cyclogenesis – T number (basics of cyclones) • Koppens Classification of climate	Essential Excessive Shifted to unit II
V	Fundamentals of Climatology (Introduction to Climatology	II	Deletion: • Indian Climatology: Monsoons • Pre monsoon: Cyclone genesis, Cyclonic storms, frequency, intensity, landfall and associated weather. • South West monsoon: Onset and advance of southwest monsoon, Semi-permanent features of monsoon, active and break in monsoon.El-Nino and La-Nina.	Shifted to unit III

			• Post monsoon: withdrawal of southwest monsoon, Northeast monsoon, cyclonic storms in the Indian seas, trends in cyclonic disturbances, Easterly waves. • Winter: western disturbances, fog, cold waves Addition: • Atmospheric disturbances: • Thermodynamics • CAPE and CINE- cloud development and stability, thunderstorm Cyclogenesis – T number (basics of cyclones) • Western disturbances, fog, cold waves • Koppens Classification of climate	Shifted from Unit I to Unit II
V	Fundamentals of Climatology (Introduction to Climatology	III	Deletion: • The Earth's Changing Climate • Climate change and sea level rise: Ocean in relation to long changes in Monsoon, tropical cyclones and climate, Land use change and climate. Cloud burst, clouds seeding and artificial rain. • Climate services: Climate and application in agriculture, water, health and disaster risk reduction and urban planning. Addition: • Indian Climatology: Monsoons • Pre monsoon: Cyclone genesis, Cyclonic storms,	Excessive

			frequency, intensity, landfall and associated weather. • South West monsoon: Onset and advance of southwest monsoon, Semi-permanent features of monsoon, active and break in monsoon. El-Nino and La-Nina. • Post monsoon: withdrawal of southwest monsoon, Northeast monsoon, cyclonic storms in the Indian seas, trends in cyclonic disturbances, Easterly waves.	Shifted from Unit II
V	Introduction to Climatology (Practical)	II	Deletion: • Seven Days Training in IMD	Excessive
V	Geography of Soil Studies	I	Deletion: • Soil classification • Soil taxonomy, Sub-orders, groups, families, series	Excessive
V	Geography of Soil Studies	III	Deletion: • Industrial, agricultural, e-waste, nuclear, urban waste, mining, deforestation, irrigation projects	Not required to be specified in soil pollution
V	Geography of Soil Studies (Practical)	I	Addition: • Soil Test (physical) 4. Moisture content calculation 5. Texture analysis 6. EC Deletion: • Particle size analysis (density, porosity)	Essential Excessive
V	Geography of Soil Studies (Practical)	II	Deletion: • Spectro-photometric analysis of soil • Quality control (trace element assessment) • Permeability and	Irrelevant

			erodibility tests • Nutrient availability of soil • Soil humus fraction Addition: • Soil Test (chemical) 4. Soil pH levels 5. NPK level testing 6. Carbon testing	Essential
V	Quantitative Techniques in Geography	III	Deletion: • Spectral Analysis (Frequency Domain) Spectrum, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Spectral Density and Entropy	Excessive
V	Quantitative Techniques in Geography (Practical)	II	Deletion • Spectral Analysis (Frequency Domain) Spectrum, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) • Maximum Spectral Density and Entropy • Stationary and Intrinsic Hypothesis	Excessive
VI	Ecology and Terrestrial Environment	I	Deletion • Meaning and Types of Biomes • Temperate Deciduous Forest	Already covered in Foundation Course: Environmental Studies Excessive
VI	Ecology and Terrestrial Environment	II	The title of unit renamed to Physical factors controlling terrestrial ecosystem Deletion • Soil formation, profile • Temperature: ecological factor, range of temperature tolerance, effects on plants and animals, morphological and physiological	Excessive

			adaptation in organism to change in temperature	
VI	Ecology and Terrestrial Environment	III	Deletion: • Threats to terrestrial environment and ecosystem • Population growth, Urbanization, Industrial growth, Military conflicts and Nuclear war, Natural hazard • Mining, dams, land use changes The entire unit reframed as: Climatic factors controlling terrestrial ecosystem Temperature: ecological factor, range of temperature tolerance, effects on plants and animals, Precipitating : Distribution , effects on plants and animal	Already covered in Foundation Course : Environmental Studies Important topic
VI	Ecology and Terrestrial Environment (Practical)	I	Deletion • Soil sampling (Field work) • Soil Testing • Grain size analysis • Soil chemistry – pH • Organic matter and organic carbon: Methods (Titration and Loss & ignition) Addition: • Field Visit : visit to a forest ecosystem • mapping of biodiversity using quadrant method • Testing relationship of soil and water with forest ecology.	Irrelevant to the course Essential for course
VI	Ecology and Terrestrial Environment (Practical)	II	Deletion: • Soil chemistry • pH testing • Organic matter and organic carbon: Methods(Titration and	Irrelevant to the course

			Loss & ignition) Addition • Field report writing and Viva	Essential for course
VI	Remote Sensing of Forest Ecology	I	Deletion: • Selecting a Measurement Method: Indirect Measurement of Forest Canopy Structure	Excessive
VI	Remote Sensing of Forest Ecology	III	Deletion • Forest Information Extraction from coarse and medium Resolution Satellite Data. • Selection of Remotely Sensed Data	Redundant
VI	Advanced Coastal Geomorphology	I	Deletion: • Climatic-factors	Irrelevant to the course
VI	Advanced Coastal Geomorphology	III	Deletion: • Application of R.S in Coastal Studies • Interpretation of coastal area: - Using SOI toposheet - Satellite images • Study of coastal problems: A case study(already in Practical) Addition • CRZ - CRZ : Meaning, zones and provision • Case study of Goa	Excessive Repeated in Practical course Essential

VI	Ecology of Estuarine Environment (Practical)	II	Deletion: • LULC • Drivers for change Entire unit reframed as: Mapping of estuaries in Goa: • Change detection using satellite data and topographical sheet • Estuarine channel profiling, bank erosion, associated landforms (using GPS, current meter and depth analyzers) • Mini project	Irrelevant to the course

Parvatibai Chowgule College of Arts and Science
(Autonomous)
DEPARTMENT OF GEOGRAPHY
COURSE STRUCTURE
THREE YEAR B.Sc. DEGREE COURSE IN GEOGRAPHY

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	GEG-I.SC1: Introduction to Geography	GEG-I.SC2: Fundamentals of Physical Geography				
II	GEG-II.SC3: Basics of Human Geography	GEG-II.SC4: Basics of Regional Geography				
III	GEG-III.SC5: Fundamentals of Remote Sensing and GIS		GEG-SE1: Spatial Analysis	GEG-SE2: Raster and Vector Data Models in GIS	GEG-SE3: Participatory GIS	GEG-SE4: Applied GIS
IV	GEG-IV.SC6: Fundamentals of Geomorphology		GEG-SE5: Coastal Geomorphology	GEG-SE6: Fluvial Geomorphology	GEG-SE7: Watershed Management	GEG-SE8: Biogeography
V	GEG-V.SC7: Introduction to Climatology		GEG-SE9: Geography of Soil Studies	GEG-SE10: Agro-Meteorology: Principles and Applications	GEG-SE11: Field Survey in Physical Geography	GEG-SE12: Quantitative Techniques in Geography
VI	GEG-VI.SC8: Ecology and Terrestrial Environment		GEG-SE13: Remote Sensing and Forest Ecology	GEG-SE14: Advanced Coastal Geomorphology	GEG-SE15: Ecology of Estuarine Environment	GEG-SE16: Disaster Management: Urban and Coastal

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER I
UPDATED ON 16TH MARCH 2020

CORE
Course Title: Introduction to Geography (Theory)
Course Code: GEG-I.SC1
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==
Prerequisite Courses: Nil

Course Objectives:
1. To acquaint the students with distinctiveness of Geography as a field of learning.
2. The philosophy of the subject is to be taught in order to develop a keen interest in the subject and to pursue it for higher studies.

Course outcomes: At the end of this course, students will be able to:
CO1: Understand fundamental concepts and dichotomies in geography
CO2: Analyze the interrelationships among fundamental concepts of geography
CO3: Acquire Basic cartographical skills such as basic elements of map and map reading, area measurements, time calculation
CO4: Differentiate and evaluate different domains of geography

Unit No.	Course Content	No. of hours
I	**Introduction of Geography** Definition, Meaning, nature and scope of geography; Major divisions of geography Major themes in Geography – location, region, process, spatial interaction and time.	15
II	**Introduction to Geosphere: I** **Atmosphere:** Meaning &Definitions-Composition& Structure of Atmosphere, Elements of Weather & Climate and their inter-relation. **Biosphere &Nanosphere** Major Natural regions of world	15
III	**Introduction to Geosphere: II** **Lithosphere:** Evolution of Earth, Geological Time scale. Orders of Relief (I, II, III), oceans and continents, classification of mountains, plateau and plains **Hydrosphere**: Hydrological Cycle Spatial distribution of water on earth.	15
		45

References:
Mandatory:
1. Goh Cheng Leong (2003): Certificate Physical and Human Geography, Oxford university press, New Delhi

Supplementary:
1. Dikshit R.D (2004): The Arts, Science of Geography, Integrated Readings Prentice Hall of India, New Delhi
2. Lal. D. S. (2007): Climatology, Pushtak Mahal, Allahabad
3. Das Gupta and Kapoor (2013): Principles of Physical Geography, S. Chand & Company Pvt. Ltd.
4. Singh Savindra (2005): Environmental Geography, Prayag Pustak Bhavan, Allahabad

Web-based:
1. https://player.uacdn.net/lesson-raw/7B40WVPQTFRB0H1UF10H/pdf/7647790894.pdf
2. https://scied.ucar.edu/atmosphere-layers
3. https://d43fweuh3sg51.cloudfront.net/media/assets/wgbh/tdc02/tdc02_doc_biomesummary/tdc02_doc_biomesummary.pdf
4. https://www.researchgate.net/publication/225491377_The_early_evolution_of_the_planet_earth_and_the_origin_of_life
5. https://www.nap.edu/resource/12161/origin_and_evolution_of_earth_final.pdf
6. https://www.researchgate.net/publication/315125743_THE_HYDROLOGIC_CYCLE

CORE
Course Title: Measurement Systems in Geography (Practical)
Course Code: GEG-I.SC1
Marks: 25
Credits: 01
Duration: 15 sessions of 2 hours each
===

Unit	Title	Practical sessions
I	1. Scales and its types: a. Verbal Statement. b. Representative Fraction. 2. Linear scale- a. Simple and comparative- b. time and distance 3. Identification of location and extension based on latitude and longitudes. 4. Grid reference system. 5. Finding directions. 6. Calculation of time based on longitude 7. Calculation of area by square method	10
II	8. Preparation of map – Title, Scale, Legend, Direction, Signs and symbols, lettering and colour scheme.	05
III	Journal	
		15

References:
Mandatory:
1. Misra, R.P. and Ramesh, A., (2005): Fundamentals of Cartography, Concept Pub. Co., New Delhi

Supplementary:
1. Campbell, J.(2004) Introductory Cartography, Prentice Hall, Inc Englewood
2. Monkhouse, I.J. and Wilkinson, H.R., (2009): Maps and Diagram, B.I. Publication, New Delhi
3. R. P Mishra. (2014) Fundamentals of Cartography, Concept Pub. Co., New Delhi
4. Gopal Singh. (2014), : Map Work and Practical Geography, 4th Edition, Sterling Book House Mumbai

Web-based:
1. http://groundwater.fullerton.edu/Maps,_Scale,_GIS_and_GPS/Guide_to_Map_Scale.html
2. https://www.timeanddate.com/geography/longitude-latitude.html
3. https://www.youtube.com/watch?v=ei5FAinKXoY
4. https://www.mathopenref.com/squarearea.html
5. http://www.fao.org/economic/the-statistics-division-ess/world-census-of-agriculture/conducting-of-agricultural-censuses-and-surveys/chapter-5-cartographic-preparation/en/

CORE
Course Title: Fundamentals of Physical Geography (Theory)
Course Code: GEG-I.SC2
Marks: 75
Credits: 3
Duration:45 lectures of 1 hour each
==
Prerequisite Courses: Nil

Course Objectives:
1. The course aims to introduce fundamental concepts of physical geography.
2. The course focuses of various spheres of the earth and their related concepts.

Course Outcomes: At the end of this course, students will be able to:
CO1: Understand fundamentals of physical geography
CO2: Apply techniques to represent different relief features
CO3: Interpret the characteristics and associate with other relief features
CO4: Analyze and interpret climate data

Unit No.	Course Content	No. of hours
I	**Concept and Nature**: Introduction to physical geography Recent developments in physical geography. **Layers of the Earth**: Lithospheric system: Interior of the earth. Layering of the earth- Mechanical layering and chemical layering. Weathering and mass movement, Rocks and its types. Soil-definition and profile.	15
II	**Basic concepts of climatology**: Definition and scope of climatology Insolation, factors affecting Insolation and Heat budget. Temperature, atmospheric pressure, wind, and humidity	15
III	**Introduction to oceanography**- Definition, Development of oceanography as a discipline, Significance and scope of oceanography	15
		45

References:
Mandatory:
1. Bloom, Arthur L., 2008: Geomorphology – A Systematic Analysis of Late Cenozoic Landforms, Prentice Hall, Engle Wood Cliff, New Jersey.
2. Dayal, P. (2nd edition) 2006: A Textbook of Geomorphology, Shukla Book Depot, Patna
3. Strahler, A.N., 2005: Physical Geography, 3rd Ed., Wiley Publications
4. Singh, S. 2005: Physical Geography, Prayag Pustak Bhawan, Allahabad
5. Lal, D.S , 2004: Oceanography, Prayag Pustak Bhavan, Allahabad

Supplementary:
1. Ahmed, E., 2005: Geomorphology, Kalyani Publishers, New Delhi
2. Sharma, V.K., 2006: Geomorphology, Earth Surface, Process and forms, Tata McGraw Hill, New York
3. Thornbury, W.D., 1969: Principles of Geomorphology, 2nd Ed., Wiley International Edition, Wiley Eastern Reprint, 2004
4. Wooldridge, S.W. and Morgan, R.S., 2008: The Physical Basis of Geography, Longman (First published in 1937)
5. Worcestor, P.G., 2005: A Textbook of Geomorphology, Van Nostrand, 2nd Ed., East West Edition, New Delhi.
6. Chorley, Richard J., 2002: Spatial Analysis in Geomorphology, Harper and Row Publishers, New York, London.
7. Sharma, H.S. (ed), 2002: Perspective in Geomorphology, Vol. I & IV, Concept, New Delhi.
8. Sharma, V.K., 2006: Geomorphology, Earth Surface Processes and Forms, Tata Mc. Graw Hill, New Delhi.
9. Sparks, B.W., 2000: Geomorphology, Longman, London, 2nd edition.

Web-based:
1. https://www.nationalgeographic.org/media/earths-interior/
2. https://www.nationalgeographic.org/encyclopedia/rock-cycle/
3. http://www.geo.hunter.cuny.edu/~fbuon/GEOL_231/Lectures/Weathering%20and%20Mass%20Wasting%20Part%202.pdf
4. http://ncert.nic.in/textbook/pdf/kegy209.pdf
5. https://www.ukessays.com/essays/geography/history-significance-oceanography-9589.php

CORE
Course Title: Fundamentals of Physical Geography (Practical)
Course Code: GEG-I.SC2
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
==

Unit	Title	Practical Sessions
I	1. Methods of Representation of Relief features a. Spot Heights, b. Bench Marks. c. Triangulation mark 2. Contours diagrams for slopes with cross sections- gentle slope, steep slope, concave and convex slope, 3. Contours diagrams for hills, plateaus, cliff, 4. Contours diagrams for V-shaped valley, waterfall, rapids, river terraces 5. Profile Drawing from contour diagram. a. Serial b. Superimposed c. composite	10
II	6. Calculation of mean, average, range of temperature. 7. Calculation of lapse rate and Relative Humidity.	5
III	Journal	
		15

References:
Mandatory:
1. Chorley, Richard. J. (ed.), 2009: Water, Earth and Man, Methuen & Co., London
2. King, C.A.M., 2006: Techniques in Geomorphology, Edward Arnold, London
3. Monkhouse, F.J. and Wilkinson, H.R., 2009: Maps and Diagrams, B.I. Publications Pvt. Ltd., New Delhi
4. Singh, R.L. and Singh Rana P.B., 2008, Elements of Practical Geography, Kalyani Publishers, New Delhi

Supplementary:
1. Goudie, Andrew, et al. (eds), 2001: Geomorphological Technique, George Allen & Unwin, London
2. Gregory, K.J. and Walling, D.E., 2003: Drainage Basin – Form and Process, Edward Arnold, London
3. Leopold, L.B, Wolman, M.G. and Miller, J.P., 2004: Fluvial Processes in Geomorphology, Freeman, San Francisco
4. Misra, R.P. and Ramesh, A., 2009: Fundamentals of Cartography, Concept Publishing Co., New Delhi

Web-based:
1. http://www.brainkart.com/article/Methods-of-Representing-Relief-Features_33844/
2. https://www.slideshare.net/gauravlath1997/contour-diagrams
3. https://geo.libretexts.org/Bookshelves/Ancillary_Materials/Laboratory/Book%3A_Laboratory_Manual_For_Introductory_Geology_(Deline%2C_Harris_and_Tefend)/03%3A_Topographic_Maps/3.6%3A_Drawing_Contour_Lines_and_Topographic_Profiles
4. https://sciencing.com/calculate-mean-annual-temperature-7236109.html
5. https://eesc.columbia.edu/courses/ees/climate/lectures/atm_phys.html

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER II
UPDATED ON 16TH MARCH 2020

CORE
Course Title: Basics of Human Geography (Theory)
Course Code: GEG-II.SC3
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==

Prerequisite Courses: Nil

Course Objectives:
1. The course provides the basic conceptual framework of Human Geography.
2. It focuses on cultivating basic knowledge through understanding and analysis of the fundamental concepts in Human geography.

Courses Outcomes: At the end of this course, students will be able to:
CO1: Understanding of fundamental concepts of Human Geography
CO2: Understand and analyze human related issues in societies
CO3: Develop an understanding of basic quantitative techniques used in Human geography
CO4: Collect, process and analyze socio economic data
CO5: Visually illustrate population data

Unit	**Topic**	**No. of hours**
I	**Concept and Nature: Meaning**, Scope and Development of Human Geography. Basic principles-Principle of Activity or Change, Principle of Terrestrial Unity or whole. Approaches in human geography (humanistic, scientific, welfare and behavioral)	15
II	**Society and Culture** Evolution of man (Australopithecus, Homo Erectus, Homo sapiens. Man's spread over the earth during the Pleistocene). Culture- meaning and components. Language and religion. (Classification, distribution, issues and challenges.) Contemporary social problems: Gender disparity and related issues Ethnicity and the related issues. (Case study of India).	15
III	**Indicators of Development:** L.D.C. and M.D.C.-social, economic and demographic. (Distribution and Density. Concepts of under population, over population, age and gender composition. Fertility, mortality, migration, Ageing population.) Demographic transition.	15
		45

Note: The course should focus on basic conceptual aspects.

References:

Mandatory:

1. Hussain, M. (2004) *Human Geography*. Rawat Publication. New Delhi.
2. H.J De Blij, Alexander B. Murphy, Erin H. Fouberg (2007) *Human Geography: People, Place and Culture.* John Wiley and sons. USA.

Supplementary:

1. Panigrahi P.K. (2011) *Human Geography-Landscape of Human Activities*. Murari Lala and sons. New Delhi.
2. Sharma Y.K. (2007) *Human Geography*. Lakshmi Narain Agrawal, Agra.
3. Rubenstein J M (2010) *Contemporary Human Geography*. PHI learning Pvt., New Delhi.
4. Chandna, R.C. (2006) *Geography of Population*. Kalyani Publishers. New Delhi
5. Hagget, P. (2002)*Geography: A Modern Synthesis*. Harper & Row, New York
6. De Blij, H.J., Human Geography, Culture, Society and Space, John Wiley, New York, 2006
7. Fellman, J.L. Human Geography-Landscapes of Human Activities, Brown and Bench man, Pub. U.S.A. 2007.
8. Arun Kumar Sharma, 2012: Principles of Human Geography, Rastogi Publications, Meerut

Web-based:

1. https://researchguides.dartmouth.edu/human_geography
2. https://freegeobook.files.wordpress.com/2009/01/0761942637.pdf
3. https://www.britannica.com/science/human-evolution
4. https://ourworldindata.org/economic-inequality-by-gender
5. https://pages.uwc.edu/keith.montgomery/Demotrans/demtran.htm

CORE
Course Title: Basics of Human Geography (Practical)
Course Code: GEG-II.SC3
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
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Unit.	Title	Practical sessions
I	Calculation and interpretation of: **1. Fertility measures**: Crude Birth Rate, General Fertility Rate **2. Mortality measures**: Crude Death Rate, Infant Mortality Rate. **3. Age data Analysis**: Age and gender composition **4.** Construction of Population Pyramid	8
II	**5. Literacy measures**: Crude Literacy Rate. Gross Enrolment Ratio. **6.** Work Participation Ratio. **7.** Per capita income **8.** GDP	7
III	Journal and viva	
		15

References:
Mandatory:
1. Bose, Ashish et. al., 2004: Population in India's Development, Vikas Publishing House, New Delhi
2. Chandna, R.C. Geography of Population: Concept, Determinants and Patterns, Kalyani Publishers, New York 2000.

Supplementary:
1. Bogue, D. J., 2001: Principles in Demography, John Wiley, New York
2. Census of India, 2001, India: A State Profile
3. Crook, Nigel, 2007, Principles of Population and Development. Pergmon Press, New York.
4. Daugherty, Helen Gin, Kenneth C.W. Kammeryir (2008) An Introduction to Population (Second Edition). The Guilford Press, New York, London
5. Mitra, Asok, 2008, India's Population. Aspects of quality and Control Vol. I & II. Abhinar Publication. New Delhi.
6. Srinivsan, K. and M. Vlassoff, 2001. Population Development Nexus in India: Challenges for the New Millennium. Tata McGraw Hill, New Delhi.
7. Srinivasan, K. Basic Demographic Techniques and Applications Sage Publications, New Delhi 2008.
8. UNDP, 2000: Human Development Report Oxford University Press, Oxford.
9. United Nations, 2004, Methods for Projections of Urban and Rural Populations. No. VIII, New York.
10. Woods, R., 2009: Population Analysis in Geography, Longman, London.
11. Sawant & Athavale, 2005: Population Geography, Mehta Publishing House, Pune.

Web-based:
1. https://ourworldindata.org/fertility-rate
2. https://www.who.int/data/gho/indicator-metadata-registry/imr-details/3130
3. https://censusindia.gov.in/census_and_you/gender_composition.aspx
4. https://www.britannica.com/topic/population-pyramid
5. https://censusindia.gov.in/Census_Data_2001/India_at_glance/workpart.aspx

CORE
Course Title: Basics of Regional Geography (Theory)
Course Code: GEG-II.SC4
Marks: 75
Credits: 3
Duration:45 lectures of 1 hour each
===
Prerequisite Courses: Nil

Course Objectives:

1. The course aims to develop a basic understanding of the regions and recognizing the significance of geography in shaping region.
2. It helps students to appreciate regional unique dimensions of regions.

Course Outcomes: At the end of this course, students will be able to:

CO1: Understand Fundamental concepts of regional geography
CO2: Apply techniques of regionalization
CO3: Differentiate among different regions spatial organization and areal variation in human activities.
CO4: Develop an understanding of basic quantitative techniques used in regional geography.
CO5: Develop the skill of calculation of different indicators of development.
CO6: Diagrammatically represent and interpret regional data
CO7: Represent and interpret characteristics of various regions.

Unit	Title	No. of hours
I	Concept of Region in Geography: Definition and characteristic The Regional Approach - area, region, space Factors of regionalization ii) Methods of Regionalization- methods of delineation of region, types of regions,	15
II	i.) Foundations of Region - Ecological, Economic, Social and Cultural Dimensions ii.) Federalism-center – state relationships. iii.) Core – Periphery iv.) Hierarchy of regions, v.) Regional Consciousness and Identity. vi.) The Regional issues. (Two case studies)	15
III	Study of Regional Organization: Their evolution, functions and inter-linkages. Globalization and the New Territorial Order.	15
		45

References:
Mandatory:
1. Singh, R.L., 2001 (ed): India – A Regional Geography, National Geographical Society, India
2. Paul Claval, 2003, *An Introduction to Regional Geography*, , Rawat Publication, Jaipur & Delhi

Supplementary:
1. Cole, J. 2000: *A Geography of the World's Major Regions*, Routledge, London
2. Israel, S. Johnson, D.I. and Wood, D., 2005: World Geography Today
3. Jackson, R.H. and Hudman, L.E, 2007: Regional Geography: Issues for Today.
4. Wheeler, J.H. Jr. and Kostbade, J.T., (1990): World Regional Geography, Holt Rinshort and Winston, Inc
5. Holier, G.P., 2008: Regional Development in Michael Pacione (ed), *The Geography of the 3rd World: Progress & Prospects*, Rutledge, London, New York.
6. Jackson, R.H. and Hudmar, L.E. 2004: Regional Geography: Issues for Today
7. Paul Claval (2008) An Introduction to Regional Geography, Wiley-Blackwell, ISBN 155786733X.

Web-based:
1. https://shodhganga.inflibnet.ac.in/bitstream/10603/39734/12/12_chapter%202.pdf
2. https://issuu.com/rengasamy/docs/regional_planning_part_ii_types_of_regions__regio
3. https://www.insightsonindia.com/2014/11/13/regionalism-dimensions-meaning-issues/
4. https://link.springer.com/chapter/10.1007/978-3-319-18971-0_7
5. https://www.longdom.org/open-access/from-globalization-to-regionalism-and-interregionalism-a-study-ofsaarc-2332-0761-1000279.pdf
6. https://institutdelors.eu/wp-content/uploads/2018/01/regionalism_globalgovernance_t.behr-j.jokela_ne_july2011_01.pdf

CORE
Course Title: Basics of Regional Geography (Practical)
Course Code: GEG-II.SC4
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
==

Unit	Topic	Practical Sessions	Marks
I	Methods of Regional Demarcation: 1. Demarcation of agricultural regions (crop combination and diversification) 2. Gravity model, 3. Breaking point Analysis, 4. Sphere of Urban Influence 5. Population potential surfaces	08	10
II	6. Network Analysis 7. Nearest Neighbor index, 8. Centro graphic analysis	07	10
III	Journal and viva		05
		15	25

References:

Mandatory:
1. Hegget Peter, Cliff A.D. et. al. (2001) Locational Methods, Locational Analysis in Human Geography, Vol. II Arnold – Heinemann Pub. (India)

Supplementary:
1. Hegget Peter, Cliff A.D. et. al. (2000) Locational Models, Locational Analysis in Human Geography. Vol. I Arnold – Heinemann Pub. (India)
2. Chandna R.C. (2003): Regional Planning: A Comprehensive Text, Kalyani Publishers, Ludhiana

Web-based:
1. https://www.thoughtco.com/reillys-law-of-retail-gravitation-1433438
2. https://www.geographyforyou.com/2019/09/maximum-positive-deviation-crop.html
3. http://www.fao.org/3/x6906e/x6906e06.htm
4. https://shodhganga.inflibnet.ac.in/bitstream/10603/10376/9/09_chapter%201.pdf
5. https://karnataka.pscnotes.com/main-notes/paper-iii-general-studies-ii/urban-spheres-of-influence-and-rural-urban-fringe/
6. https://transportgeography.org/?page_id=623
7. https://www.geoib.com/nearest-neighbor-index.html
8. https://rashidfaridi.com/2017/09/14/centrographic-techniques/
9. http://www.geodz.com/eng/d/population-potential/population-potential.htm

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY

BACHELOR OF SCIENCE

SEMESTER III

UPDATED ON 16TH MARCH 2020

CORE
Course Title: Fundamentals of Remote Sensing and GIS (Theory)
Course Code: GEG-III.SC5
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==

Prerequisite Courses: Nil

Course Objectives:
1. To introduce key concepts of Remote Sensing and GIS**.**

Course Outcomes:
At the end of this course, students will be able to:
CO1: Understand the basic science of remote sensing
CO2: Interpret and analyze remotely sensed data.
CO3: Carry out photogrammetric observations and calculate area, height, depth and changes in the same.
CO4: Understand interaction of EMR with Earth surface materials

Unit	Title	No. of hours
I	**Concepts of Remote Sensing , Introduction to remote sensing system, stages-**Electromagnetic Radiation, theories of radiation and its components: Characteristics of Electromagnetic Spectrum Energy Types of Remote sensing Introduction to Sensors and platforms	15
II	Interactions with Earth's atmosphere and surface features; Spectral response of Earth's natural surface. Resolution Aerial Photography:- Types, Error In Flying, Geometry, Scale, Relief Displacement, Stereoscopes Parallax	15
III	**Visual Interpretation of Satellite Images and Aerial Photographs :** Elements of Image interpretation, Interpretation of Multi-Spectral Imagery, Identification of Earth Surface Features Levels of interpretation	15
		45

References:

Mandatory:

1. Lillesand T.M. and Kiefer R.W., (2002) Remote Sensing and Image Interpretation, John Wiley and Sons, New Delhi.
2. George Joseph (2005) Fundamentals of Remote Sensing, University press Private Ltd, Hyderabad.
3. J. R. Jensen, (2003) Remote Sensing of Environment, An Earth Resource Perspective, Pearson Education Pvt. Ltd., New Delhi.

Supplementary:

1. C.P. Lo and Albert K. W. Yeung, (2002) Concepts and Techniques of Geographic Information System, Prentice –Hall, India.
2. Heywood I. (2011) An Introduction to Geographical Information Systems, Pearson Education Pvt. Ltd., New Delhi.
3. Kang – tsung – Chang, (2002) Introduction to Geographical Information System, , McGraw Hill.
4. P. A. Burrough and R. A. McDonnell, (2000) Principles of Geographical Information System, , Oxford University Press.
5. Paul A. Lonfley, et al.(2002), Introduction to Geographic Information Systems and Science, , John Wiley and Sons Ltd

Web Based:

1. https://www.nrcan.gc.ca/maps-tools-publications/satellite-imagery-air-photos/remote-sensing-tutorials/fundamentals-remote-sensing-introduction/9363
2. https://nptel.ac.in/courses/105/108/105108077/
3. https://crisp.nus.edu.sg/~research/links/rs-tut.html
4. http://www2.geog.ucl.ac.uk/~mdisney/teaching/PPRS/
5. https://gisgeography.com/remote-sensing-of-the-environment/

CORE
Course Title: Fundamentals of Remote Sensing and GIS (Practical)
Course Code: GEG-III.SC5
Marks: 25
Credits: 01
Duration: 15 sessions of 2 hours each
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Unit	Title	Practical sessions
I	Determination of scale, coverage, area, distance and height. Determination of parallax using mirror stereoscope. Interpretation of Aerial Photographs & Satellite images	07
II	Visual interpretation of aerial photo and satellite imageries Identification of physical and cultural features using elements of interpretation and their verification and ground truthing Levels of interpretation- 1 & 2	08
III	Journal	
		15

References:
Mandatory:
1. Lillesand T.M. and Kiefer R.W., (2002) Remote Sensing and Image Interpretation, John Wiley and Sons, New Delhi.
2. George Joseph (2005) Fundamentals of Remote Sensing, University press Private Ltd, Hyderabad.
3. J. R. Jensen, (2003) Remote Sensing of Environment, An Earth Resource Perspective, Pearson Education Pvt. Ltd., New Delhi.

Supplementary:
1. C.P. Lo and Albert K. W. Yeung, (2002) Concepts and Techniques of Geographic Information System, Prentice –Hall, India.
2. Heywood I. (2011) An Introduction to Geographical Information Systems, Pearson Education Pvt. Ltd., New Delhi.
3. Kang – tsung – Chang, (2002) Introduction to Geographical Information System, , McGraw Hill.
4. P. A. Burrough and R. A. McDonnell, (2000) Principles of Geographical Information System, , Oxford University Press.
5. Paul A. Lonfley, et al.(2002), Introduction to Geographic Information Systems and Science, , John Wiley and Sons Ltd

Web Based:
1. https://www.nrcan.gc.ca/maps-tools-publications/satellite-imagery-air-photos/remote-sensing-tutorials/fundamentals-remote-sensing-introduction/9363
2. https://nptel.ac.in/courses/105/108/105108077/
3. https://crisp.nus.edu.sg/~research/links/rs-tut.html
4. http://www2.geog.ucl.ac.uk/~mdisney/teaching/PPRS/
5. https://gisgeography.com/remote-sensing-of-the-environment/

ELECTIVE
Course Title: Spatial Analysis (Theory)
Course Code: GEG-SE1
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==
Prerequisite Courses: Nil

Course Objectives:

1. To introduce the fundamentals of spatial analysis through pattern recognition, interpolation, locational and topographical analysis.

Course Outcomes:
At the end of this course, students will be able to:

CO1: Differentiate between spatial and attribute data using GIS software
CO2: Process raster data in raster processing software
CO3: Process vector data in GIS
CO4: Acquire the skills of spatial analysis
CO5: Prepare topographic models and study morphometric properties of terrain

Unit	Topic	No. of hours
I	**Introduction to Spatial Analysis**: concepts, functions of spatial analysis Characteristics, importance of geo-data base Topology and types Concept and sources of Spatial and Non-Spatial Data	15
II	Concept and methods of spatial Interpolation. Raster analysis. Overlay analysis.	20
III	**Topographic Analysis**: Digital Elevation Model, Slope, Aspect, Flow Accumulation, Flow Direction etc.	10
		45

References:

Mandatory:

1. Alias A. Rahman and Morakot Pilouk (2008) Spatial Data Modeling for 3D GIS, Springer New York
2. Thurston, J., Poiker, T.K. and J. Patrick Moore. (2003). Integrated Geospatial Technologies: A Guide to GPS, GIS, and Data Logging. Hoboken, New Jersey: Wiley.

Supplementary:

1. Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W. (2005). Geographic Information Systems and Science. Chichester: Wiley. 2nd edition.
2. M Goodrich (2000). Data Structures and Algorithms in Java, 2nd Edition Wiley.
3. Malczewski, J. (1999). GIS and Multicriteria Decision Analysis. New York: John Wiley and Sons
4. Ott, T. and Swiaczny, F. (2001). Time-integrative GIS. Management and analysis of spatio-temporal data. Berlin / Heidelberg / New York: Springer.

Web based:

1. https://www.usna.edu/Users/oceano/pguth/md_help/html/mapb38f5.htm
2. https://www.researchgate.net/publication/311953089_An_integrated_algorithm_to_evaluate_flow_direction_and_flow_accumulation_in_flat_regions_of_hydrologically_corrected_DEMs
3. https://www.slideshare.net/RohitKumar431/topology-in-gis
4. http://www.geography.hunter.cuny.edu/~jochen/GTECH361/lectures/lecture07/concepts/07%20-%20Topology.htm
5. https://www.slideshare.net/SumantDiwakar/spatial-vs-non-spatial

ELECTIVE
Course Title: Spatial Analysis (Practical)
Course Code: GEG-SE1
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hour each
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Unit	Topic	Practical Sessions
I	**Vector Operations** (Single Layer): Dissolve, Buffer, Multi Ring Buffer. Vector Operations (Multi Layer): Clip, Erase, Merge, Intersect. **Raster Operations**: clip and mosaic (Extract By Mask). Spatial Queries and Non-Spatial Queries based on locations	10
II	**Interpolation**: Inverse Distance Weighted method Topo to Raster. **Overlay Operations** (Point in Polygon, Line in Polygon, Polygon in polygon).	05
III	Journal	-
		15

References:
Mandatory:
1. Alias A. Rahman and Morakot Pilouk (2008) Spatial Data Modeling for 3D GIS, Springer New York
2. Thurston, J., Poiker, T.K. and J. Patrick Moore. (2003). Integrated Geospatial Technologies: A Guide to GPS, GIS, and Data Logging. Hoboken, New Jersey: Wiley.

Supplementary:
1. Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W. (2005). Geographic Information Systems and Science. Chichester: Wiley. 2nd edition.
2. M Goodrich (2000). Data Structures and Algorithms in Java, 2nd Edition Wiley.
3. Malczewski, J. (1999). GIS and Multicriteria Decision Analysis. New York: John Wiley and Sons
4. Ott, T. and Swiaczny, F. (2001). Time-integrative GIS. Management and analysis of spatio-temporal data. Berlin / Heidelberg / New York: Springer.

Web Based:
1. https://mgimond.github.io/Spatial/spatial-operations-and-vector-overlays.html
2. https://onlinelibrary.wiley.com/doi/10.1002/9781118826171.ch9
3. http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=How_Inverse_Distance_Weighted_(IDW)_interpolation_works
4. https://mgimond.github.io/Spatial/spatial-interpolation.html
5. https://webapps.fundp.ac.be/geotp/SIG/interpolating.pdf

ELECTIVE
Course Title: Raster and Vector Data Models in GIS (Theory)
Course Code: GEG-SE2
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==

Prerequisite Courses: Nil

Course Objectives:
1. To introduce basic concepts and principles of GIS and emphasize on the role of raster and vector data models.
2. To introduce students to data processing, transformation and visualization of data using various models.

Course Outcomes
At the end of this course, students will be able to:
CO1: Integrate raster and vector data models and also appreciate the role of these models in visualizing graphical outputs through GIS.
CO2: Process & interpolate using 2D and 3D raster and vector data.
CO3: Perform network analysis and cluster analysis.
CO4: Understand projections and use it for spatial data presentation in GIS

Unit	Title	No. of hours
I	GIS Concepts, Principles, Geospatial Data Models, Organization of GIS Data and System Functionality, Map Projections, Coordinate Systems and Transformations.	15
II	Fundamentals of Raster data models, metadata and data exchange 2D and 3D raster data models Fundamentals of raster maps, Raster data transformation	15
III	Vector data Basics of vector data and Generation of vector data, fundamentals of Vector map queries and statistics, Basics of Point analysis Basics of Network analysis	15
		45

References:
Mandatory:

1. C.P. Lo and Albert K. W. Yeung, (2002) Concepts and Techniques of Geographic Information System, Prentice –Hall, India.
2. Heywood I. (2011) An Introduction to Geographical Information Systems, Pearson Education Pvt. Ltd., New Delhi.
3. Kang – tsung – Chang, (2002) Introduction to Geographical Information System, , McGraw Hill.
4. Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W. (2005). Geographic Information Systems and Science. Chichester: Wiley. 2nd edition.

Supplementary

1. Markus Neteler and Helena Mitasova (2008) OPEN SOURCE GIS, A GRASS GIS Approach (Third Edition) Springer, USA
2. McCartney Taylor, Nik Freeman (2014) Getting Started With GIS Using QGIS (Kindle Edition) McCartney Taylor.

Web based:

1. https://mgimond.github.io/Spatial/index.html
2. https://www.esri.com/content/dam/esrisites/en-us/media/pdf/teach-with-gis/raster-faster.pdf
3. https://gisgeography.com/spatial-data-types-vector-raster/
4. https://www.gislounge.com/geodatabases-explored-vector-and-raster-data/
5. https://support.pitneybowes.com/SearchArticles/VFP05_KnowledgeWithSidebarHowTo?id=kA180000000Cu9DCAS&popup=false&lang=en_US
6. https://desktop.arcgis.com/en/arcmap/10.3/manage-data/raster-and-images/what-is-raster-data.htm

ELECTIVE
Course Title: Raster and Vector Data Models in GIS (Practical)
Course Code: GEG-SE2
Marks: 25
Credits: 1
Duration: 15 Sessions of 2 hour each
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Unit	Title	Practical sessions
I	Import of raster data, Coordinate transformation, Raster map algebra Raster data transformation and interpolation Spatial analysis with raster data	8
II	Vector Data generation Network Analysis Cluster analysis Transformations to Raster(vectorization - rasterization) Spatial Interpolation.	7
III	Journal	
		15

References:
Mandatory:
1. C.P. Lo and Albert K. W. Yeung, (2002) Concepts and Techniques of Geographic Information System, Prentice –Hall, India.
2. Heywood I. (2011) An Introduction to Geographical Information Systems, Pearson Education Pvt. Ltd., New Delhi.
3. Kang – tsung – Chang, (2002) Introduction to Geographical Information System, , McGraw Hill.
4. Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W. (2005). Geographic Information Systems and Science. Chichester: Wiley. 2nd edition.

Supplementary
1. Markus Neteler and Helena Mitasova (2008) OPEN SOURCE GIS, A GRASS GIS Approach (Third Edition) Springer, USA
2. McCartney Taylor, Nik Freeman (2014) Getting Started With GIS Using QGIS (Kindle Edition) McCartney Taylor.

Web based:
1. https://mgimond.github.io/Spatial/index.html
2. https://www.esri.com/content/dam/esrisites/en-us/media/pdf/teach-with-gis/raster-faster.pdf
3. https://gisgeography.com/spatial-data-types-vector-raster/
4. https://www.gislounge.com/geodatabases-explored-vector-and-raster-data/
5. https://support.pitneybowes.com/SearchArticles/VFP05_KnowledgeWithSidebarHowTo?id=kA180000000Cu9DCAS&popup=false&lang=en_US
6. https://desktop.arcgis.com/en/arcmap/10.3/manage-data/raster-and-images/what-is-raster-data.htm

ELECTIVE
Course Title: Participatory GIS (Theory)
Course Code: GEG-SE3
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
===

Prerequisite Courses: Nil

Course Objectives:
1. To expose students to applications of GIS in the context of community and people's participation.
2. To enhance Geographical Information through shared knowledge and information.

Course Outcomes:
At the end of this course, students will be able to:
CO1: Understand the concepts of PRA, P-GIS pGIS, Pgis
CO2: Develop the skill of data management and community mapping
CO3: Prepare a community resource inventory (any two case studies)
CO4: Evaluate the role of local people in developing and maintaining the community resources

Unit	Title	No. of hours
I	Participatory Geographic Information Systems Concepts and Methods, History (PRA, P-GIS pGIS Pgis) Ethics, Partnership, role and responsibility of the scientist. Methodology for Pgis, implementation and limitations of the participation Methods, Techniques, advantages of community mapping. Data management. Features of interest for socio-economic analysis and social development skills and training requirements. P-GIS and the livelihoods approach.	15
II	Contribution of P-GIS through Community Mapping in Water Resource Inventory. Urban and Peri-Urban Partnership and Community Empowerment Community Resource Mapping in Forest, Agriculture and Water Resources Management: Bridging the Divide between Community and Government Voluntary Information and PGIS (VI & PGIS)	15
III	Neo-geography and GIS/2 : value addition to P-GIS Needs of Participatory GIS. Perspectives on Participatory mapping and PGIS	15
		45

References

Mandatory:

1. Abbot, J., Chambers, R., Dunn, C., Harris, T., Merode, E. d., Porter, G., Townsend, J.,Weiner, D., de Merode, E., (1998). 'Participatory GIS: opportunity or oxymoron?' PLA Notes33. IIED: Londo
2. Elwood, Sarah (2006) Participatory GIS and Community Planning: Restructuring Technologies, Social Processes, and Future Research in PPGIS Collaborative Geographic Information Systems edited by Shivanand Balram and Suzana Dragicevic, Idea Group Inc. University of Arizona, USA

Supplementary:

1. Elwood, Sarah (2006), Critical Issues in Participatory GIS: Deconstructions, Reconstructions, and New Research Directions Transactions in GIS, 10(5): 693–708
2. McCall, Michael K. (2004) Can Participatory-GIS Strengthen Local-level Spatial Planning? Suggestions for Better Practice. Dept. of Urban & Regional Planning and GeoInformation Management ITC. Course prepared for: GISDECO 2004 Skudai, Johor, Malaysia, 10-12 May (2004)
3. Quan, Julian, Oudwater,Nicoliene, Pender, Judith and Martin, Adrienne (2001)*GIS And Participatory Approaches In Natural Resources Research*. SOCIO-ECONOMIC METHODOLOGIES FOR NATURAL RESOURCES RESEARCH BEST PRACTICE GUIDELINES. Published by Natural Resources Institute, The University of Greenwich 2001
4. Minang, Peter A. and McCall, Michael K. (2006) Participatory GIS and local knowledge enhancement for community carbon forestry planning: an example from Cameroon. Participatory Learning and Action.

Web based:

1. https://www.participatorymethods.org/method/participatory-geographical-information-systems-pgis
2. https://vimeo.com/channels/pgis
3. http://www.ppgis.net/about-pgis/
4. http://www.iapad.org/wp-content/uploads/2015/07/ppgis_the_future_of_environmental_gis.pdf
5. https://pages.uoregon.edu/schlossb/articles/schlossberg_brehm_PGIS_active_transportation2.pdf
6. https://www.involve.org.uk/resources/methods/participatory-gis

ELECTIVE
Course Title: Participatory GIS (Practical)
Course Code: GEG-SE3
Marks: 25
Credits: 1
Duration: 15 Sessions of 2 hour each
==

Unit	Title	Practical Sessions
I	Data processing and computing indices Linear Model & Linear Combination Method (LCM) Assessment Index (AI) Employment index (M) Education index (E) Health index (S) Housing index (H) Infrastructure index The Principal Component Analysis Method (PCAM) Marginality Index (MI) Human Development Index	5
II	Case study of any one of the following (mini project) Water Resource Inventory Urban and Peri-Urban Agriculture Forest and Water Resources Management Using software like GRASS (Geographic Resources Analysis Support System) and ILWIS (Integrated Land and Water Information System)	10
III	Project report	
		15

References
Mandatory:

1. Abbot, J., Chambers, R., Dunn, C., Harris, T., Merode, E. d., Porter, G., Townsend, J.,Weiner, D., de Merode, E., (1998). 'Participatory GIS: opportunity or oxymoron?' PLA Notes33. IIED: Londo
2. Elwood, Sarah (2006) Participatory GIS and Community Planning: Restructuring Technologies, Social Processes, and Future Research in PPGIS Collaborative Geographic Information Systems edited by ShivanandBalram and SuzanaDragicevic, Idea Group Inc. University of Arizona, USA
3. Françoise Orban-FeraugeV.Aguilar, E. Alarcon, A. Carmona, N. Daix, B. Denil, A. Ignacio, J. Martinez, M. McCall, G.Miscione, E. Olivarez, M. Pandan. G. Rambaldi, R. Teruel, J. Verplanke participatory geographic information systems and land planning life experiences for people empowerment and community transformation , Technical Centre for Agricultural and Rural Cooperation ACP-EU (CTA) Wageningen, The Netherlands

Supplementary:

1. Elwood, Sarah (2006), Critical Issues in Participatory GIS: Deconstructions, Reconstructions, and New Research Directions Transactions in GIS, 10(5): 693–708
2. McCall, Michael K. (2004) Can Participatory-GIS Strengthen Local-level Spatial Planning? Suggestions for Better Practice. Dept. of Urban & Regional Planning and GeoInformation Management ITC. Course prepared for: GISDECO 2004 Skudai, Johor, Malaysia, 10-12 May (2004)
3. Quan, Julian, Oudwater,Nicoliene, Pender, Judith and Martin, Adrienne (2001)*GIS And Participatory Approaches In Natural Resources Research*. SOCIO-ECONOMIC METHODOLOGIES FOR NATURAL RESOURCES RESEARCH BEST PRACTICE GUIDELINES. Published by Natural Resources Institute, The University of Greenwich 2001
4. Minang, Peter A. and McCall, Michael K. (2006) Participatory GIS and local knowledge enhancement for community carbon forestry planning: an example from Cameroon. Participatory Learning and Action.

Web based:

1. https://www.participatorymethods.org/method/participatory-geographical-information-systems-pgis
2. https://vimeo.com/channels/pgis
3. http://www.ppgis.net/about-pgis/
4. http://www.iapad.org/wp-content/uploads/2015/07/ppgis_the_future_of_environmental_gis.pdf
5. https://pages.uoregon.edu/schlossb/articles/schlossberg_brehm_PGIS_active_transportation2.pdf
6. https://www.involve.org.uk/resources/methods/participatory-gis

ELECTIVE
Course Title: Applied GIS (Theory)
Course Code: GEG-SE4
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
===

Prerequisite Courses: Nil

Course Objectives:
1. To introduce various recent application of GIS in business, society, transportation and spatial planning.

Course Outcomes:
At the end of this course students will be able to:
CO1: Correlate knowledge of GIS in business applications
CO2: Understand the applications of GIS in socio-economic planning.
CO3: Use GIS to address local problems and suggest realistic spatial solutions
CO4: Understand applications of GIS in transport and network planning
CO5: Understand and apply spatial modeling to real time situations.

Unit	Title	No. of hours
I	**Geo-business** Retail Application of Spatial Modelling to Solve: Retail Location Problems, Location Based Services for Mobile Applications Mass Appraisal Model, Lifestyle Segmentation Profiles, Neighbourhood Model, Housing Price Mass Appraisal Model.	15
II	**Social Application**: Assessing Clusters of Deprivation in City Regions, GIS for Joined up Government Spatial Statistical Methods to the Detection of Geographical Patterns of Crime **Transport and Location**: Demand Responsive Passenger Transport Services, Strategic Land Use / Transportation Model, Relocation of Facilities. Probability Based GIS Model.	15
III	**Spatial Planning** Modelling Migration, Modeling Regional Economic Growth, Carrying Capacity, Planning Network of Site, Assessing Service Provision,	15
		45

References:

Mandatory:

1. Stillwell, John and Clarke, Graham (2004) Applied GIS and Spatial Analysis (Ed). John Willy and Sons LTD England

Supplementary:

1. C.P. Lo and Albert K. W. Yeung, (2002) Concepts and Techniques of Geographic Information System, Prentice –Hall, India.
2. Heywood I. (2011) An Introduction to Geographical Information Systems, Pearson Education Pvt. Ltd., New Delhi.
3. Kang – tsung – Chang, (2002) Introduction to Geographical Information System, , McGraw Hill.
4. P. A. Burrough and R. A. McDonnell, (2000) Principles of Geographical Information System, , Oxford University Press.
5. Paul A. Lonfley, et al.(2002), Introduction to Geographic Information Systems and Science, , John Wiley and Sons Ltd

Web based:

1. https://www.esri.com/en-us/arcgis/products/arcgis-storymaps/albums/applied-gis
2. https://mgimond.github.io/Spatial/introGIS.html
3. https://publishing.monash.edu/epress/ag/index.html
4. https://scholar.harvard.edu/files/dell/files/090110combined_gis_notes.pdf
5. https://dash.harvard.edu/bitstream/handle/1/27007691/Applying%20GIS%20Methods.pdf?sequence=3&isAllowed=y

ELECTIVE
Course Title: Applied GIS (Practical)
Course Code: GEG-SE4
Marks: 25
Credits: 1
Duration: 15 Sessions of 2 hour each
==

Unit	Title	Practical Sessions
I	Spatial Modelling: Land Use transformation model and Transportation Model, Neighboring Model (NNI)	8
II	Spatial Statistic: Cluster Analysis, Crime Pattern Analysis, Mass Appraisal	7
III	Journal	
		15

References:
Mandatory:
1. Stillwell, John and Clarke, Graham (2004) Applied GIS and Spatial Analysis (Ed). John Willy and Sons LTD England

Supplementary:
1. C.P. Lo and Albert K. W. Yeung, (2002) Concepts and Techniques of Geographic Information System, Prentice –Hall, India.
2. Heywood I. (2011) An Introduction to Geographical Information Systems, Pearson Education Pvt. Ltd., New Delhi.
3. Kang – tsung – Chang, (2002) Introduction to Geographical Information System, , McGraw Hill.
4. P. A. Burrough and R. A. McDonnell, (2000) Principles of Geographical Information System, , Oxford University Press.
5. Paul A. Lonfley, et al.(2002), Introduction to Geographic Information Systems and Science, , John Wiley and Sons Ltd

Web based:
1. https://www.esri.com/en-us/arcgis/products/arcgis-storymaps/albums/applied-gis
2. https://mgimond.github.io/Spatial/introGIS.html
3. https://publishing.monash.edu/epress/ag/index.html
4. https://scholar.harvard.edu/files/dell/files/090110combined_gis_notes.pdf
5. https://dash.harvard.edu/bitstream/handle/1/27007691/Applying%20GIS%20Methods.pdf?sequence=3&isAllowed=y

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER IV
UPDATED ON 16TH MARCH 2020

CORE
Course Title: Fundamentals of Geomorphology (Theory)
Course Code: GEG-IV.SC6
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
===

Prerequisite Courses: Nil

Course Objectives:
1. To provide the fundamentals of geomorphology.
2. To focus on application of geomorphological knowledge to resolve the challenging issues of man environment relationships.

Course Outcomes:
At the end of this course, students will be able to:
CO1: Understand fundamentals of geomorphology.
CO2: Analyze soil properties.
CO3: Understand the concepts and processes of geomorphic landforms.
CO4: Develop the skill of comparative analysis of slope development and their effect on human activities.
CO5: Understand application of geomorphology in various fields.

Unit	Title	No. of hours
I	Geomorphic concept : major geomorphic concept	18
II	Slope development theory. Davis and Penck. Aeolian landforms: Erosional & Depositional. Glacial Landforms: Erosional and Depositions	12
III	Application of Geomorphology: • Mining • Hazard management • Agriculture • Environmental management	15
		45

References:
Mandatory:

1. Bloom, Arthur L., 2008: Geomorphology – A Systematic Analysis of Late Cenozoic Landforms, Prentice Hall, Engle Wood Cliff, New Jersey.
2. Dayal, P. (2nd edition) 2006: A Textbook of Geomorphology, Shukla Book Depot, Patna
3. Strahler, A.N., 2005: Physical Geography, 3rd Ed., Wiley Publications
4. Singh, S. 2005: Physical Geography, Prayag Pustak Bhawan, Allahabad
5. Chorley, Richard J., 2002: Spatial Analysis in Geomorphology, Harper and Row Publishers, New York, London.

Supplementary:

1. Ahmed, E., 2005 : Geomorphology , Kalyan Publishers, New Delhi
2. Cooke R. U. and Doornkamp J.C. (1989): Geomorphology in Environmental Management, 2nd Edition, Oxford : Clarendon Press
3. Sharma, H.S. (ed), 2002: Perspective in Geomorphology, Vol. I & Vol. IV, Concept, New Delhi.
4. Sharma, V.K., 2006 : Geomorphology, Earth Surface Processes and Forms, Tata Mc. Graw Hill, New Delhi
5. Sharma, V.K., 2006 : Geomorphology, Earth Surface, Process and forms, Tata McGraw Hill, New York
6. Sparks, B.W., 2000: Geomorphology, Longman, London, 2nd edition.
7. Thornbury W.D, 2001: Principles of Geomorphology , 2nd Ed., Wiley International edition, Wiley Eastern Reprint, 2001
8. Wooldridge, S.W. and Morgan, R.S., 2000: The Physical Basis of Geography, Longman.
9. Worcestor, P.G., 2005: A textbook of Geomorphology, Van Nostrand, 2nd Ed., East west Edition, New Delhi

Web based:

1. http://shaileshchaure.com/Notes/GEOMCON.pdf
2. https://www.iasj.net/iasj?func=fulltext&aId=16936
3. https://www.nps.gov/subjects/geology/aeolian-landforms.htm
4. https://www.nps.gov/subjects/geology/glacial-landforms.htm
5. https://www.researchgate.net/publication/247773175_Geomorphology_Concepts_and_Applications

CORE
Course Title: Fundamentals of Geomorphology (Practical)
Course Code: GEG-IV.SC6
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hour each
==

Unit	Title	Practical sessions
I	Identification of rocks and their properties Soil profile, Soil analysis	9
II	Interpretation of geological map, structural landforms (aerial photo or geological maps): identifications of faults, lineaments, dykes and sills, rock types Identification of Aeolian and Glacial Landforms from toposheet	6
III	Journal and viva voce	
		15

References:
Mandatory:
1. Bloom, Arthur L., 2008: Geomorphology – A Systematic Analysis of Late Cenozoic Landforms, Prentice Hall, Engle Wood Cliff, New Jersey.
2. Dayal, P. (2nd edition) 2006: A Textbook of Geomorphology, Shukla Book Depot, Patna
3. Strahler, A.N., 2005: Physical Geography, 3rd Ed., Wiley Publications
4. Singh, S. 2005: Physical Geography, Prayag Pustak Bhawan, Allahabad
5. Chorley, Richard J., 2002: Spatial Analysis in Geomorphology, Harper and Row Publishers, New York, London.

Supplementary:
1. Ahmed, E., 2005 : Geomorphology , Kalyan Publishers, New Delhi
2. Cooke R. U. and Doornkamp J.C. (1989): Geomorphology in Environmental Management, 2nd Edition, Oxford : Clarendon Press
3. Sharma, H.S. (ed), 2002: Perspective in Geomorphology, Vol. I & Vol. IV, Concept, New Delhi.
4. Sharma, V.K., 2006 : Geomorphology, Earth Surface Processes and Forms, Tata Mc. Graw Hill, New Delhi
5. Sharma, V.K., 2006 : Geomorphology, Earth Surface, Process and forms, Tata McGraw Hill, New York
6. Sparks, B.W., 2000: Geomorphology, Longman, London, 2nd edition.
7. Thornbury W.D, 2001: Principles of Geomorphology , 2nd Ed., Wiley International edition, Wiley Eastern Reprint, 2001
8. Wooldridge, S.W. and Morgan, R.S., 2000: The Physical Basis of Geography, Longman.
9. Worcestor, P.G., 2005: A textbook of Geomorphology, Van Nostrand, 2nd Ed., East west Edition, New Delhi

Web based:
1. http://earthsci.org/mineral/rockmin/identification/identification.html
2. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=nrcs142p2_054308
3. https://study.com/academy/lesson/understanding-interpreting-a-geologic-map.html
4. https://www.nps.gov/subjects/geology/aeolian-landforms.htm
5. https://www.nps.gov/subjects/geology/glacial-landforms.htm

ELECTIVE
Course Title: Coastal Geomorphology (Theory)
Course Code: GEG-SE5
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==
Prerequisite Courses: Nil

Course Objectives:
1. To familiarize students about the mechanism of landform development resulting from coastal processes.

Course Outcomes:
At the end of this course, students will be able to:
CO1: Understand various processes and associated landforms in coastal region
CO2: Learn the methods of coastal hazard management
CO3: Prepare and interpret coastal landscape maps.
CO4: Conduct beach profiling using survey instruments.

Unit	Title	No. of hours
I	Introduction to coastal Processes Waves: Formation, Drifts and Tides. Types of coastlines, Coastal erosion and deposition. Coastal landforms.	15
II	Beach Geomorphology: Types and Configuration of beaches Coastal wetlands. Coral reefs and marine environment.	15
III	Coastal Ecosystem Management. Coastal Hazard Management.	15
		45

References:
Mandatory:

1. Eric Bird: Coastal Geomorphology: An Introduction, John Wiley & Sons; 1 edition (November 7, 2000),
2. Kale, V. S. and Gupta, A. (Rep.2011): Introduction to Geomorphology, Orient Longman, Calcutta.
3. Karlekar, S. (2009): Coastal Processes and Landforms: Diamond Publications, Pune
4. Ahmed, E., 2005 : Geomorphology , Kalyan Publishers, New Delhi
5. Bloom, Arthur L., 2004: Geomorphology – A systematic Analysis of Late Cenozoic Landforms, Prentice Hall, engle Wood Cliff, N.J

Supplementary:

1. Cooke R. U. and Doornkamp J.C. (1989): Geomorphology in Environmental Management, 2nd Edition, Oxford : Clarendon Press
2. Gerhard Masselink , Michael Hughes :An Introduction to Coastal Processes and Geomorphology (Hodder Arnold Publication), ISBN-10: 0340764112 , ISBN-13: 978-0340764114

3. Richard Davis Jr. , Duncan Fitzgerald : Beaches and Coasts, Wiley-Blackwell; 1st edition (July 15, 2004), ISBN-10: 0632043083 , ISBN-13: 978-0632043088
4. Timothy Beatley , Anna K. Schwab , David Brower (2002):An Introduction to Coastal Zone Management, Island Press; REV edition

Web based:
1. https://www.nature.com/scitable/knowledge/library/coastal-processes-and-beaches-26276621/
2. https://www.marineinsight.com/environment/a-comprehensive-list-of-different-types-of-sea-waves/
3. https://geography.name/types-of-coastlines/
4. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/coastal-wetland
5. http://www.oas.org/cdcm_train/courses/course1/Chapter%204-Coastal%20Hazards%20and%20Vulnerability.pdf

ELECTIVE
Course Title: Coastal Geomorphology (Practical)
Course Code: GEG-SE5
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
===

Unit	Title	Practical sessions
I	Identification of coastal features and processes on SOI toposheet.	05
II	Beach profiling & identification of major and minor coastal features on beach. Profile of various types of coast. Geomorphic mapping of Coastal Areas.	10
III	Journal and Viva	
		15

References:
Mandatory:

1. Misra, R.P. and Ramesh, A., 2005: Fundamentals of Cartography, Concept Pub. Co., New Delhi
2. Monkhouse, I.J. and Wilkinson, H.R., 2001: Maps and Diagram, B.I. Publication, New Delhi
3. Singh, R.L.: Elements of Practical Geography, Kalyani Publishers, New Delhi ,2000

Supplementary:

1. Bygot, J.: An Introduction to Map Work and Practical Geography, 2001
2. Campbell, J., 2004: Introductory Cartography, Printice Hall, Inc Englewood
3. Jackson, R.H. and Hudmar, L.E.: Regional Geography: Issues for today ,2001
4. Raisz, E.: General Cartography, McGraw Hills Co., London ,2005
5. Robinson, A.H., et al,: Elements of Cartography, John Wiley and Sons, New York,2003
6. Singh, R ; Singh L.R., Mapworks in Practical Geography, Central book Depot, Allahabad,2001

Web based:

1. https://www.nature.com/scitable/knowledge/library/coastal-processes-and-beaches-26276621/
2. https://www.brainkart.com/article/Profile-Diagram_33845/
3. http://www.jsu.edu/dept/geography/mhill/phylabtwo/lab6/profile.html
4. https://www.worldatlas.com/articles/how-many-types-of-beaches-are-there-based-on-composition.html
5. http://geomorphology.sbg.ac.at/research/map-symbols/

ELECTIVE
Course Title: Fluvial Geomorphology (Theory)
Course Code: GEG-SE6
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==
Prerequisite Courses: Nil

Course Objectives:
1. To introduce students to fluvial landforms and processes.

Course Outcomes:
At the end of this course, students will be able to:
CO1: Understanding the fundamental concepts of river and its processes.
CO2: Prepare drainage map and interpret fluvial landscape.
CO3: Conduct survey for river profiling using instruments.
CO4: Carry out morphometric analysis of a river basin.
CO5: Correlate drainage pattern with structural features.

Unit	Title	No. of hours
I	River basin and Drainage Network: River and Stream, Drainage basin and network characteristics, River Dynamics, Classification, Phases of development, Patterns.	15
II	Fluvial processes: Erosion, Transportation and Deposition. Fluvial cycle and Fluvial landforms.	15
III	Applied fluvial geomorphology: Environmental changes and river metamorphosis. Flood and its impact (case studies)	15
		45

Reference Books:
Mandatory:
1. Kale, V. S. and Gupta, A. (Rep.2011): Introduction to Geomorphology, Orient Longman, Calcutta.
2. Singh, Savindra (Rep. 2011): Geomorphology, PrayagPustakBhawan, Allahabad
3. Strahler A. H and Strahler, A. N. (1992) : Modern Physical Geography, John Wiley, New York

Supplementary:
1. Chorley, R. J., Schumm, S. A. and Sugden, D. E. (1984): Geomorphology, Methuen, London.
2. Fairbridge, R. W. (1968): Encyclopedia of Geomorphology, Reinholdts, New York.
3. Goudie, Andrew, S. (2004), Encyclopedia of Geomorphology, 1& 2, Routledge, Taylor & Francis, New York
4. Luna Bergere Leopold, Markley Gordon Wolman, John P. Miller (1995): Fluvial Processes in Geomorphology. Dover Publications Inc., New York
5. R.J. Small (1989)Geomorphology and Hydrology (Longman modular geography series), Longman Publication, Harlow, Essex, England
6. Thomas, S.G. David, (2016) The Dictionary of Physical Geography, 4th Edition, Wiley-Blackwell, New Jersey, USA
7. Thornbury, W. D. (Rep.2011): Principles of Geomorphology, John Wiley and Sons, New York.

Web based:

1. https://www.tandfonline.com/doi/full/10.1080/24749508.2018.1525670
2. https://www.yourarticlelibrary.com/rivers/rivers-classification-stages-and-meandering/60873
3. https://books.google.co.in/books?id=FV3bDwAAQBAJ&pg=PA29&lpg=PA29&dq=glock+model+river+development&source=bl&ots=jR5C8fkDTJ&sig=ACfU3U31ZCqJuXh-h5N24la5785drbb1IQ&hl=en&sa=X&ved=2ahUKEwiy_Im659PpAhWHYH0KHd-zDMEQ6AEwAnoECAYQAQ#v=onepage&q=glock%20model%20river%20development&f=false
4. http://www.physicalgeography.net/fundamentals/10z.html
5. https://www.chiefscientist.qld.gov.au/publications/understanding-floods/flood-consequences

ELECTIVE
Course Title: Fluvial Geomorphology (Practical)
Course Code: GEG-SE6
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
==

Unit	Title	Practical sessions
I	Preparation of drainage map. Identification and Interpretation of fluvial landforms, Patterns and processes from SOI toposheet. Slope analysis.	05
II	Drainage basin morphometry: Morphometric analysis of drainage basin. Field visit : river Profiling and to observe fluvial processes	10
III	Journal and Viva	
		15

References:
Mandatory:
1. Singh, R ; Singh L.R., Mapworks in Practical Geography,Central book Depot, Allahabad,2001
2. Misra, R.P. and Ramesh, A., 2005: Fundamentals of Cartography, Concept Pub. Co., New Delhi
3. Robinson, A.H., et al,: Elements of Cartography, John Wiley and Sons, New York,2003

Supplementary:
1. Bygot, J.: An Introduction to Map Work and Practical Geography,2001
2. Campbell, J., 2004: Introductory Cartography, Printice Hall, Inc Englewood
3. Monkhouse, I.J. and Wilkinson, H.R., 2001: Maps and Diagram, B.I. Publication, New Delhi
4. Raisz, E.: General Cartography, McGraw Hills Co., London ,2005
5. Singh, R.L.: Elements of Practical Geography, Kalyani Publishers, New Delhi ,2000

Web based:
1. https://www.usgs.gov/special-topic/water-science-school/science/watersheds-and-drainage-basins?qt-science_center_objects=0#qt-science_center_objects
2. https://www.tandfonline.com/doi/full/10.1080/24749508.2018.1525670
3. https://www.yourarticlelibrary.com/rivers/rivers-classification-stages-and-meandering/60873
4. https://www.ijsr.net/archive/v4i7/24071501.pdf
5. https://www.internetgeography.net/topics/cross-profiles-of-a-river/

ELECTIVE
Course Title: Watershed Management (Theory)
Course Code: GEG-SE7
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
===

Prerequisite Courses: Nil

Course Objective:
1. To acquaint students with basic concepts and importance of Watershed Management.
2. To help students in understanding various processes that take place and that are involved in a watershed.

Course Outcomes:
At the end of this course, students will be able to:
CO1: Understand concepts of Watershed Management.
CO2: Develop a process-based understanding of watershed.
CO3: Understand the methods and techniques of watershed management.
CO4: Relate watershed management using the different methods in GIS.
CO5: Understand hydrological process in watershed
CO6: Understand various techniques for conservation of watershed management.

Unit	Title	No. of hours
I	Introduction to Watershed Management : Definition, Principles, objectives, Need of Watershed Management, Identification of problems in Watershed Management Approaches watershed management	15
II	Characteristics of watershed Runoff, River discharge Sediment load	15
III	Hydrological Process in Watershed : Ecological Characteristics of the river Soil management techniques in watershed Watershed Conservation methods.	15
		45

References:
Mandatory:

1. Heathcote. W. Isobel , 2009, Integrated Watershed Management : Principles and Practice, 2nd Edition, Hoboken, N.J. : John Wiley & Sons, New Jersey
2. Singh Rajvir, 2003, Watershed Planning and Management, 2nd Edition, Yash Publishing House, Bikaner, India

Supplementary:
1. Manual of water and soil conservation: Government of India, ICAR
2. Manuals of the USDA
3. DeBarry. A. Paul, 2004, Watersheds : Processes, Assessment, and Management, Hoboken, N.J. : John Wiley & Sons, New Jersey
4. National Watershed Program Manual, The U.S. Department of Agriculture (USDA), Washington, D.C, December, 2009
5. Narayana, V.V. Dhruva, 2002, Soil and water conservation research in India, Published by ICAR, New Delhi

Web based
1. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=125296
2. https://www.geographynotes.com/watershed-management-2/drainage-basin/areal-aspects-of- drainage-basin-watershed-management-geography/6374
3. https://www.geographynotes.com/watershed-management-2/drainage-network/linear-aspects-of-drainage-network-3-aspects-watershed-management/6287
4. http://www.keralasoils.gov.in/index.php/2016-04-27-09-26-39/soil-water-conservation-techniques
5. https://www.yourarticlelibrary.com/watershed-management/watershed-management-meaning-types-steps-and-programmes/77309

ELECTIVE
Course Title: Watershed Management (Practical)
Course Code: GEG-SE7
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
==

Unit	Title	Practical Sessions
I	Sediment load analysis	5
II	Measurement and Estimation of Soil Erosion – Revised Universal Soil Loss Equation (RUSLE). Field Visit and Report: visit to watershed (Identification of problems of watershed, soil and water management) Survey, Database Generation.	10
III	Journal and Viva-voce	
		15

References:
Mandatory:
1. Heathcote. W. Isobel , 2009, Integrated Watershed Management : Principles and Practice, 2nd Edition, Hoboken, N.J. : John Wiley & Sons, New Jersey
2. Singh Rajvir, 2003, Watershed Planning and Management, 2nd Edition, Yash Publishing House, Bikaner, India

Supplementary:
1. DeBarry, A. Paul, 2004, Watersheds : Processes, Assessment, and Management, Hoboken, N.J. : John Wiley & Sons, New Jersey
2. National Watershed Program Manual, The U.S. Department of Agriculture (USDA), Washington, D.C, December, 2009
3. Narayana, V.V. Dhruva, 2002, Soil and water conservation research in India, Published by ICAR, New Delhi

Web based:
1. https://www.geographynotes.com/watershed-management-2/drainage-network/linear-aspects-of-drainage-network-3-aspects-watershed-management/6287
2. https://www.yourarticlelibrary.com/watershed-management/watershed-management-meaning-types-steps-and-programmes/77309
3. https://library.wmo.int/doc_num.php?explnum_id=1709s
4. https://www.researchgate.net/publication/305841586_Estimation_of_Soil_Erosion_Using_RUSLE_Model_and_GIS_Techniques_for_Conservation_Planning_from_Kulekhani_Reservoir_Catchment_Nepal
5. https://support.esri.com/en/technical-article/000012346

ELECTIVE
Course Title: Biogeography (Theory)
Course Code: GEG-SE8
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==
Prerequisite Courses: Nil

Course Objective:
1. To acquaint students with spatial and temporal patterns of biological diversity and the factors that govern the distribution and abundance.

Course Outcomes:
At the end of this course, students will be able to:
CO1: Understand the concept of biogeography and its evolution
CO2: Evaluate the role of global organizations and partnerships in protecting biodiversity
CO3: Analyze the characteristics of biodiversity hotspots (any two)
CO4: Understand the traditional and modern method of biodiversity conservation
CO5: Evaluate different social movements of biodiversity conservations in India

Unit	Title	No. of hours
I	Concept of Biogeography. Historical evolution of Biogeography. Global patterns of Biodiversity.	18
II	Niche. Speciation and extinction. Accident and invasion. Endemism, vicariance and conservation. Island biogeography. Zoogeography and its Environmental Relationship. Palaeo botanical and Palaeo Climatological records of environmental change.	10
III	Biodiversity hotspots. Forest communities and their distribution. Conservation- laws and practices. Social Movements of conservation.	17
		45

References:
Mandatory:
1. Bhattacharyya, N.N., 2018: Biogeography, Rajesh Publications, New Delhi. **ISBN** : 978-81-85891-50-7

Supplementary:
1. Richard John Huggett 2004: Fundamentals of Biogeography (Routledge Fundamentals of Physical Geography), Routledge; 2nd edition
2. Mark V. Lomolino , Brett R. Riddle, Robert J. Whittaker, James H. Brown 2010, Biogeography 4th Edition, Sinauer Associates, Oxford University Press
3. Glen MacDonald, 2001: Biogeography: Introduction to Space, Time, and Life 1st Edition, Wiley
4. Husain, M. (ed)., 1994: Biogeography(Part I & II), Anmol Publications, Pvt. Ltd., New Delhi.
5. Singh, Savindra, 2010: Biogeography, Prayag Pustak Bhawan, Allahabad.

Web based:
1. http://www.nyu.edu/projects/fitch/courses/evolution/html/biogeography.html
2. https://www.sparknotes.com/biology/evolution/evidence/section2/
3. https://study.com/academy/lesson/biogeography-definitions-examples.html
4. https://evolution-outreach.biomedcentral.com/articles/10.1007/s12052-012-0421-2
5. https://www.geo.arizona.edu/Antevs/ecol438/lect02.html
6. http://faculty.washington.edu/timbillo/Readings%20and%20documents/global%20div%20patterns%20origins/Gaston%20Nature%20Global%20Biodiv%20patterns.pdf

ELECTIVE
Course Title: Biogeography (Practical)
Course Code: GEG-SE8
Marks: 25
Credits: 1
Duration: 15 Sessions of 2 hrs each
==

Unit	Title	Practical Sessions
I	Vegetation Map interpretation Biodiversity indexing Biomass analysis Canopy structure Stock analysis	07
II	NDVI Density of tree Plant tress analysis Disturbance analysis	08
III	Journal and viva voce	
		15

References:
Mandatory:
1. Bhattacharyya, N.N., 2018: Biogeography, Rajesh Publications, New Delhi. **ISBN** : 978-81-85891-50-7

Supplementary:
1. Richard John Huggett 2004: Fundamentals of Biogeography (Routledge Fundamentals of Physical Geography), Routledge; 2nd edition
2. Mark V. Lomolino , Brett R. Riddle, Robert J. Whittaker, James H. Brown 2010, Biogeography 4th Edition, Sinauer Associates, Oxford University Press
3. Glen MacDonald, 2001: Biogeography: Introduction to Space, Time, and Life 1st Edition, Wiley
4. Husain, M. (ed)., 1994: Biogeography(Part I & II), Anmol Publications, Pvt. Ltd., New Delhi.
5. Singh, Savindra, 2010: Biogeography, Prayag Pustak Bhawan, Allahabad.

Web based:
1. https://www.researchgate.net/publication/262061314_Vegetation_Analysis_with_Reference_to_Topographic_Variables_using_Remote_Sensing_Data
2. https://academic.oup.com/jpe/article/1/1/9/1132900
3. https://cyfar.org/sites/default/files/cyfar_research_docs/Biodiversity%20Index.pdf
4. https://www.biologydiscussion.com/biodiversity/types/2-types-of-diversity-indices-of-biodiversity/8388
5. https://www.researchgate.net/publication/326898794_Biodiversity_Indexes_Value_and_Evaluation_Purposes
6. https://www.amnh.org/learn-teach/curriculum-collections/biodiversity-counts/plant-ecology/how-to-calculate-a-biodiversity-index
7. https://cid-inc.com/blog/the-forest-canopy-structure-roles-measurement/

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER V
UPDATED ON 16TH MARCH 2020

CORE
Course Title: Introduction to Climatology (Theory)
Course Code: GEG-V.SC7
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
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Prerequisite Courses: Nil

Course Objectives:
1. To introduce key concepts of climatology in general and Indian monsoon in details.

Course Outcomes:
At the end of this course, students will be able to:
CO1: Understand and analyze climatological concepts.
CO2: Interpret and analyze weather and climatic phenomena
CO3: Understand the main patterns of the various types of Earth's climates and the main climate classification schemes
CO4: Understand the relationships between climate and other forms of environmental changes

Unit	Title	No. of hours
I	**Fundamental of Atmospheric circulation** Primary, secondary and tertiary circulation	15
II	**Atmospheric disturbances:** Thermodynamics CAPE and CINE- cloud development and stability, thunderstorm Cyclogenesis – T number (basics of cyclones) Western disturbances, fog, cold waves **Koppens Classification of climate**	15
III	**Indian Climatology: Monsoons** **Pre monsoon:** Cyclone genesis, Cyclonic storms, frequency, intensity, landfall and associated weather. **South West monsoon:** Onset and advance of southwest monsoon, Semi-permanent features of monsoon, active and break in monsoon. El-Nino and La-Nina. **Post monsoon:** withdrawal of southwest monsoon, Northeast monsoon, cyclonic storms in the Indian seas, trends in cyclonic disturbances, Easterly waves.	15
		45

References:
Mandatory:
1. Critchfield, H.J, 1998 : General Climatology, Prentice-Hall
2. Lal, D.S., 2011: Climatology, Sharda Pustak Bhavan

Supplementary:
1. Barry R.G. and Chorley, R. J., 2009: Atmosphere, Weather and Climate, Routledge
2. Bunnett R.B. , 1993: Physical geography in Diagrams, Longman
3. Monkhouse, F.J., 1975 – Principles of Physical Geography , Hodder Murray Publishers
4. P. Birot, 1966: General Physical Geography, Longman, Green & Co
5. Strahler, A.H., 1983: Modern Physical Geography, John Wiley and Sons
6. Strahler A. M. and Strahler A.H., 1983: Elements of Physical Geography, John Wiley and Sons
7. Stringer, E.T., 1972: Foundation of Climatology: An Introduction to Physical, Dynamic, Synoptic, and Geographical Climatology, W.H. Freeman & Co. Ltd.
8. Tikka - R.N., 1998 - Physical Geography. KedarNath Ram Nath, Meerut
9. Trewartha, G.T., 1968: Introduction to Climate, McGraw-Hill

Web based:
1. https://www.nationalgeographic.org/encyclopedia/climatology/
2. https://www.environmentalscience.org/climatology
3. https://climate.ncsu.edu/edu/AtmosCirculation
4. http://shantashrimsl.yolasite.com/resources/T_5%20-%20Atmospheric%20Disturbances.pdf
5. http://www.imdpune.gov.in/
6. https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter14_FINAL.pdf

CORE
Course Title: Introduction to Climatology (Practical)
Course Code: GEG-V.SC7
Marks: 25
Credits: 01
Duration: 15 sessions of 2 hours each
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Unit	Title	Practical sessions
I	Representation of weather phenomena using isolines Isohyets map Isotherm map Isobars Representation of wind data Evapotranspiration Determining atmospheric stability (Tephigram) Preparation of weather Station Model. Upper air chart, isotach (wind)	05
II	• Study of weather symbols and IMD weather charts. Interpretation of IMD weather charts (at least 1 map of three seasons) • Visit to IMD for hands- on- training: handling of weather instruments, taking readings, temperature, pressure, sunshine chart interpretation and forecasting.	10
III	Journal and Viva	
		15

References:
Mandatory:

1. Singh, R.L. and Singh Rana P.B.(2008), Elements of Practical Geography, Kalyani Publishers, New Delhi
2. Strahler, A.N., 2000: Physical Geography, 3rd Ed., Wiley.

Supplementary:

1. Campbell, J. (2004), Introductory Cartography, Prentice Hall, Inc Englewood
2. Chorley, Richard. J. (ed.), 2001: Water, Earth and Man, Methuen & Co., London
3. Khullar.D.R. (2007), Essentials of Practical Geography, New Academic Publishing Co., Jalandher
4. Misra, R.P. & Ramesh, A., 2009: Fundamentals of Cartography, Concept Publishing Co., New Delhi
5. Monkhouse, F.J. & Wilkinson, H.R., 2009: Maps and Diagrams, B.I. Publications Pvt. Ltd., New Delhi
6. Sarkar, Ashis (2000), Practical Geography: A Systematic Approach, Orient Longman Pvt. Ltd., Kolkata

Web based:

1. https://www.weather.gov/media/epz/mesonet/CWOP-WMO8.pdf
2. http://kejian1.cmatc.cn/vod/comet/mesoprim/tephigram/print_3.php.htm
3. https://sites.google.com/site/crisflopt/comunicaes/areas/intrep-sat-images?tmpl=%2Fsystem%2Fapp%2Ftemplates%2Fprint%2F&showPrintDialog=1
4. http://www.imdpune.gov.in/training/Observational%20system-IMTC.pdf
5. https://metnet.imd.gov.in/imdnews/ar2018.pdf

ELECTIVE
Course Title: Geography of Soil Studies (Theory)
Course Code: GEG-SE9
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
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Prerequisite Courses: Nil

Course Objectives:

1. To understand the process of soil formation, development and distribution.
2. To equip students with basics of soil structure, composition, content and conservation practices.

Course Outcomes:

At the end of this course, students will be able to:

CO1: Identify and differentiate between various soils profiles and types

CO2: Understand different types of processes of soil formation, characteristics and importance in agricultural practices

CO3: Test the soil properties and quality of collected soil samples using various instruments and prepare lab reports.

CO4: Map various soil types in terms of physical and chemical properties.

Unit	Topic	No. of hours
I	**Introduction to soil:** Concept , soil formation Soil water dynamic, Factors affecting soil formation. Soil structure, composition Soil profile, Texture	15
II	**Soil and organisms** - Organic matter of soil, Sources of organic matter – Biomass, Termites, worms, ants, algae, fungi, bacteria, Carbon cycle – simple decomposition, Agricultural importance of soils - Nitrogen fixation	15
III	**Soil Conservation and management** Soil erosion, degradation and pollution, its sources and impacts : Soil conservation and management practices traditional and modern Case studies	15
		45

References:
Mandatory:

1. Brady Nyle. (2002). The nature and properties of soil. MacMillan Publishing company, USA

Supplementary:

1. Foth Henry. (1984). Fundamentals of soil science. John Wiley & Sons, Inc. USA
2. Munns Donald and Singer Michael. (1996). Soils – An introduction. Prentice-Hall Inc, New Jersey, USA
3. Lal R and Stewart B.A. (1990). Advances in soil sciences. Springer-Verlag New York.
4. White Robert. (2005). Principles and Practice of Soil Science: The Soil as a Natural Resource, 4th Edition. Wiley & Sons, Inc – Blackwell. USA

Web based:

1. https://www.nature.com/scitable/knowledge/library/soil-water-dynamics-103089121/
2. http://www.fao.org/3/a0100e/a0100e0d.htm
3. https://www.sare.org/Learning-Center/Books/Building-Soils-for-Better-Crops-3rd-Edition/Text-Version/The-Living-Soil/Soil-Microorganisms
4. https://www.britannica.com/science/soil-organism
5. https://www.soils4teachers.org/biology-life-soil
6. https://www.infonet-biovision.org/EnvironmentalHealth/Introduction-soil-conservation-measures

ELECTIVE
Course Title: Geography of Soil Studies (Practical)
Course Code: GEG-SE9
Marks: 25
Credits: 1
Duration: 15 Sessions of 2 hours each
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Unit	Topic	Practical sessions
I	Field visit: pre field, fieldwork and post fieldwork Sample preparation **Soil Test (physical)** 1. Moisture content calculation 2. Texture analysis 3. EC	10
II	**Soil Test (chemical)** 1. Soil pH levels 2. Carbon testing	05
III	Journal and Viva	
		15

References:
Mandatory:

1. Brady Nyle. (2002). The nature and properties of soil. MacMillan Publishing company, USA

Supplementary:

1. Foth Henry. (1984). Fundamentals of soil science. John Wiley & Sons, Inc. USA
2. Munns Donald and Singer Michael. (1996). Soils – An introduction. Prentice-Hall Inc, New Jersey, USA
3. Lal R and Stewart B.A. (1990). Advances in soil sciences. Springer-Verlag New York.
4. White Robert. (2005). Principles and Practice of Soil Science: The Soil as a Natural Resource, 4th Edition. Wiley & Sons, Inc – Blackwell. USA

Web based:

1. https://www.nature.com/scitable/knowledge/library/soil-water-dynamics-103089121/
2. http://www.fao.org/3/a0100e/a0100e0d.htm
3. https://www.sare.org/Learning-Center/Books/Building-Soils-for-Better-Crops-3rd-Edition/Text-Version/The-Living-Soil/Soil-Microorganisms
4. https://www.britannica.com/science/soil-organism
5. https://www.soils4teachers.org/biology-life-soil
6. https://www.infonet-biovision.org/EnvironmentalHealth/Introduction-soil-conservation-measures

ELECTIVE
Course Title: Agrometeorology: Principles and Applications (Theory)
Course Code: GEG-SE10
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==
Prerequisite Courses: Nil

Course Objectives:
1. To study agro-meteorology and its application in agriculture.
2. To develop an understanding of the physical and human interventions that affect agricultural systems and management practices.

Course Outcomes:
At the end of this course, students will be able to:
CO1: Determine Photosynthetically Active Radiation (PAR) and Solar Radiation Use Efficiency
CO2: Understand the effect of temperature on crop production
CO3: Understand the methods of managing of farm water resources
CO4: Monitor drought and prepare irrigation schedule
CO5: Use remote sensing technology in Agrometeorology

Unit	Title	No. of hours
I	**Agrometeorology:** Perspectives and Applications: Definition and scope and development. **Solar Radiation and Its Role in Plant Growth:** The Source of Energy, Laws of Radiation, Earth's Annual Global Mean Radiative Energy Budget, Solar Radiation and Crop Plants, Solar Radiation Interception by Plants, Photosynthetically Active Radiation (PAR), Solar Radiation Use Efficiency **Environmental Temperature and Crop Production:** Soil and Air Temperature, Plant Injury Due to Sudden Changes in Temperature, Frost: Damage and Control, Thermoperiodism, Temperature As a Measure of Plant Growth and Development.	15
II	**Climatological Methods for Managing Farm Water Resources**- Water for Crop Production, Making Effective Use of Rainfall, Evaporation and Evapotranspiration, Water Use and Loss in Irrigation. Climatological Information in Improving Water-Use Efficiency (WUE), Reducing Water Losses from Reservoirs, **Drought Monitoring and Planning for Mitigation:** water budgeting, irrigation scheduling, Drought Monitoring and Planning for Mitigation. **Climate, Crop Pests:** Role of Weather and Climate, Some Important Insect Pests of Crop Plant.	15
III	Remote-Sensing Applications in Agrometeorology**.** Computer Models in Managing Agricultural Systems, Agro-climatological Services, using Climate Information to improve Agricultural Systems, Climate Change and Its Impact on Agriculture.	15
		45

References:

Mandatory:

1. G. Kathiresan (2015) Agrometeorology: A Simplified Textbook. New India Publishing Agency
2. G.S. Mahi& P.K. Kingra (2014): Fundamentals of Agrometeorology. Kalyani Publishers
3. Mavi H S (2003): Introduction To Agrometeorology. Oxford &Ibh

Supplementary:

1. Grigg, David (2005) An Introduction to Agricultural Geography (2nd Ed), Routeledge, London and New York
2. Harpal S. Mavi and Graeme J.,Tupper (2004), Agrometeorology Principles and Applications of Climate Studies in Agriculture. The Haworth Press, Inc., Binghamton, NY.
3. Rao and Prasada (2008) Agricultural Meteorology. PHI Learning PVT. LTD., New Delhi
4. Seemann, Jochen, Chirkov, Y. I., Lomas, J., Primault, B. (2012): Agrometeorology. Springer-Verlag Berlin and Heidelberg GmbH & Co. KG
5. SR Reddy & D.S. Reddy (2014) Agrometeorology. Kalyani Publishers
6. S. Venkatraman (2015): Principles and Practice of Agricultural Meterology. BS Publications.
7. WMO (2011), Agricultural Meteorology Guide to Climatological Practices World Meteorological Organization, Geneva.

Web based:

1. http://articles.adsabs.harvard.edu//full/1979ESASP1020....3F/0000003.000.html
2. http://www.fao.org/nr/climpag/pub/Workshop%20on%20radio%20broadcasting%202001%20Gommes.pdf
3. http://www.wamis.org/agm/gamp/GAMP_Chap04.pdf
4. https://www.researchgate.net/publication/308749358_Role_of_Remote_Sensing_and_GIS_in_Agrometeorology
5. http://www.oecd.org/greengrowth/sustainable-agriculture/49040929.pdf
6. http://www.fao.org/climate-smart-agriculture-sourcebook/production-resources/module-b6-water/chapter-b6-4/en/
7. https://drought.unl.edu/archive/Documents/NDMC/Workshops/136/Pres/Svoboda_Drought%20Plan%20Case%20Studies-US_Caribbean.pdf
8. http://www.wamis.org/tools/info/droughtplanning.pdf
9. https://om.ciheam.org/om/pdf/a80/00800448.pdf
10. https://www.droughtmanagement.info/wp-content/uploads/2015/12/Session-5_Thematic-Presentation.pdf

ELECTIVE
Course Title: Agrometeorology: Principles and Applications (Practical)
Course Code: GEG-SE10
Marks: 25
Credits: 01
Duration: 15 sessions of 2 hours each
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Unit	Title	Practical sessions
I	Green leaf response to Electro Magnetic Radiation Photosynthetically Active Radiation (PAR) Solar radiation use efficiency Temperature and crop growth	07
II	Measurement of effective rainfall (using Huggins and Kassam water balance approach) Water balance, Measurement of evaporation and calculation of evapotranspiration irrigation scheduling for crops Analyzing the water deficiency (drought) , drought index Use of thermal data in drought monitoring	08
III	Journal and Viva	
		15

References:
Mandatory:

1. G. Kathiresan (2015) Agrometeorology: A Simplified Textbook. New India Publishing Agency
2. G.S. Mahi& P.K. Kingra (2014): Fundamentals of Agrometeorology. Kalyani Publishers
3. Mavi H S (2003): Introduction to Agrometeorology. Oxford &Ibh

Supplementary:

1. Don Ankerman; Richard Large (2013) Agronomy Handbook. Midwest Laboratories Inc., OMAHA, NE
2. Harpal S. Mavi and Graeme J. Tupper (2004), Agrometeorology Principles and Applications of Climate Studies in Agriculture, The Haworth Press, Inc., Binghamton, NY.
3. Indian Council of Agricultural Research (2011) Handbook of Agriculture, Indian Council of Agricultural Research
4. Rao and Prasada (2008) Agricultural Meteorology. PHI Learning PVT. LTD., New Delhi
5. WMO (2011), Agricultural Meteorology Guide to Climatological Practices World Meteorological Organization, Geneva.

Web based:

1. https://www.researchgate.net/publication/321363262_Effective_Rainfall_Calculation_Methods_for_Field_Crops_An_Overview_Analysis_and_New_Formulation
2. http://www.fao.org/3/x5560e/x5560e03.htm
3. https://iopscience.iop.org/article/10.1088/1755-1315/54/1/012067/pdf
4. https://www.researchgate.net/publication/270555940_Radiation_Use_Efficiency_Evaluation_of_Cropping_and_Management_Systems
5. https://www.scielo.br/scielo.php?pid=S0100-204X2009001000001&script=sci_arttext
6. http://www.fao.org/3/a-ai593e.pdf
7. https://www.unisdr.org/files/1871_VL102138.pdf

ELECTIVE
Course Title: Field Survey in Physical Geography (Theory)
Course Code: GEG-SE11
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==
Prerequisite Courses: Nil

Course Objectives:
1. To introduce various surveying instrument used in Physical Geography.
2. To provide exposure to operation and the application of the instruments and methods of surveying.

Course Outcomes:
At the end of this course, students will be able to:
CO1: Understand the different survey techniques
CO2: Understand functions and applications of dumpy level, Plane table and Global Positioning Systems (GPS) in field based studies.
CO3: Independently handle survey instruments and prepare maps and field reports.
CO4: Independently prepare Field Books for field surveys in physical geography
CO5: Acquire knowledge about preparation of map layout.

Unit	Topic	No. of hours
I	Significance and Methods of Survey; Classification of Surveying; Fundamentals of Plane Table Survey: a) Radiation Method b) Intersection Method Pre survey work: Safety Measures, Field Book Preparation, Literature Survey, Sharing Responsibilities and Plan of Action Post field survey work: Data Processing Methods, Analysis, Mapping and Report Writing.	15
II	Dumpy level surveying : meaning, functioning elements, applications and Methods(Rise-fall and Collimation method) Profile drawing: Beach and River. Beach and River Morphology. Observation of slope, river and coastal morphology on toposheet. Pre survey and Post survey tasks.	15
III	GPS survey: Meaning, Space Segment, Ground Segment and GPS Receivers, Applications.	15
		45

References:
Mandatory:
1. Khullar, D.R. (2007), Essentials of Practical Geography, New Academic Publishing
2. Monkhouse, I.J. and Wilkinson, H.R. (2009), Maps and Diagram, B.I. Publication, New Delhi
3. Sarkar, Ashis (2000), Practical Geography: A Systematic Approach, Orient Longman Pvt. Ltd., Kolkata

Supplementary:
1. Campbell, J. (2004), Introductory Cartography, Prentice Hall, Inc Englewood
2. Co.,Jalandher
3. Misra, R.P. and Ramesh, A. (2005), Fundamentals of Cartography, Concept Pub. Co., New Delhi
4. Singh, R.L. and Singh Rana P.B.(2008), Elements of Practical Geography, Kalyani Publishers, New Delhi

Web-based:
1. https://explorable.com/types-of-survey
2. https://www.slideshare.net/gauravhtandon1/plane-table-survey-27614680
3. https://libguides.usc.edu/writingguide/fieldreport
4. https://theconstructor.org/surveying/dumpy-level-surveying-components-procedure-advantages/20456/
5. https://www.gps.gov/systems/gps/

ELECTIVE
Course Title: Field Survey in Physical Geography (Practical)
Course Code: GEG-SE11
Marks: 25
Credits:1
Duration: 15 Sessions of 2 hours each
===

Unit	Topic	Practical sessions
I	Plane table survey: a) Radiation Method :2 Exercises B) Intersection Method: 2 Exercises	07
II	Dumpy Level Survey: Rise-Fall and Collimation Method GPS Survey: Use of GPS in Mapping And Location Observation Of Slope, River and Coastal Morphology on Field	08
III	Journal /Field report	
		15

References:
Mandatory:

1. Khullar, D.R. (2007), Essentials of Practical Geography, New Academic Publishing
2. Monkhouse, I.J. and Wilkinson, H.R. (2009), Maps and Diagram, B.I. Publication, New Delhi
3. Sarkar, Ashis (2000), Practical Geography: A Systematic Approach, Orient Longman Pvt. Ltd., Kolkata

Supplementary:

1. Campbell J. (2004), Introductory Cartography, Printice Hall, Inc Englewood
2. Misra, R.P. and Ramesh, A. (2005), Fundamentals of Cartography, Concept Pub. Co., New Delhi
3. Singh, R.L. and Singh Rana P.B.(2008), Elements of Practical Geography, Kalyani Publishers, New Delhi

Web-based:

1. https://explorable.com/types-of-survey
2. https://www.slideshare.net/gauravhtandon1/plane-table-survey-27614680
3. https://libguides.usc.edu/writingguide/fieldreport
4. https://theconstructor.org/surveying/dumpy-level-surveying-components-procedure-advantages/20456/
5. https://www.gps.gov/systems/gps/

ELECTIVE
Course Title: Quantitative Techniques in Geography (Theory)
Course Code: GEG-SE12
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
===
Prerequisite Courses: Nil

Course Objectives:
1. To expose students to basic and advance statistical methods in geography in general**.**

Course Outcomes:
At the end of this course, students will be able to:
CO1: Test various statistical tools applied in earth science.
CO2: Understand various stochastic models and forecasting methods in the discipline of earth science.
CO3: Test and analyze various statistical tools applied in geography.
CO4: Formulate hypothesis and prove it applying various stochastic models and forecasting methods in the discipline of geography.

Unit	Title	No. of hours
I	Statistical Methods in Geography Basics of Sampling, Data Collection and Sample Design, Hypothesis Quantification and Prediction / projection, The Concept of Variable, Probability, Frequency Function.	15
II	Frequency Analysis and Simulation, Measure of Central tendency, Dispersion, Skewness and Kurtosis, Correlation and Regression, Chi Square(X^2)	15
III	Stochastic Modelling (Time Series Analysis) and Forecasting Processes, Autocorrelation, Moving Average.Maximum Entropy Method	15
		45

References:
Mandatory:
1. Ashis Sarkar (2013), Quantitative Geography: Techniques and Presentations, Orient Blackswan
2. Rogerson., P. A.(2001) : Statistical Methods for Geography. SAGE Pub. New Delhi

Supplementary:
1. Pal S. K., 1998: Statistics for Geoscientists: Techniques and Application, Concept, New Delhi.
2. Sharma, D.D. (2008): Geostatistics with Application in Earth Sciences, Springer, with Capital Publishing Company, New Delhi, India.
3. Spence, N. & Owens, A. (2011) :Methods of Geographical Analysis. University of London
4. Tomislav Hengl (2009): A Practical Guide to Geostatistical Mapping. The European Communities, Luxembourg

Web based:
1. https://ajsmit.github.io/Basic_stats/descriptive-statistics-central-tendency-and-dispersion.html
2. https://www.skillsyouneed.com/learn/sampling-sample-design.html
3. https://www.researchgate.net/publication/322656396_DATA_COLLECTION_AND_SAMPLING
4. https://personal.utdallas.edu/~scniu/OPRE-6301/documents/Data_Collection_and_Sampling.pdf
5. https://www.statisticshowto.com/probability-and-statistics/hypothesis-testing/

ELECTIVE
Course Title: Quantitative Techniques in Geography (Practical)
Course Code: GEG-SE12
Marks: 25
Credits: 01
Duration: 15 sessions of 2 hours each
==

Unit	Title	Practical sessions
I	Measure of Central tendency and Dispersion Mean (Z) Estimates for the Mean, Confidence Limits for the Mean Skewness and Kurtosis Correlation and Regression, Correlation Coefficient Hypothesis testing :The Chi-square (X^2) Test, Time Series Analysis and Forecasting	07
II	Variogram and Estimation Variance Entropy Method,	08
III	Journal and Viva	
		15

Note : Only physical geography data should be used.

References:
Mandatory:

1. Ashis Sarkar (2013), Quantitative Geography: Techniques and Presentations, Orient Blackswan
2. Rogerson., P. A.(2001) : Statistical Methods for Geography. SAGE Pub. New Delhi

Supplementary:

1. A. Stewart Fotheringham, Chris Brunsdon and Martin Charlton. (2000): Quantitative Geography Perspectives on Spatial Data Analysis. SAGE Publications Ltd
2. Rogerson, Peter A. (2015) Statistical Methods for Geography. (4th Ed) SAGE Publications Ltd
3. Sharma, D.D. (2008): Geostatistics with Application in Earth Sciences, Springer, with Capital Publishing Company, New Delhi, India.
4. Spence, N. & Owens, A. (2011) Methods of Geographical Analysis. University of London
5. Robert Hammond, Patrick McCullagh; (1974): Quantitative techniques in geography: an introduction. Clarendon Press,

Web based:

1. https://ajsmit.github.io/Basic_stats/descriptive-statistics-central-tendency-and-dispersion.html
2. https://www.skillsyouneed.com/learn/sampling-sample-design.html
3. https://www.researchgate.net/publication/322656396_DATA_COLLECTION_AND_SAMPLING
4. https://personal.utdallas.edu/~scniu/OPRE-6301/documents/Data_Collection_and_Sampling.pdf
5. https://www.statisticshowto.com/probability-and-statistics/hypothesis-testing/

SYLLABUS FOR AUTONOMOUS COURSES IN GEOGRAPHY
BACHELOR OF SCIENCE
SEMESTER VI
UPDATED ON 16TH MARCH 2020

CORE
Course Title: Ecology and Terrestrial Environment (Theory)
Course Code: GEG-VI.SC8
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==
Prerequisite Courses: Nil

Course Objectives:
1. To introduce the concepts of terrestrial ecology which will help in sustainable management of the same.

Course Outcomes:
At the end of this course, students will be able to:
CO1: Understand Biomes and ecological factors
CO2: Analyze sustainable strategies for conservation of terrestrial ecology.
CO3: Acquire skills of water and soil testing
CO4: Understand the climatic factors controlling terrestrial ecosystem.
CO5: Understand pattern of terrestrial Biomes.

Unit	Title	No. of hours
I	**Biomes of the world:** • Biogeography: Species distribution, Historic effect of plate tectonics-past and present pattern of Biogeography • Terrestrial Biomes : Tropical Rain Forest, Savannah, Tundra, Desert	15
II	**Physical factors controlling terrestrial ecosystem** • Soil : soil as an ecological factor, texture, • Water: Classification, properties of water as ecological factors: properties, composition, effect of rainfall and moisture on growth and distribution of plants and animals.	15
III	**Climatic factors controlling terrestrial ecosystem** Temperature: ecological factor, range of temperature tolerance, effects on plants and animals, Precipitating : Distribution , effects on plants and animal	15
		45

References:
Mandatory:
1. Monkhouse, F. J. and Wilkinson, H. R. (1971): Maps and Diagrams, Methuen and Co., London
2. Strahler, A. N. (1964): Quantitative Geomorphology of Drainage Basins and Channel Networks, McGraw-Hill, New York

Supplementary:
1. Dhaliwal GS, Sangha GS, Ralhan PK, 1996: Fundamentals of Environment Science, Kalyani Publishers New Delhi,
2. J.L Chapman and MJ Reiss, 1999: Ecology: Principles and Application, Second Edition, Cambridge University Press, UK
3. Kotpal RL, Bali NP, 1998: Concepts Of Ecology, Vishal Publication, Jalendhar
4. Purphit SS, Ranjan R, 2003: Ecology, Environment and Pollution, Agrobios (India) Publication, Jodhpur

Web based:
1. https://science.umd.edu/classroom/bsci124/lec35short.html
2. https://evolution.berkeley.edu/evolibrary/article/0_0_0/history_18
3. https://www.environmentalpollution.in/environment/5-ecological-factors-that-constitute-the-environment-of-an-organism/178
4. https://www.researchgate.net/publication/322419790_Physical_Chemical_and_Biological_Characteristics_of_Water_e_Content_Module
5. https://www.nature.com/scitable/knowledge/library/causes-and-consequences-of-dispersal-in-plants-15927714/

CORE
Course Title: Ecology and Terrestrial Environment (Practical)
Course Code: GEG-VI.SC8
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
==

Unit	Title	Practical sessions
I	**Field Visit** : visit to a forest ecosystem and Grassland ecosystem mapping of biodiversity using quadrant method Testing relationship of soil and water with forest ecology.	08
II	Field report writing and Viva Pre field preparations and post field analysis and report generation	07
		15

References:
Mandatory:
1. Monkhouse, F. J. and Wilkinson, H. R. (1971): Maps and Diagrams, Methuen and Co., London
2. Strahler, A. N. (1964): Quantitative Geomorphology of Drainage Basins and Channel Networks, McGraw-Hill, New York

Supplementary:
1. Handbook of Applied Hydrology, VenTe Chow, Ed., Section 4-II, McGraw-Hill Book Company, New York
2. King, C. A. M. (1966): Techniques in Geomorphology, Edward Arnold Ltd., London
3. Miller, A. A. (1953): The Skin of the Earth, Methuen and Co. Ltd., London

Web based:
1. https://ag.tennessee.edu/fwf/craigharper/Documents/PB1441%20Terr%20Aqu%20Ecol.pdf
2. https://fire.biol.wwu.edu//hooper/204_14ecologyintro.pdf
3. https://www.arrowenergy.com.au/__data/assets/pdf_file/0004/28957/Section_17-Terrestrial-Ecology.pdf
4. https://www.fs.fed.us/rm/pubs_other/rmrs_2009_neary_d002.pdf
5. https://www.csus.edu/indiv/b/baxterj/bio%20221b/vegetation%20sampling%20quadrat.pdf
6. https://www.youtube.com/watch?v=uBYqBNyojMQ

ELECTIVE
Course Title: Remote Sensing of Forest Ecology (Theory)
Course Code: GEG-SE13
Marks: 75
Credits: 3
Duration: 45 sessions of 1 hour each
==
Prerequisite Courses: Nil

Course Objective:
1. To introduce the fundamental application of remote sensing in the forest ecology.

Course outcomes:
At the end of this course, students will be able to:
CO1: Use remotely sensed data in forest applications
CO2: Prepare forest map and interpret the forest dynamics.
CO3: Utilize open source remotely sensed data for forest studies
CO4: Process different techniques for land use studies in forest.

Unit	Title	No. of hours
I	**Remote Sensing of Forest Environments** Spectral Response of Vegetation. Measuring and monitoring: General Methods of Measuring Vegetation.	15
II	Measurement of Vegetation: Biophysical Measure, Timing of Measurements, Forest Structure and Composition, Species richness and composition	15
III	Modeling Forest Productivity Using Data Acquired Through Remote Sensing Understanding Forest Dynamics: spatial and temporal changes	15
	Total	45

References:
Mandatory:
1. Ned Horning, Julie A. Robinson, Eleanor J. Sterling, Woody Turner, and Sacha Spector (2010), Remote Sensing for Ecology and Conservation, A Handbook of Techniques. Oxford University Press, Oxford.

Supplementary:
2. Adrian Newton (2007) Forest Ecology and Conservation, A Handbook of Techniques in Ecology & Conservation. Oxford New York
3. Hamlyn G Jones and Robin A Vaughan (2010) Remote Sensing of Vegetation Principles, Techniques, and Applications. Oxford University Press, Oxford.
4. Michael Wulder and Steven E. Franklin (2003) Remote Sensing of Forest. Environments, Concepts and Case Studies. (Ed) Springer, US.
5. Roger M. McCoy (2005) Field Methods in Remote Sensing. The Guilford Press, New York London.
6. Van Der Valk, Arnold (2009) Forest Ecology Recent Advances in Plant Ecology. Springer.

Web based:
1. gsp.humboldt.edu/OLM/Courses/GSP_216_Online/lesson2-1/vegetation.htm
2. https://www.e-education.psu.edu/natureofgeoinfo/c8_p5.html
3. https://www.webpages.uidaho.edu/veg_measure/Modules/Lessons/Module%204(Range%20Health)/4_3_ForestInventory.htm
4. https://www.sciencedirect.com/science/article/pii/S1470160X15001454
5. https://grindgis.com/remote-sensing/vegetation-spectral-signature-cheat-sheet

ELECTIVE
Course Title: Remote Sensing of Forest Ecology (Practical)
Course Code: GEG-SE13
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
==

Unit	Title	Practical sessions
I	**Measurement of Forest Canopy** Accuracy Assessment of forest map Sub-Pixel Analysis of Forest Structure Extracting Individual Tree Information Tree Canopy structure Fragmentation Analysis using Entropy approach	10
II	**Vegetation indices** • NDVI • Mapping forest disturbances	5
		15

References:
Mandatory:
1. Ned Horning, Julie A. Robinson, Eleanor J. Sterling, Woody Turner, and Sacha Spector (2010) Remote Sensing for Ecology and Conservation, A Handbook of Techniques. Oxford University Press, Oxford.
2. Roger M. McCoy (2005) Field Methods in Remote Sensing. The Guilford Press, New York London.

Supplementary:
3. Adrian Newton (2007) Forest Ecology and Conservation, A Handbook of Techniques Techniques in Ecology & Conservation. Oxford New York
4. Hamlyn G Jones and Robin A Vaughan (2010) Remote Sensing of Vegetation Principles, Techniques, and Applications. Oxford University Press, Oxford.
5. Michael Wulder and Steven E. Franklin (2003) Remote Sensing of Forest. Environments, Concepts and Case Studies. (Ed) Springer, US.
6. Van Der Valk, Arnold (2009) Forest Ecology Recent Advances in Plant Ecology. Springer.

Web based:
1. https://cid-inc.com/blog/forest-plant-canopy-analysis-tools-methods/
2. http://www.fao.org/3/a-i5601e.pdf
3. https://pdfs.semanticscholar.org/38aa/3621437d3dcc8895584cb2e56992a8310a1c.pdf
4. https://www.researchgate.net/publication/251494059_Detection_of_subpixel_treefall_gaps_with_Landsat_imagery_in_Central_Amazon_forests
5. https://www.sciencedirect.com/science/article/pii/S0895717711006765
6. http://web.pdx.edu/~nauna/resources/8-2012_lecture1-vegetationindicies.pdf
7. https://www.hindawi.com/journals/js/2017/1353691/

ELECTIVE
Course Title: Advanced Coastal Geomorphology (Theory)
Course Code: GEG-SE14
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
==

Prerequisite Courses: Nil

Course Objectives:
1. To introduce the process of coastal formation and coastal geomorphology of India.
2. To introduce the application of geo-spatial data which will help in understanding coastal processes.

Course Outcomes:
At the end of this course, students will be able to:
CO1: Acquire skills to develop models on coastal processes by using GIS tools and methods.
CO2: Understand coastal systems and processes which shape the coastlines.
CO3: Identify and differentiate between different coastal geomorphological features on the East and West coast of India using map & images.
CO4: Identify recent coastal issues (Goan coastal zone (CRZ)).

Unit	Title	No. of hours
I	**Tectonic and coast** • Structural factors -Tectonic Coasts, Orientation of coastal tectonic movement, rates of coastal tectonic movement • Formation of coast • Structurally controlled coasts- Bold and Low coast • Coastal Process and sea-level fluctuations	15
II	**Coastal Geomorphology of India:** • Indian coast- Extent & Topography Geology & structure of coastal zone, Evidence of emergence and submergence, • Shore features-Beach, Bar, Lagoons-lake, Delta, Estuaries, Coral reefs and islands • Classification of Indian coast	15
III	**CRZ** CRZ : Meaning, zones and provision Case study of Goa	15
		45

References:

Mandatory:

1. Gerhard Masselink , Michael Hughes :An Introduction to Coastal Processes and Geomorphology (Hodder Arnold Publication), ISBN-10: 0340764112 , ISBN-13: 978-0340764114
2. Eric Bird (2000): Coastal Geomorphology: An Introduction, 1 edition, John Wiley & Sons
3. Ahamad.E (1972) Coastal geomorphology of India, Orient Longman Delhi.

Supplementary:

1. Bloom. L. Arthur (2012):Geomorphology, Rawat Publication Delhi.
2. Cooke R. U. and Doornkamp J.C. (1989): Geomorphology in Environmental Management, 2nd Edition, Oxford : Clarendon Press
3. Kale, V. S. and Gupta, A. (Rep.2011): Introduction to Geomorphology, Orient Longman, Calcutta.
4. Karlekar, S. (2009): Coastal Processes and Landforms: Diamond Publications, Pune
5. Pethick J. (1995): Introduction to Coastal Geomorphology, John Wiley & Sons Inc.
6. Richard Davis Jr. , Duncan Fitzgerald : Beaches and Coasts, Wiley-Blackwell; 1st edition (July 15, 2004), ISBN-10: 0632043083 , ISBN-13: 978-0632043088
7. Timothy Beatley , Anna K. Schwab , David Brower (2002):An Introduction to Coastal Zone Management, Island Press; REV edition

Web based:

1. https://www.nap.edu/read/2249/chapter/7#74
2. http://keralaczma.gov.in/pdfs/Coastal_Zones_of_India.pdf
3. http://www.geosocindia.org/index.php/bgsi/article/view/55966
4. http://uregina.ca/~sauchyn/geog323/coastal.html
5. http://www.dstegoa.gov.in/RSIReport-CRZ-Goa/GOAreport1.pdf

ELECTIVE
Course Title: Advanced Coastal Geomorphology (Practical)
Course Code: GEG-SE14
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
==

Unit	Title	Practical sessions
I	Demarcation of shoreline and tide level and coastal features using GIS software from satellite and SOI toposheet.	05
II	Case study of any coastal problems: Field work and use of geospatial technology	10
III	Journal and Viva	
		15

References:

Mandatory:

1. Gerhard Masselink , Michael Hughes :An Introduction to Coastal Processes and Geomorphology (Hodder Arnold Publication), ISBN-10: 0340764112 , ISBN-13: 978-0340764114
2. Eric Bird (2000): Coastal Geomorphology: An Introduction, 1 edition, John Wiley & Sons
3. Ahamad.E (1972) Coastal geomorphology of India, Orient Longman Delhi.

Supplementary:

1. Bloom. L. Arthur (2012):Geomorphology, Rawat Publication Delhi.
2. Cooke R. U. and Doornkamp J.C. (1989): Geomorphology in Environmental Management, 2nd Edition, Oxford : Clarendon Press
3. Kale, V. S. and Gupta, A. (Rep.2011): Introduction to Geomorphology, Orient Longman, Calcutta.
4. Karlekar, S. (2009): Coastal Processes and Landforms: Diamond Publications, Pune
5. Pethick J. (1995): Introduction to Coastal Geomorphology, John Wiley & Sons Inc.
6. Richard Davis Jr. , Duncan Fitzgerald : Beaches and Coasts, Wiley-Blackwell; 1st edition (July 15, 2004), ISBN-10: 0632043083 , ISBN-13: 978-0632043088
7. Timothy Beatley , Anna K. Schwab , David Brower (2002):An Introduction to Coastal Zone Management, Island Press; REV edition

Web based:

1. https://www.researchgate.net/publication/326096173_Methods_of_Shoreline_Demarcation_and_Validation_using_Remote_Sensing_and_GIS
2. http://environmentclearance.nic.in/writereaddata/online/EC/06052015M3QUWAT6DemarcationofHtide&LtideforHazira.pdf
3. http://ncscm.res.in/cms/more/pdf/reports/htl_manual.pdf
4. http://www.ijitee.org/wp-content/uploads/papers/v2i4/D0545032413.pdf
5. https://www.omicsonline.org/open-access/coastal-erosion-and-shoreline-change-in-ganjam-coast-along-east-coast-of-india-2157-7617-1000467-100842.html

ELECTIVE
Course Title: Ecology of Estuarine Environment (Theory)
Course Code: GEG-SE15
Marks: 75
Credit: 03
Duration: 45 lectures of 1 hour each
==

Prerequisite Courses: Nil

Course objectives:
1. To study estuaries and their unique ecosystems.
2. To explore the features of estuarine ecosystem and analyze the effects of anthropogenic activities on estuaries.

Course Outcomes:
At the end of this course, students will be able to:

CO1: Understand the estuarine processes, anthropogenic effects on estuaries.
CO2: Test and analyze various parameters associated with estuarine ecology
CO3: Suggest remedial measures for the protection of the same.
CO4: Map estuaries and detect the changes using satellite data and topographical sheets.

Unit	**Contents**	**No. of hours**
I	**Physical attributes of Estuaries** • Concept and Significance. • Physical characteristics of estuaries • Classification of estuaries. • Environment in estuaries: mudflats, salt marsh, mangroves, salt pans • Sediment source, transportation and deposition in estuaries.	15
II	**Estuarine dynamics** • Tides and tidal currents in estuaries • Estuarine circulation and mixing. • Estuaries as sources of food for marine organisms and nurseries for marine organisms.	15
III	**Anthropogenic Effects on estuaries and mitigation** • Agricultural runoff. • Fishing • Urban development and Reclamation of land for development. • Recreational activities. • Ports and harbors	15
		45

References:

Mandatory:

1. Dronker J and Leussen W.V (1988) Physical Processes In Estuaries, Springer Verlag Publishers. London

Supplementary:

1. Dyer. K.R (1997) Estuaries- Physical Introduction, 2nd edition John Wiley and Sons, New York
2. Gade, Edward and Svendson(1982) Coastal Oceanography, Plenum Press London.
3. Nair N. B. and Thampy, D.M.: (1989), Textbook of Marine Ecology. Macmillan Publishers
4. Tait, R.V- (1982), Elements of Marine Ecology: An Introductory Course, 3rd Edition, Butterworth-Heinemann

Web based:

1. https://cerm.mandela.ac.za/About-Estuaries/Physical-Characteristics
2. http://www.waterencyclopedia.com/En-Ge/Estuaries.html
3. https://www.nationalgeographic.org/encyclopedia/estuary/
4. https://oceanservice.noaa.gov/education/tutorial_currents/02tidal1.html
5. http://marinespecies.org/introduced/wiki/Morphology_of_estuaries
6. https://www.sciencelearn.org.nz/resources/1231-human-impact-on-estuaries

ELECTIVE
Course Title: Ecology of Estuarine Environment (Practical)
Course Code: GEG-SE15
Marks: 25
Credit: 01
Duration: 15 sessions of 2 hours each
==

Unit No	Contents	Practical sessions
I	Mapping of estuaries from Indian coasts using SOI toposheets (any 3)	6
II	**Mapping of estuaries in Goa:** • Change detection using satellite data and topographical sheet • Estuarine channel profiling, bank erosion, associated landforms (using GPS and current meter)	9
III	Journal and Viva	
		15

References:
Mandatory:

1. Dronker J and Leussen W.V (1988) Physical Processes In Estuaries, Springer Verlag Publishers. London

Supplementary:

1. Dyer. K.R (1997) Estuaries- Physical Introduction, 2nd edition John Wiley and Sons, New York
2. Gade, Edward and Svendson(1982) Coastal Oceanography, Plenum Press London.
3. Nair N. B. and Thampy, D.M.: (1989), Textbook of Marine Ecology. Macmillan Publishers
4. Tait, R.V- (1982), Elements of Marine Ecology: An Introductory Course, 3rd Edition, Butterworth-Heinemann

Web based:

1. https://www.isprs.org/proceedings/XXXVI/part4/RS-GEO-18.pdf
2. https://www.google.com/intl/en_in/earth/
3. https://library.wmo.int/doc_num.php?explnum_id=1709
4. http://www.ipublishing.co.in/jggsvol1no12010/EIJGGS1006.pdf
5. https://icaci.org/files/documents/ICC_proceedings/ICC2001/icc2001/file/f11062.pdf

ELECTIVE
Course Title: Disaster Management: Urban and Coastal (Theory)
Course Code: GEG-SE16
Marks: 75
Credits: 3
Duration: 45 lectures of 1 hour each
===
Prerequisite Courses: Nil

Course Objectives:
1. To provide insights of basics and applications of landscape and disaster management.

Course Outcomes:
At the end of this course, students will be able to:
CO1: Be familiar with the concepts of disaster management
CO2: Understand the causes and effects of different natural hazards
CO3: Assess the risks of urban hazards (any one case study)
CO4: Evaluate coastal hazard risks and their management (any two local case studies)
CO5: Prepare hazard management and mitigation plan for any one local site.

Unit	Title	No. of hours
I	**Introduction to Disaster Management:** • Definition, Types, Concepts of Disaster Management • Importance of Disaster Management • Introduction to mitigation methods • Disaster Management Cycle • Indian Scenario **Natural Hazards & Landscapes:** • Types of landscapes & natural hazards • Distribution Pattern • Consequences • Mitigation measures	15
II	**Urban Landscape & Disaster Management:** • Understanding Risk of Urban hazard • Case study	15
III	**Coastal Landscape & Disaster Management:** • Understanding Risk of coastal hazards • Coastal risk, mitigation and planning. • Case study	15
		45

References:

Mandatory:

1. Ban Wisner, (2005), At Risk: Natural Hazards, People's Vulnerability and Disasters, Routledge
2. Chowdhury Emdadul. Haque, (2005), Mitigation of Natural Hazards And Disasters: International Perspectives, Springer
3. FitzGerald. M. Duncan, (2003), Beaches and Coasts, Blackwell Publishing

Supplementary:

1. Asian Development Bank, (2016), Reducing Disaster Risk by managing Urban Landuse-Guidance notes for planners, Metro Manila, Philippines
2. Natural Hazards and Disaster Management, (2006), A Supplementary Textbook in Geography for Class XI on Unit 11: Natural Hazards and Disasters, Published by: The Secretary, Central Board of Secondary Education, 2, Community Centre, PreetVihar, Delhi-110092
3. Vernberg. F. John, Vernberg. Winona B, (2001), The Coastal Zone: Past, Present, and Future, University of South Carolina Press

Web based:

1. https://www.academia.edu/8610063/An_Introduction_to_Disaster_Management_Concept_and_Meaning
2. https://www.researchgate.net/publication/320126456_Concepts_and_Practices_of_Disaster_Management_Concepts_and_Practices_of_Disaster_Management
3. https://www.adrc.asia/publications/LWR/LWR_abridged/definitions.pdf
4. http://www.nzdl.org/gsdlmod?e=d-00000-00---off-0aedl--00-0----0-10-0---0---0direct-10---4-------0-1l--11-en-50---20-about---00-0-1-00-0-0-11-1-0utfZz-8-10&cl=CL1.4&d=HASHcd2bae0c8381ef0542840a.2&gt=1
5. https://www.samhsa.gov/find-help/disaster-distress-helpline/disaster-types
6. https://www.linkedin.com/pulse/disaster-management-definition-process-various-phases-chatterjee
7. https://www.uu.nl/en/research/department-of-physical-geography/research/landscape-functioning-and-natural-hazards
8. https://www.intechopen.com/books/sea-level-rise-and-coastal-infrastructure/revealing-landscape-planning-strategies-for-disaster-prone-coastal-urban-environments-the-case-of-is
9. https://penniur.upenn.edu/initiatives/disaster-in-urban-landscapes-preparedness-response-and-recovery
10. https://www.iitk.ac.in/nicee/wcee/article/14_S08-032.PDF
11. https://www.sutori.com/story/how-do-natural-hazards-affect-landforms-and-landscapes--ZsqHdntyog8jiGrgAZDi212d
12. http://www.fao.org/3/AG127E10.htm
13. https://www.orfonline.org/research/making-indias-coastal-infrastructure-climate-resilient-challenges-and-opportunities-54330/

ELECTIVE
Course Title: Disaster Management: Urban and Coastal (Practical)
Course Code: GEG-SE16
Marks: 25
Credits: 1
Duration: 15 sessions of 2 hours each
==

Unit	Title	Practical sessions
I	1. Mapping Flood risk area 2. Mapping Landslide and Erosion prone sites 3. Mapping Rock fall prone sites	07
II	4. Mapping the urban land surface temperature (Urban Heat Islands) 5. Risk sensitive land use map 6. Calculating permissible density of hazards.	8
III	Journal	
		15

References
Mandatory:
1. Ban Wisner, (2005), At Risk: Natural Hazards, People's Vulnerability and Disasters, Routledge
2. Chowdhury Emdadul. Haque, (2005), Mitigation of Natural Hazards And Disasters: International Perspectives, Springer

Supplementary:
1. Asian Development Bank, (2016), Reducing Disaster Risk by managing Urban Landuse-Guidance notes for planners, Metro Manila, Philippines
2. FitzGerald. M. Duncan, (2003), Beaches and Coasts, Blackwell Publishing
3. Natural Hazards and Disaster Management, (2006), A Supplementary Textbook in Geography for Class XI on Unit 11: Natural Hazards and Disasters, Published by: The Secretary, Central Board of Secondary Education, 2, Community Centre, PreetVihar, Delhi-110092
4. Vernberg. F. John, Vernberg. Winona B, (2001), The Coastal Zone: Past, Present, and Future, University of South Carolina Press

Web based:
1. https://www.hindawi.com/journals/amete/2016/4891015/
2. https://www.sciencedirect.com/science/article/pii/S1110982314000209
3. http://www.oas.org/dsd/publications/unit/oea66e/ch10.htm
4. https://www.preventionweb.net/files/65868_f222odhiambolandslidessouthafrica[1].pdf
5. https://journals.openedition.org/geomorphologie/12778
6. https://www.sciencedirect.com/science/article/pii/S2226585619300445
7. https://www.sciencedirect.com/science/article/pii/S1110982317301114
8. http://dpnet.org.np/public/uploads/files/Learning%20Document%20Issue%207%20-%20Risk%20Sensitive%20Land%20Use%20Planning%20for%20Urban%20Risk%20Management%20(002)%202019-05-16%2010-15-42.pdf
9. https://ngs.org.np/demo/wp-content/uploads/2019/09/Geo-disaster-and-risk-sensitive-land-use-planning-in-Nepal-Thapa-2018.pdf

ANNEXURE A

B.Sc. GEOGRAPHY

(Summary of changes incorporated in the syllabus)

Semester	Course Title	Existing (Indicate only the unit where the change is proposed)	Changes Proposed	Specify the reason for the change
I	Fundamentals of Physical Geography (Theory)	III	Deletion: Dynamics of ocean water: - Waves, Tides, and surface currents of Indian and Atlantic Ocean. Addition: Introduction to oceanography- Definition, Development of oceanography as a discipline, Significance and scope of oceanography,	
II	Basics of Regional Geography (Theory)	I	Addition: Factors of regionalization	
III	Fundamentals of Remote Sensing and GIS (Theory)	I	Addition: Theories of radiation	Essential topic
III	Fundamentals of Remote Sensing and GIS (Theory)	III	Addition: Levels of interpretation Deletion: **Introduction to digital analysis** **Concepts in GIS :** Content of GIS, objectives of GIS, Elements of GIS, Hardware & Software Requirements, Point Line and Polygon, Layers and Coverage Raster and Vector Data, Components of GPS.	Essential Too advanced for basic level
III	Fundamentals of Remote Sensing and GIS (Practical)	II	Deletion: Geo-referencing of scanned maps. Digitization of point, line and polygon layers. GPS survey on field and Identification of geographic feature on image and on actual	Too advanced for basic level

			ground	
IV	Fundamentals of Geomorphology (Practical)	I	Deletion: Soil Analysis applications	Too advanced for basic level
IV	Fundamentals of Geomorphology (Practical)	II	Addition: Structural landforms (aerial photo or geological maps):	Essential topic
IV	Watershed Management (Theory)	I	Addition: Approaches watershed management	Added considering recent advances
V	Geography of Soil Studies (Practical)	II	Deletion: 1. NPK level testing	Not essential
VI	Ecology and Terrestrial Environment (Practical)	II	Addition: Pre field preparations and post field analysis and report generation	Essential
VI	Practical in Remote Sensing of Forest Ecology (Practical)	II	Deletion: Principal Component Analysis (method specify)	Not relevant
VI	Ecology of Estuarine Environment (Practical)	II	Deletion: Mini project	Excessive

GEOLOGY

DEPARTMENT OF GEOLOGY

Approved syllabus of Semester I and Semester II in Geology under Autonomy

Paper Title: FUNDAMENTALS OF MINERALOGY
Paper Code: GEL-I. C-1
Name of the faculty: Meghana S Devli
Marks: 75
Credits: 3

Course objectives: The course deals with the study of minerals, their chemistry and identification in hand specimen. Further, it also deals with the study of crystals w.r.t their morphology, symmetry and the normal crystal classes.

Learning outcomes: Studying the basics of mineralogy and crystallography helps in understanding and building the overall knowledge in geology.

MODULE 1

Elemental and oxide composition of the earth's crust - Major elements, Minor elements and Trace elements
Types of Atomic bonds. (Ionic/Covalent/Metallic/ Van der Waal)
Atomic arrangement in crystalline matter. (HCP/CCP)
Radius Ratio, Ionic Radius, Co-ordination Number. Types of co-ordination.
Crystals and crystallization
Crystalline state and Amorphous state.
Important and abundant mineral groups: silicate, sulfides, sulfates, carbonates; oxides; halides; native metals (with three examples each)

MODULE 2

Space lattice.Unit cell.External morphology of a crystal. Crystal Forms with examples.
Crystallographic axes and Crystal systems.
Symmetry in crystals. (Axis, Plane, Center)
Interfacial angles and Contact Goniometer.
Parameters and Indices
Study of the Normal Class (w.r.t the crystallographic axes, crystal symmetry, crystal forms, examples) of the crystal systems

MODULE 3

Mineral.Rock-forming minerals and ore minerals.
Physical properties of minerals: Colour; Streak, Luster; Diaphaneity, Habit (imitative form); Hardness; Cleavage; Fracture; Specific Gravity
Tenacity, Luminescence
Thermal, Electrical, Magnetic properties of minerals
Polymorphism, Isomorphism, Pseudomorphism, Diadochy
Classification based on silicate structures: (sorosilicate/ cyclosilicate/ nesosilicate/ inosilicate/ phyllosilicate/tectosilicate)
Introduction to rock-forming mineral groups: Olivine, Pyroxene, Amphibole, Mica, Feldspar, Silica

List of recommended reference books:

1. *Dana's Manual of Mineralogy* (2010) by Dana J. D and Ford W. E.(J. Wiley & Sons)
2. *The Manual of Mineral Science* (2007) by Klein, C. and B. Dutrow (John Wiley & Sons, Inc.)
3. *Mineralogy* (3rd edition) by Perkins, D (PHI learning Private Limited, New Delhi)
4. *An Introduction to the rock forming minerals* by Deer W A, Howie R. A and Zussman J. (John Wiley and Sons)
5. *Rutley's elements of Mineralogy* (1988) by Read, H. H (CBS Publications)

Practical Code: GEL-I. P -1
Marks: 25
Credit: 1

1. Identifying and determining the crystal symmetry, class, system and forms in the normal class of the six systems.
2. Identification and study of ore minerals w.r.t their physical properties, occurrence, chemical composition and use.

Paper Title: **ELEMENTARY PETROLOGY**
Paper Code: **GEL-I.C-2**
Name of Faculty: **Allan Rodrigues**
Marks: **75**
Credits: **3**

Learning objectives:

Petrology is the science of rocks. The course will help the students to exhibit an improved understanding of fundamental petrologic processes and common rock types. In practicals, students learn to identify, describe and classify rocks using hand specimens.

Learning outcomes:

On completion of the course the students:

(i) Will have gained an understanding of the processes involved in the formation of a rock, their textures, structures, classifications and their importance.
(ii) Will have learned to differentiate between the different rock types based on their properties.

MODULE 1

- Rocks: Definition; Classification; The rock cycle
    - Definition of Igneous rocks
    - Magma: Definition, formation, composition,
        - Properties: temperature, density, viscosity
        - Bowen's Reaction Series
    - Mode of occurrences of Igneous rocks
        - Intrusive forms
            - Dykes (Radiating, Arcuate, Ring dykes, and cone-sheets), Sills, Laccoliths, Lopoliths, Phacoliths, Volcanic necks, Batholiths (stocks, bosses and roof - pendants), Multiple and Composite intrusions.
        - Extrusive forms
            - Central and Fissure type
    - Structures of Igneous rocks

- Textures of Igneous rocks
- Classification: Based on
    - Fabric (phaneritic, aphanitic, glassy and volcaniclastic)
    - Field relations (volcanic/extrusive, intrusive hypabyssal, and intrusive plutonic).
    - Mineralogical composition
    - Chemical composition
- Study of the following rocks: Granite, Rhyolite, Gabbro, Dolerite, Basalt, Syenite, Trachyte, Dunite, Pyroxenite, Peridotite

MODULE 2

- Introduction, Scope and Significance
- Weathering (definition, types – Chemical and Physical, and products), Erosion, Transportation and Deposition
- Diagenesis (definition and processes)
- Primary Structures
- Textures
- Classification of sedimentary rocks
- Sedimentary environments
- Study of the following rock types (Structures, textures, mineral composition, origin): Shale, Sandstone, Conglomerate, Breccia, Limestone, Dolomite, Laterite

MODULE 3

- Metamorphism: definition, agents of metamorphism.
- Types of metamorphism, their tectonic setting
- Metamorphic minerals; stress and anti-stress minerals
- Metamorphic textures and structures.
- Metamorphic grade, Index minerals and Isograds
- Protolith: definition, recognition and types (Ultramafic, Mafic, Quartzo-feldspathicor felsic, Pelitic, Calcareous, Calc-silicate)
- Metasomatism
- Nomenclature of metamorphic rocks.
- Study of the following metamorphic rocks with reference to their parent rock type, grade and type of metamorphism, fabric and mineral composition: Slate, Phyllite, Schist, Banded Gneiss, Augen Gneiss, Mylonite, Quartzite, Marble.

List of Recommended Reference Books

1. *Igneous Petrology* by Mihir K. Bose (The World Press Private Limited, 1997)
2. *Igneous and Metamorphic Petrology* by Myron Best (Cambridge:Blackwell science, 1995)
3. *Sedimentary Rocks* by F. J. Pettijohn (Delhi:CBS Publishers,1984)
4. *Petrology, Igneous, Sedimentary and Metamorphic* by Ehlers, E.G. and H. Blatt (1982), (W.H Freeman, San Francisco)
5. *A textbook of Geology* by G. B. Mahapatra (CBS)
6. *A Textbook of Engineering and General Geology* (Seventh Ed) by Parbin Singh
7. *A textbook of Geology* by P. K. Mukherjee (World Press)
8. *Principles of Petrology: An Introduction to the Science of Rocks* by Tyrell G.W. (1980), (1st Indian Edn., B.I. Publn. India)

Practical Code: **GEL-I.P-2**

Marks: **25**

Credit: **1**

1. Identification and study of rock-forming minerals w.r.t. their physical properties, occurrence and chemical composition.
2. Megascopic study of rocks (Igneous, Sedimentary and Metamorphic) in hand specimen.

Paper Title: EARTH'S DYNAMICS &TECTONICS
Paper Code: GEL-II. C-3
Name of the faculty: M S Katti
Marks: 75
Credits: 3

Course objectives: Structural Geology is a core branch of earth science which deals with basic concepts of natural internal forces shaping the earth. Further, the course deals with geological structures resulting from the action of these forces on rocks. Also, presents an understanding of the processes in action on the earth's surface and their impact on man and his institutions.

Learning outcomes: the study of this paper strengthens students' knowledge w.r.t understanding the essentials of the structural dynamics of the earth.

MODULE 1

Origin of Solar System (Nebular Concept) and formation of a layered Earth.
Structure of the Earth: Atmosphere to Core

Geologic Forces:

Internal : Epeirogenic & Orogenic movements, Volcanic activity, Isostacy ; Glacial Rebound.

External: Hydrological Cycle, Rock cycle.

Earth's Gravity : Acceleration due to gravity, change with latitude and altitude.
Size and shape of the Earth.

Earth's Magnetism : Earth as a magnet; lines of force, Source of Earth's Magnetic field, Declination and inclination, Geomagnetic axis & Geographic axis.

MODULE 2

Introduction to Plate Tectonics: lithosphere, asthenosphere, convection currents, Plate margins & boundaries and associated seismicity and volcanism.

Lithostatic or confining pressure, Differential forces: tension, compression, couple concept of stress & strain: stages of deformation: Elastic, Plastic & Rupture.

Brittle & ductile substances.

Geological Hazards: Earthquakes & Tsunami, Volcanic activity, Landslides & avalanches.

Earthquakes: Elastic rebound theory, Seismic waves, Intensity (Richter scale) Seismogram, determination of Epicenter, Types of Earthquakes (shallow, intermediate, deep), Relation of Earthquakes to plate boundaries.

MODULE 3

Map & Scales, Compass bearings, Systems of notation of bearings, Fore bearing & back bearing.

Representation of relief: Contours, Properties of contours, Contour reading, patterns & uses of contours.

Stratification, Strike & dip (true & apparent dip) strike & dip symbols.

Outcrop patterns of Horizontal, Inclined & vertical strata on various types of grounds (horizontal ground, valley & spur).

Folds: Terminology, causes, types of folds; symmetrical, asymmetrical, overturned, recumbent, isoclinal, fan, chevron, monocline, structural terrace, plunging & non-plunging; significance. Outcrop pattern of folds on horizontal ground, valley and spur.

Faults: Definition & terminology, geometric classification, significance; horst & graben.

Joints: Geometric classification, map symbols, columnar joints & sheet structure, significance.

Unconformities: Stages of development, types, significance; outliers & inliers; overlap & offlap.

List of books recommended for reference:

1. *Living with Earth* (2012) by Hudson Travis, Phi Learning Pvt. Ltd., New Delhi.
2. *Physical Geology* by Charles C. Plummer and David McGeary (4th edition), Wm C. Brown Publishers.
3. *Understanding the Earth* (4th edition) by Press, Siever, Grotzinger and Jordan.
4. *The Changing Earth: Exploring Geology and Evolution* (3rd edition) by Monroe and Wicanter.
5. *A Textbook of Engineering and General Geology* (7th edition) by Parbin Singh.
6. *Holmes' Principles of Physical Geology* edited by P.McL.D.Duff (ELBS).
7. *Elements of Structural Geology* by E.S. Hills (Methuen)
8. *A Textbook of Geology* by P K Mukherjee (World Press)
9. *Elements of Geology* (3rd edition) by Zumberge J.H. & Nelson C.A. John Wiley & Sons, New York.

Practical Code: GEL-II. P -3
Marks: 25
Credit: 1

1. Drawing cross-section and description of structural maps involving single series (Horizontal and Inclined)
2. Graphical solution to structural problems.

Paper Title: PRINCIPLES OF STRATIGRAPHY AND PALAEONTOLOGY
Paper Code: GEL-II. C-4
Name of the faculty: H S S Nadkarni
Marks: 75
Credits: 3

Course objectives: Stratigraphy and Palaeontology, the two branches of Geology work together to unearth the secrets of age from rocks of the earth's crust. Stratigraphers study the composition and arrangement of layered, or stratified rocks. Palaeontologists study the remains of plants and animals which have been preserved in the earth's crust by natural processes. With these objectives in mind it becomes pertinent to understand the basic concepts of Stratigraphy and Palaeontology.

Learning outcome: The study of stratigraphy and Palaeontology encompasses the aspects of the age of the earth, chronological arrangement of rocks and appearance and evolution of life through the geologic time.

The knowledge of the concepts in stratigraphy, correlation, and palaeontology would enable the students to understand the changes that occurred in the history of the earth and relate them to their field observations and also, in understanding the framework of the stratigraphy of India.

Module 1

Scope and Objectives of Stratigraphy:

Laws of: Uniformitarianism, Original horizontality, Order of superposition, Faunal succession, Cross-cutting relationship, Inclusions.

Age of the earth: Brief outline of early methods, radiometric dating; Principles.

Measurement of geologic time:
Time Units: Eon-Era-Period-Epoch-Age
Standard Stratigraphic Scale.

Lithostratigraphic/ Rock Units: Group-Formation-Member-Bed
Indian Stratigraphic Sequence
Chrono-/ Time stratigraphic units: Erathem-System-Series-Stage

Correlation and methods of Correlation:
Paleontological Criteria : Index/ Zone fossils
Lithological Similarity: Marker/ Key bed
Structural relations: Tectonic criteria
Radiometric dating criteria

Field observations and applications.

Divisions of Geologic time: Primary-secondary-Tertiary Periods .Stratigraphical subdivisions based upon the progress of life: The Seven Ages.

Physiographic subdivisions of India and their distinctive characters.

Brief account of the Dharwar Group of rocks and their stratigraphic position.

Brief account of the Geological Formations of Goa.

Module 2

Scope and importance of Palaeontology:

Fossils: Mega- Micro-Ichnofossils

Conditions for fossilization; Favourable environments for fossilization.

Modes of fossilization: Petrification, Carbonisation,
Natural moulds and casts,
Ichnofossils, Frozen and mummified fossils.

Uses of fossils:
Correlation: Index/ Zone fossils
Dating, locating coal and petroleum deposits.

Module 3

Binomial nomenclature of organisms and Taxonomy

Morphology of the hard parts and geological time range of the following:

Phyllum: Arthropoda- Class: Trilobita

:Mollusca- Class : Pelecypoda
:Gastropoda
:Cephalopoda- Nautiloidea
Ammonoidea
Belemnoidea

: Brachiopoda

:Echinodermata- class: Echinoidea

Books for study and reference:

1. *Basic concepts of Historical Geology* by Edgar, Winston, Spencer (Oxford & IBH Publishing Co.).
2. *Manual of Geology* by J.D. Dana (Anmol Publications).
3. *Fundamentals of Historical Geology and Stratigraphy of India* by Ravindra Kumar- New Age International Publishers.
4. *Fundamentals of Invertebrate Palaeontology* by M.A.Koregave-Book World Enterprises.
5. *The Changing Earth: Exploring Geology and Evolution* (3^{rd} edition) by Monroe and Wicanter
6. *The Elements of Palaeontology* by Rhona M. Black- Cambridge University Press.
7. *A Textbook of Geology* by P.K Mukherjee (world Press).

Practical Code: GEL-II. P -4
Marks: 25
Credit: 1

1. Use of clinometer compass
2. Exercises on bearings
3. Study of fossils/casts/shells w.r.t their morphology and geological age.

Parvatibai Chowgule College of Arts and Science, Margao- Goa (Autonomous)

DEPARTMENT OF GEOLOGY

THREE YEAR B.Sc. DEGREE COURSE IN GEOLOGY (2016 onwards)

Course Structure and List of Core, Elective and Foundation Courses

COMPONENT A

SEMESTER	CORE COURSES		ELECTIVE COURSES			
I	**GEL-I.C-1** Fundamentals of Mineralogy	**GEL-I.C-2** Elementary Petrology	-----	-----	-----	-----
II	**GEL-II.C-3** Earth's Dynamics and Tectonics	**GEL-II.C-4** Principles of Stratigraphy and Paleontology	-----	-----	-----	-----
III	**GEL-III.C-5** Optical and Systematic Mineralogy		**GEL-III.E-1** Physical Geology	**GEL-III.E-2** Groundwater and Hydrogeology	**GEL-111.E-3** Engineering Geology.	**GEL-III.E-4** Marine Geology
IV	**GEL-III.C-6** Structural Geology		**GEL-IV.E-5** Ore Genesis	**GEL-IV.E-6** Stratigraphy of India – Part I	**GEL-IV.E-7** Natural Hazards and Management	**GEL-IV.E-8** Geotectonics
V	**GEL-V.C-7** Igneous Petrology	**GEL-V.CP** Core Project	**GEL-V.E-9** Stratigraphy of India – Part II	**GEL-V.E-10** Petroleum Geology	**GEL-V.E-11** Principles of Geophysical Exploration	**GEL-V.E-12** Remote Sensing and GIS Applications
VI	**GEL-VI.C-8** Sedimentary Petrology	**GEL-VI.CP** Core Project	**GEL-VI.E-13** Metamorphic Petrology	**GEL-VI.E-14** Mining and Mineral Exploration	**GELVI.E-15** Surveying and Mapping	**GEL-VI.E-16** Gemstone Testing and Evaluation

Core Course papers for students offering **Geology as the Minor Subject**

SEMESTER I
GEL-I.C-1: Fundamentals of Mineralogy
SEMESTER II
GEL-II.C-3: Earth's Dynamics and Tectonics
SEMESTER III
GEL-III.C-5: Optical and Systematic Mineralogy
SEMESTER IV
GEL-IV.C-6: Structural Geology
SEMESTER V
GEL-V.C-7: Igneous Petrology
SEMESTER VI
GEL-VI.C-8: Sedimentary Petrology

Component B: Foundation Course

- **Interdisciplinary Papers**

Semester V
GEL-V.GC-1: Environmental and Physical Geology
Semester VI
GEL-VI.GC-2: Gemmology

SEMESTER

III

Paper Title: **OPTICAL AND SYSTEMATIC MINERALOGY**

Paper Code: **GEL-III.C-5** (Core Course)

Marks: **75**

Credits: **3 (45 Contact hours)**

Course Objectives:

- The course covers the basics of geoscientific studies in Mineralogy. The knowledge of optics is applied in understanding the genesis and identification of minerals.

Learning Outcomes:

- The course will enable the students not only to differentiate them based on their optical properties, but also to understand how they originate and associate with each other in a rock.

MODULE 1: **15 Lectures**

Introduction: Nature of light, Polarized light, Refractive Index, Critical angle and Total Internal reflection, Wave Surface, Double Refraction.

Parts and working of a Polarizing / Petrological microscope

Properties of minerals in Plane Polarised Light (PPL): Colour, Form, Cleavage/Cracks; Relief, Twinkling; Pleochroism, Pleochroic halos.

Optical characters of minerals: Isotropism and Anisotropism

Properties of minerals Between Crossed Polars (BXP): Interference colours: Formation, Newton's Scale, Anomalous interference colours; Extinction and Extinction types. Twinning, Zoning, Alteration, Inclusions.

Uniaxial indicatrix
Biaxial indicatrix

Optical accessories

Convergent Light: Principle

Uniaxial Interference Figure
Biaxial Interference Figure
Optic sign of Uniaxial and Biaxial Minerals
2V and 2E

MODULE 2: **(15 Lectures)**

Physical and optical properties, Paragenesis, stability relations of the following group of minerals:

- Olivine group
- Pyroxene group
- Amphibole group
- Garnet group

MODULE 3: **(15 Lectures)**

Physical and Optical properties, Paragenesis, Stability relations of the following group of minerals

- Mica group
- Feldspar group
- Feldspathoid group
- Silica group

Practicals

Marks: **25**
Credit: **1 (15 Practicals)**

- Identification of 20 common rock forming minerals based on optical properties
- Interference figures (Demonstration)
- Determination of optic sign (demonstration)
- Determination of An-content using extinction angles (demonstration)

List of recommended reference books:

- Kerr, P., 1977, Optical Mineralogy, McGraw Hill Publishers.
- Nesse, D. W., 2012, Introduction to Optical Mineralogy, Oxford University Press.
- Ford, W. E., 2006. Dana’s Textbook of Mineralogy (with extended treatise Crystallography and Physical Mineralogy). CBS Publishers, New Delhi.
- Deer, W. A, Howie, R. A and Zussman. J., 2013, An Introduction to Rock-Forming Minerals, Mineralogical Society.
- Griffen, D. T, Phillips, W. R and William, R. Phillips., 2004. Optical Mineralogy: The Nonopaque Minerals. CBS Publishers, New Delhi.
- Mason and Berry., 2004. Mineralogy, CBS Publishers, New Delhi.

Paper Title: PHYSICAL GEOLOGY

Paper Code: **GEL-III.E-1**

Marks: **75**

Credits: **3 (45 Contact hours)**

Prerequisites: GEL-I.C-1 and GEL-II. C-3

Course Objectives:
The natural agencies like wind, rivers, glaciers have been moulding and remoulding the surface of the earth over millions of years. This paper aims at the understanding of the processes and the physical forces responsible in developing the surficial features and highlighting the role of these natural agencies in grading and degrading the land surface.

Learning Outcomes:
The students are expected to relate the activity of the various natural agents to the existence of different types of physical features on the earth's surface and, will be able to understand the dynamism in their creation.

MODULE 1: (15 Lectures)

Weathering;

- Physical weathering: Frost wedging; Temperature fluctuations, Exfoliation, activity of organisms, attrition
- Chemical weathering: hydrolysis, leaching, oxidation, dissolution and spheroidal weathering

Processes of Erosion, Transportation and Deposition.

Geological action of Wind : Wind as a geological agent.
Sediment transport by wind: Bed load, suspended load.
Erosional features: Desert pavement, Ventifacts, Yardangs, Pedestal/Mushroom rocks.
Depositional landforms: Dunes: Formation and migration of dunes; Types of dunes; Loess.

MODULE 2: **(15 Lectures)**

Geological action of Rivers: Stream, Stages of river, stream channels, long profile, cross-sectional shape.
Erosion by running water: Laminar flow, turbulent flow, hydraulic action, abrasion; Bed load; Base level of erosion.
Erosional feature: Waterfalls, mesas, butte, Cuesta, Hogback, Meanders and ox-bow lakes
Depositional landforms: Braided stream, alluvial fans; deltas.

Geological action of Ground water: Origin of ground water, groundwater movement, Zone of aeration, saturated zone, water table, perched water table.
Erosion by ground water: Dissolution, Carbonate Caverns and Sink holes, Karst topography.
Deposition by ground water: Cave deposits; Dripstones, Stalactites and Stalagmites
Springs, Hot springs and Geysers.

MODULE 3: **(15 Lectures)**

Geological work of Glaciers: Snowline, Formation of ice; Glaciers; movement of glaciers, Valley glaciers, Piedmont glaciers, Ice-sheets; Crevasses.
Glacial erosion: Abrasion, Quarrying, Frost wedging;
Erosional features; Cirques, Arêtes, Horns, U- shaped valleys, Fjords, Hanging valleys.
Glacial transport: Drift, Till and Erratics
Depositional landforms: Moraines, Drumlins, Outwash plains, Kettles, Eskers, Varves.

Geological action of Oceans and Sea: Waves, Tides and currents;: breaking waves, surf
Coastal erosion and landforms: wave-cut platform, sea cliff, sea-caves, sea-arches, sea-stack.
Coastal deposits: Beaches, spits, bars and tombolos.

Practicals:

Marks: **25**

Credit: **1(15 Practicals)**

- Calculation of length using Rotameter
- Calculation of area using Square grid, Strip method, Hero's rule (Triangle method), Planimeter (demonstration)
- Drawing of long profile and cross profile of rivers selected from S.O.I Toposheets.

- Basin Morphometry
- Hypsometry
- Study and description of common landforms from 3D models.

List of books recommended for references:

- Monroe, S. J and R. Wicander., 2014, The Changing Earth: Exploring Geology and Evolution, Brooks Cole Publishers.

- Duff, D and Holmes, A., 1993, Holmes Principles of Physical Geology, Springer.

- Skinner, J. B and S, C. Porter., 2003. The Dynamic Earth: An Introduction to Physical Geology, John Wiley and Sons.

- Mathur, S. M., 2012. Physical Geology of India, National Book Trust.

Paper Title: **GROUNDWATER AND HYDROGEOLOGY**

Paper Code: **GEL-III.E-2**

Marks: 75

Credits: **3** (45 CONTACT HOURS)

Prerequisites: GEL-I.C-1 and GEL-II. C-3

Course Objectives: To impart knowledge about groundwater, its movement, methods of its exploration, the criteria of its quality, methods of its conservation, recharge of groundwater, monitoring of groundwater quality and quality.

Learning Outcomes: On completion of the course, the student will have gained an understanding of:

- Hydrogeological concepts, exploration, exploitation and recharge of groundwater
- Methods of monitoring groundwater quality and sources of pollution

MODULE I **(15 LECTURES)**

- Hydrologic cycle: its components
- Infiltration: its controlling factors
- Hydrologic budget
- Vertical distribution of sub surface water
- Types of Groundwater: Juvenile, Connate, Magmatic, Meteoric water
- Rock properties affecting movement of Ground water : 1) Porosity(primary and secondary), effective porosity, controlling factors of porosity
  2) Permeability: Darcy's law, laboratory methods of measurement of permeability (constant head , falling head), specific yield , specific retention.
- Relation between grain size, porosity ,specific yield and specific retention .
- Definition of an aquifer, aquiclude, aquitard, aquifuge, and types of aquifers: Unconfined, Confined (Artesian), Perched aquifer

MODULE II **(15 LECTURES)**

- Groundwater Exploration: Resistivity methods
- Aquifer parameters: 1) Transmissivity, 2) Storativity,3) Hydraulic conductivity: methods of determination (pumping test and tracer test)
- Drawdown and cone of depression
- Flow nets

- Groundwater quality:
    - Parameters :physical ,chemical and biological
    - Major, minor and trace constituents.
    - I.S.I standards for drinking water

MODULE III **(15 LECTURES)**

- Effects of withdrawal, effects of waterlogging
- Artificial recharge
- Saline water intrusion in aquifer
- Ghyben-Hertzberg relation
- Pollution of ground water: Arsenic and Flourine

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Practicals:

Marks: **25**

Credit: **1 (15 Practicals)**

- Drawing flow nets
- Determination of depth to water table from bore hole data.
- Numerical problems on determinationof porosity, bulk density, saturation percentage and void ratio of sample
- Problems based on Ghyben –Hertzberg formulae
- Graphical presentation of chemical data of water
  resistivity survey(demonstration)

List of recommended reference books:

1. Todd , D.K and Mays, L.W., 3rd edition , 2012. Groundwater Hydrology, Wiley India Pvt. Ltd.
2. Valdiya K.S., 1987, Environmental Geology: Indian Context, Tata-McGraw Hill
3. Ragunath H.M., 1983, Groundwater, Wiley Eastern Ltd, New Delhi.
4. Keller, E.A., 4th edition, 2011. Environmental Geology, CBS Publishers, NewDelhi.

Paper Title: **ENGINEERING GEOLOGY**

Paper Code: **GEL-III. E-3**

Marks: **75**

Credits: **3 (45 contact hours)**

Prerequisites: GEL-I.C-1 and GEL-II. C-3

Course Objective: To impart sufficient knowledge of engineering geology so as to be able to anticipate the technical problems related to geology of various engineering sites and suggest possible remedial measures.

Learning Outcome: Upon completion of the course the student will become aware of the importance of geological studies and its applicability to various engineering problems.

MODULE I **(15 LECTURES)**

- Introduction to engineering geology
- Scope of engineering geology
- Engineering properties of rocks
  1. Rocks used as building stones.
  2. Rocks at foundation sites.
  3. Rocks used as aggregates.
- Factors affecting engineering properties of rocks
- Aggregates: Sources and Types.

MODULE II **(15 LECTURES)**

- Soils
  1. Types of soils.
  2. Soil profile.
  3. Engineering properties of soil
- Dams
  1. Parts of a dam.
  2. Types of dams.
  3. Selection of sites.
  4. Forces acting on a dam
  5. Geological conditions at the dam site.
  6. Spillways and Types of spillways

- Bridges
    1. Geological considerations in the selection of sites for the construction of a bridge.
    2. Types of bridges.

MODULE II **(15 LECTURES)**

- Tunnels
    1. Types of Tunnels.
    2. Geological considerations in tunneling.
    3. Lining of tunnels
    4. Environmental effect of tunnels
- Remedial measures for site improvement.
- Properties of important building stones..
- Case study of major dams, tunnels and bridges in India.

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Practicals:

Marks: **25**

Credit: **1 (15 Practicals)**

- Site feasibility based on geological map.
- Core logging
- Computation of reservoir area, catchment area, reservoir capacity
- Numerical problems on ultimate strength of rocks

List of recommended reference books.

1. Singh, P., 7th edition, Engineering and General Geology, S.K Kataria and Sons.
2. Blyth, F.G.H and De Freitas., 7th edition, Geology for Engineers, ELBS.
3. Kesavulu, N.C., 2nd edition, A textbook of Engineering Geology, Laxmi Publications.
4. Krynine, D. and Judd W., Indian Reprint (1998), Principles of Engineering Geology and Geotectonics, McGraw Hill.#indian reprint
5. Billings, M.P., 3rd Edition, Structural Geology, CBS Publishers, New Delhi.
6. Sathya, N S., 2nd edition, Engineering Geology, B.S, Dhanpat Rai and Co. Pvt Ltd.
7. Gupte R.B. (1992)., A Textbook of Engineering Geology., Pune Vidyarthi Griha Prakashan.

Paper Title: **MARINE GEOLOGY**

Paper Code: **GEL-III. E-4**

Marks: **75**

Credits: **3 (45 Contact hours)**

Prerequisites: GEL-I.C-1 and GEL-II. C-3

Course Objectives:

- To provide essential concepts of oceanography.

- To study the tectonics, geology, economic resources w.r.t. the oceans.

Learning Outcomes:

- A student will understand and learn about the basic concepts of marine science with respect to geology as to enable them to work as a marine researcher.

MODULE 1: **(15 Lectures)**

- Introduction to Marine Geology
- Morphological features of the ocean floor: continental margin provinces (continental shelf, continental slope, continental rise), ocean basin provinces (sea mounts, guyots, abyssal plain), Mid Oceanic Ridges.
- Ocean basins: Shape, size of the Pacific, Atlantic and Indian Oceans

MODULE 2: **(15 Lectures)**

- Classification of marine sediments (terrigenous, biogenous, chemogenous, authigenic, cosmogenous), Sediment distribution on the Ocean floor
- Sedimentation rates, sediment budget, sediment transport, accumulation of sediments in the ocean; sedimentation processes on continental shelves - physical processes, sediment response; deep-sea sediments.
- Provenance of sediments.
- Geochronology of marine sediments and rocks (dating methods).
- Seawater chemistry - salinity, components of salinity, sources of ocean's salts, processes controlling the composition of sea water, determining salinity.

MODULE 3: **(15 Lectures)**

- Classification of coasts.
- Exclusive Economic Zone (EEZ); Minerals in the EEZ of India.
- Instrumentation for sea bed sampling, Sea-bed deposits,
- Marine Resources: Physical Resources - sand and gravel, polymetallic nodules, gas hydrates, metallic sulfides (black and white smokers) and muds.

Practicals:

Marks: **25**

Credit: **1 (15 Practicals)**

- Grain size analysis and its statistical parameters.
- Beach profiling
- Demonstration of samplers.

List of books recommended for references:

- Trujillo, A. P and Thurman H., 2013. Essentials of Oceanography, Eastern Economy Edition, PHI Learning Pvt. Ltd, New Delhi.
- Kennett J P., 1981. Marine Geology, Prentice Hall.
- Qasim, S.Z., 1996, India's Exclusive Economic Zone, Omega Scientific Roonwal, G.S. Publishers.
- Thurman, H V. and Trujillo A., 2003, Introductory Oceanography, Prentice Hall.

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SEMESTER III

EVALUATION AND ASSESSMENT SCHEME

Each course (Core or Elective) = 4 credits of 100 marks

Theory: 75 marks = 3 credits

- Continuous Assessment (CA): 30 marks.
- Semester End Examination (SEE): 45 marks.

Practicals: 25 marks = 1 credit

i. Assessment in practicals will be done by continuous assessment throughout the Semester.

ii. Practicals will be supported by appropriate field work.

SEMESTER

IV

Paper Title: **STRUCTURAL GEOLOGY**

Paper Code: **GEL-IV.C-6** (Core Course)

Marks: **75**

Credits: **3 (45 Contact hours)**

Course Objectives:

- The course is designed for the students to understand the geometry and mechanics of the various geological structures that result through the deformative processes operative within the earth.

Learning Outcomes:

- The student will
  - gain knowledge of the geometry of the rock structures.
  - understand the mechanism of the evolution of rock structures and its application in the field.

MODULE I: **(15 Lectures)**

- Objectives of Structural Geology,
- Principles of mechanical behavior of rocks, forces, composition and resolution of forces stress, strain, stress-strain diagram. Mohr's envelope, Factors controlling mechanical behavior of rocks.
- Determination of top of beds with the help of primary and secondary features: ripple marks, graded and cross bedding, fossils.

MODULE II: **(15 Lectures)**

- *Folds*: Recognition, causes of folding; tectonic and non-tectonic. Genetic classification of folds
- Drag folds and their significance
- *Unconformities*: types of unconformities, recognition and distinction from faults and intrusive contacts.

MODULE III: **(15 Lectures)**

- *Joints*: Principles of failure by rupture (experimental data), relation of rupture to stress and strain (stress and strain ellipsoid), genetic classification of joints.

- *Faults*: Terminology, separation, genetic classification, criteria for recognizing faults, types of faults (normal, strike-slip, dip-slip, reverse, thrust, overthrust)
- *Cleavage and Schistosity*: types, origin and relation to major structures.
- *Secondary lineation*: Kinds of secondary lineation and their origin.

Practicals

Marks: **25**

Credit: **1 (15 Practicals)**

- Solving Geological Maps
- Completion of Outcrops
- Stereographic Projection of Structural Data
- Graphical Solution for Structural Problems

List of recommended reference books:

- Twiss, R. J and Moores, E. M., 2006. Structural Geology, W H Freeman and Company.
- Davis, G. H., 1996. Structural Geology of Rocks and Regions, Wiley
- Pollard, D. D and Fletcher, R. C., 2005.Fundamentals of Structural Geology, Cambridge University Press.
- Marshak, S and G. Mitra., 1988. Basic Methods of Structural Geology, Prentice Hall.
- Billings, M., 2008. Structural Geology, PHI Learning Pvt. Ltd, New Delhi.
- Hobbs, B and Alison, O. R. D., 2014. Structural Geology: The Mechanics of Deforming Metamorphic Rocks, Elsevier Science Publishing Co. Inc
- Fossen, H., 2010. Structural Geology, Cambridge University Press

Paper Title: ORE GENESIS

Paper Code: GEL-IV. E-5

Marks: 75

Credits: 3 (45 contact hours)

Prerequisites: GEL-I.C-1, GEL-I.C-2, GEL-II.C-3 and GEL-II. C-4

Course Objectives: The course deals with the study of various processes of formation of ore deposits. It also deals with the study of various mineral deposits with respect to their mode of occurrence, geologic and geographic distribution, classification and their genesis. Furthermore, it also deals with the identification of economic minerals in hand specimens.

Learning Outcome: On completion of the course, the student will have gained sufficient knowledge regarding the formation of various ore deposits and also be able to differentiate between economic minerals and identify them. Furthermore, the student will gain an idea about the mineral wealth of our country.

MODULE 1 **(15 lectures)**

- Introduction to Ore Genesis.
- Scope and Application of Economic Geology.
- Concepts of the terms ore, gangue, grade, tenor, resources, reserves.
- Classification of Mineral deposits
    1. Lindgren's scheme.
    2. Bateman's scheme.
- Epigenetic and Syngenetic deposits.
- Process of formation of various ore deposits
    1. Magmatic Concentration
    2. Sedimentation
    3. Metamorphism
    4. Contact Metasomatism

MODULE 2 **(15 lectures)**

- Process of formation of various ore deposits
    5. Hydrothermal Processes (Cavity filling and Metasomatic replacement)
    6. Oxidation and Supergene Enrichment
    7. Sublimation
    8. Residual Concentration
    9. Mechanical Concentration

MODULE 3 **(15 lectures)**

- Classification, mode of occurrence, genesis and geological and geographic distribution of the following metallic deposits in India.
    1. Iron
    2. Manganese
    3. Aluminium
    4. Chromium
    5. Copper
    6. Lead-Zinc
    7. Gold
- Classification, Mode of Occurrence, Genesis and Geological and Geographic distribution of the following non-metallic deposits in India .
    1. Coal
    2. Petroleum and Natural Gas
    3. Diamond
    4. Nuclear minerals
    5. Industrial minerals: (Refractory, Abrasives, Cement, Fertilizer, Electrical and Electronic industries)
- List of type deposits and leading global ore producers of the above metallic and non metallic deposits.

Practicals:

Marks: **25**

Credit: **1 (15 Practicals)**

1. Study of Economic minerals in hand specimen
2. Location of various ore deposits on the outline map of India

List of recommended reference books:

1. Jensen, M.L and Bateman A.M., 3rd Edition, (1979), Economic Mineral Deposits, John Wiley and Sons.
2. Prasad, U., 2nd edition, (2014) Economic Geology: Economic Mineral Deposits, CBS Publishers, New Delhi.
3. Krishnaswamy, S., (1979), Indian Mineral Resources, Oxford and IBH.
4. Gokhale, G.V.G.K., (1983), Ore Deposits of India, CBS Publishers, New Delhi.
5. Singh, P., 7th edition, (2008) Engineering and General Geology, SK Kataria and Sons.

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Title: **STRATIGRAPHY OF INDIA- Part I**

Paper Code: **GEL-IV.E-6**

Marks: **75**

Credits: **3 (45 Contact hours)**

Prerequisites: GEL-I.C-1, GEL-I.C-2, GEL-II.C-3 and GEL-II. C-4

Course Objectives:

- To understand the stratigraphic units.
- To correlate International Geological Time Scale with Indian Stratigraphic Time Scale.
- To understand the geology, stratigraphy, fossil content, economic resources of the lithounits from the Peninsular India.

Learning Outcomes:

- The student will gain knowledge about the stratigraphy and geology of India with emphasis on the Peninsular India which will help in understanding the different episodes on the earth during the geologic past.

MODULE I **15 Lectures**

- Introduction to Stratigraphy
- Classification of Stratigraphic Units: Lithostratigraphic Units, Biostratigraphic Units, Chronostratigraphic Units, Magnetostratigraphic Units
- Indian Stratigraphic Time Scale
- Physiography, drainage, structure and tectonism of Peninsular India.

MODULE II **15 Lectures**

- *Cratonic provinces of Peninsular India shield*: (Dharwar craton, Singhbhum craton, Bundelkhand craton, Aravalli craton, Bastar craton) and their economic importance, with emphasis on the Dharwar craton.
- *Mobile Belts of Peninsular India*: Eastern Ghat Mobile Belt, Satpura Mobile Belt, Pandayan Mobile Belt
- *Major Archaean Basement Complexes*: Peninsular Gneiss of Karnataka (in detail), Banded Gneissic Complex (BGC) of Rajasthan, Older Metamorphic Complex (OMC) of Eastern India
- *Greenschist/Greenstone Belts of Peninsular India*:
    - *Older Greenstones*: Sargur Supracrustals

  - *Younger Greenstones*: Dharwar Supergroup: Bababudan Group, Chitradurga Group (Goa Group of rocks)

- *Proterozoic Basins of Peninsular India*:
  - Vindhyan Supergroup;
  - Cuddapah Supergroup;
  - Kaladgi Supergroup (in detail).

- Outline of Bhīma Supergroup, Delhi Supergroup, Kurnool Supergroup

MODULE III **15 Lectures**

- Precambrian of Extra-Peninsular in the Spiti valley and Kashmir region: Salkhala Group, Vaikrita Group.
- Tectonic history of Paleozoic Era, Paleozoic life.
- Marine Paleozoic Formations of Kashmir and Spiti Valley.
- Gondwana sequence of Peninsular India: Sedimentation and Paleoclimates, Lower Gondwana succession; Upper Gondwana succession

Practicals:

Marks: **25**

Credit: **1 (15 Practicals)**

- Study of rock formations of Goa in hand specimen
- Study of Fossils
- Drawing of geological cross sections using bore hole data.

List of books recommended for references:

- Ramakrishnan, M and R Vaidynadhan., 1994, Geology of India, Geological Society of India Publication, Bangalore. Vol. I &II.
- Nanda, H., 2014, Indian Stratigraphy, Anmol Publications Pvt. Ltd. New Delhi.
- Kumar, R., 1998, Fundamentals of Historical Geology and Stratigraphy of India, New Age International Publisher.
- Wadia, D. N., 1975. Geology of India, McGraw-Hill Company.
- Krishnan, M. S., 2009. Geology of India and Burma, CBS Publishers, New Delhi
- Mascarenhas, A and Kalavampara, G., 2015. Natural Resources of Goa: A Geological Perspective. Geological Society of Goa.

PAPER TITLE: NATURAL HAZARDS AND MANAGEMENT

Paper Code: GEL-IV.E-7

Marks: 75

Credits: 3 (45 Contact hours)

Prerequisites: GEL-I.C-1, GEL-I.C-2, GEL-II.C-3 and GEL-II. C-4

Course objectives:
The course is designed with an aim to give the student an understanding about: various natural hazards; stages in management aimed at avoiding and / or reducing loss to life and property; and Agencies involved in mitigation and management of damage due to hazards.

Learning outcome:
On completion of the course, the student will become aware of the nature and effects of various natural hazards, and know about how to cope with them. The student will also come to know about different agencies and other resources available to deal with the effects of natural hazards.

MODULE I (15 LECTURES)

- Definition of Hazard/ Disaster and Classification: Natural and man-made
- Natural Disasters:
  - Earthquakes: Definition, Causes, Magnitude and intensity, Recording, effects
  - Volcanic eruption: Types, localization, volcanic products, Hot spots and trails
  - Landslides and Avalanches: Classification of mass wasting, mechanics , causes of landslides and stabilizing methods of slopes; causes and localization of avalanches.
  - Subsidence: Causes, slow and brisk types

MODULE II (15 LECTURES)

  - Floods: causes and effects , prediction, Flashfloods
  - Tsunamis and : Tsunamis, relation of Tsunamis to tectonics; Damage due to tsunamis, Co- ordinated approach to early warning of tsunamis.
  - Cyclones Origin, Prediction of cyclones and pathtracking.
- CRZ act and its impact on disaster mitigation
- Causal factors of disasters
- Concept of Disaster Management: Pre disaster risk reduction and post disaster recovery
- Disaster Management Cycle: Mitigation, preparedness, response and recovery.

MODULE III **(15 LECTURES)**

- Planning strategy: co-operative plan, Identifying resources, setting priorities
- Hazard coping operations and rehabilitation: .
- National Disaster Management: national and international support
- Proposed operational processes for individual Natural Disasters mentioned above.

Practicals:

Marks: 25

Credit: 1 (15 Practicals)

1. Hazard zonation map of India: cyclones ,earthquakes, floods, famine
2. Hazard zonation map of world: tsunamis, cyclones ,earthquakes, floods, famine
3. Land-use land cover mapping
4. Demarcating CRZ on satellite imagery

List of recommended books:

1. Sethi, V. K., 2009, Disaster Management, Essential Books PW, New Delhi.
2. Hess, D.,2012, Mc Knight's Physical Geography, PHI learning, Pvt Ltd, New Delhi.
3. Krynine, D. and Judd W., 1998, Principles of Engineering Geology and Geotectonics, McGraw Hill.
4. Holmes, A., edited by Duff P.M.D., 4th edition, Physical Geology, E.L.B.S Publications.
5. Valdiya K.S., 1987, Environmental Geology: Indian Context, Tata-McGraw Hill
6. Keller, E. A., 2011, Environmental Geology, Santa Barbara Prentice Hall.
7. Joshi M.V., 2004, Environmental Disaster, Causes, Impacts and Remedies, Adhyayan Publishers.

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Paper Title: GEOTECTONICS

Paper Code: **GEL-IV.E-8**

Marks: **75**

Credits: **3 (45 Contact hours)**

Prerequisites: GEL-I.C-1, GEL-II.C-3

Course Objectives: Ever since the creation of the earth, there have been marked changes in the distribution of land and sea. The dynamics of these changes are stupendous. Several theories have come forth to explain and understand the mechanism of such changes. Each great mountain chain in the world was created by intense tectonic forces. The subject of Geotectonics deals with the structure of the earth and the processes responsible for the movement and redistribution of continents and seas.

Learning Outcomes:
The students will gain an insight into the operating processes leading to the global changes in the positioning of continents and seas, and the creation of great mountain chains.

MODULE I **(15 Lectures)**

Interior of the earth:

- Clues from the study of earthquake and density;
- The earths layers; the crust-continental crust and oceanic crust;
- Crust-mantle boundary
- Structure of the mantle
- Low Velocity Zone (LVZ)

- Lithosphere and the asthenosphere;
- Core-mantle boundary; P wave shadow zone,
- Nature of the core; S wave shadow zone.

Earth's Magnetic field:

- Origin and nature
- Dynamo hypothesis and Herndon's Georeactor Theory.
- Geocentric axial dipole,
- Paleomagnetism,
- Marine magnetic anomalies,
- Magnetic reversals and magnetic stripes

MODULE II **(15 LECTURES)**

Continental drift:

- Wegener's hypothesis.
    - Evidences: Continental fit; similarity of rock sequences and mountain ranges; glacial evidence, fossil evidence;
- Paleomagnetism and Polar wandering.

Plate tectonics:

- Plate margins, plate boundaries and associated activities,
- Triple junctions;
- Divergent, Oceanic Ridges, Sea floor spreading, transform faults; hotspots.
- Convergent: oceanic–oceanic, oceanic-continental, continental-continental; oceanic trenches, subduction zones
- Transform boundaries;
- Birth, growth and decline of ocean basins: Rift valleys, the Red sea and the Gulf of Aden;

Geometrical aspects and mechanism of plate motion.

MODULE III **(15 LECTURES)**

Mountain building: Orogenesis

Plate boundaries and orogenesis: Orogenesis at oceanic-oceanic plate boundaries, oceanic-continental plate boundaries and continental-continental plate boundaries.

Case study: Tracking the rise of Himalayas.
Case study: Frequency of Earthquakes in North India
Case Study: Occurrence of Tsunami in SE Asia

Practicals:

Marks: **25**

Credit: **1 (15 Practicals)**

1. Plotting of oceanic ridges, trenches, subduction zones, sea mounts, plate boundaries
2. Exercises in plate tectonics.

List of books recommended for reference:

- Marshak, S., 2011. Earth: Portrait of a Planet, W. W. Norton & Company.
- Duff, D and Holmes, A., 1993, Holmes Principles of Physical Geology, Springer.
- Monroe, S. J and R. Wicander., 2014. The Changing Earth: Exploring Geology and Evolution, Brooks Cole Publishers.
- Skinner, J. B and S, C. Porter., 2003. The Dynamic Earth: An Introduction to Physical Geology, John Wiley and Sons.
- Condie, K. C., 1997. Plate Tectonics and Crustal Evolution, Butterworth-Heinemann.
- Prasad, C. V. R. K., 2005. Elementary Exercises in Geology, Universities Press.

SEMESTER IV

EVALUATION AND ASSESSMENT SCHEME

Each course (Core or Elective) = 4 credits of 100 marks

Theory: 75 marks = 3 credits

- Continuous Assessment (CA): 30 marks.
- Semester End Examination (SEE): 45 marks.

Practicals: 25 marks = 1 credit

i. Assessment in practicals will be done by continuous assessment throughout the Semester.

ii. Practicals will be supported by appropriate field work.

MODEL QUESTION PAPER

PARVATIBAI COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)
B.Sc. SEMESTER END EXAMINATION
GEOLOGY

Duration: 2 hrs   Max. Mks: 45

<table>
<tr><td>Q.1</td><td>Answer <u>any three</u> of the following:

A. ..
B. ..
C. ..
D. ..</td><td>Q.1 to cover all the three modules of the syllabus</td><td>(3 mks x 3 = 09 mks)</td></tr>
<tr><td>Q.2</td><td>Answer <u>any two</u> of the following:

A. ..
B. ..
C. ..</td><td rowspan="3">Each question to cover the syllabus of one module each</td><td>(6 mks x 2 = 12 mks)</td></tr>
<tr><td>Q.3</td><td>Answer <u>any two</u> of the following:

A. ..
B. ..
C. ..</td><td>(6 mks x 2 = 12 mks)</td></tr>
<tr><td>Q.4</td><td>Answer <u>any two</u> of the following:

A. ..
B. ..
C. ..</td><td>(6 mks x 2 = 12 mks)</td></tr>
</table>

Parvatibai Chowgule College of Arts and Science, Margao- Goa Autonomous

DEPARTMENT OF GEOLOGY

THREE YEAR B.Sc. DEGREE PROGRAMME IN GEOLOGY (June 2017)

Course Structure and List of Core and Elective Courses

COMPONENT A

SEMESTER	CORE COURSES		ELECTIVE COURSES			
I	**GEL-I.C-1** Fundamentals of Mineralogy	**GEL-I.C-2** Elementary Petrology	-----	-----	-----	-----
II	**GEL-II.C-3** Earth's Dynamics and Tectonics	**GEL-II.C-4** Principles of Stratigraphy and Paleontology	-----	-----	-----	-----
III	**GEL-III.C-5** Optical and Systematic Mineralogy		**GEL-III.E-1** Physical Geology	**GEL-III.E-2** Groundwater and Hydrogeology	**GEL-111.E-3** Engineering Geology	**GEL-III.E-4** Marine Geology
IV	**GEL-IV.C-6** Structural Geology		**GEL-IV.E-5** Ore Genesis	**GEL-IV.E-6** Stratigraphy of India – Part I	**GEL-IV.E-7** Natural Hazards and Management	**GEL-IV.E-8** Geotectonics

V	**GEL-V.C-7** Igneous Petrology	**GEL-V.CP** Core Project	**GEL-V.E-9** Stratigraphy of India – Part II	**GEL-V.E-10** Petroleum Geology	**GEL-V.E-11** Principles of Geophysical Exploration and Mining	**GEL-V.E-12** Remote Sensing and Digital Image Processing
VI	**GEL-VI.C-8** Sedimentary Petrology	**GEL-VI.CP** Core Project	**GEL-VI.E-13** Metamorphic Petrology	**GEL-VI.E-14** Rock Deformation Microstructures	**GELVI.E-15** Surveying and Field Geology	**GEL-VI.E-16** Gemstone Testing and Evaluation

Core Courses for students offering **Geology as the Minor**

SEMESTER I GEL-I.C-1: Fundamentals of Mineralogy
SEMESTER II GEL-II.C-3: Earth's Dynamics and Tectonics
SEMESTER III GEL-III.C-5: Optical and Systematic Mineralogy
SEMESTER IV GEL-IV.C-6: Structural Geology
SEMESTER V GEL-V.C-7: Igneous Petrology
SEMESTER VI GEL-VI.C-8: Sedimentary Petrology

SEMESTER V

CORE COURSE

Paper Code: **GEL-V. C-5**
Paper Title: **IGNEOUS PETROLOGY**
Credits: **3 (45 Contact hours)**
Marks: **75**

Learning Objectives:

The course will help the students to understand petrologic processes and common rock types. In practical's, students learn to identify, describe and classify rocks using hand specimens and rock thin sections.

Learning Outcomes:

On completion of the course the students:

(i) Will have gained an understanding of the processes involved in the formation of igneous rocks, their textures, structures, classifications and their importance.

(ii) Will have learned the composition, properties and genesis of different rock types.

MODULE I **(15 Lectures)**

Origin and Evolution of Magmas:

- Composition of the earth's interior; evidences to composition of the earth
- Distribution of various elements within the different layers of the earth
- Plate tectonics and igneous activity
- Diversity of natural magma compositions (Felsic and Mafic)
- Magma Diversity:
  - Partial Melting
    Ultramafics, Basalts: Magma types, Basalt Tetrahedron,
  - Igneous layering - crystal settling
    Gabbroic rocks, Anorthosite, Layered complexes (including Indian examples)
  - Differentiation: Fractional Crystallization, liquid immiscibility, volatile transport, flowage differentiation,

MODULE II **(15 Lectures)**

- Role of volatiles in magmatic crystallization;
- Ascent and emplacement of magma
- Stages of crystallization of magma

Textures and microstructures of igneous rocks:

a. Primary: Nucleation, Growth, Diffusion
b. Secondary: Oswald ripening, twinning, zoning

Classification and Description of Igneous Rocks:

The International Union of Geological Sciences (IUGS) Classification System.Chemical Classification.

Ternary diagram: Diopside-Albite-Anorthite (Di-Ab-An)

MODULE III **(15Lectures)**

Study of the following Rock Types (Mineralogy, petrography & Petrogenesis)

Ophiolites
Granitoids
Syenites & Trachytes
Carbonatites
Kimberlites
Lamprophyres & Lamproites

Practical: **1 Credit (30 contact hours = 15 practical sessions)**
Maximum Marks: 25

1. Study of minimum 15 igneous rocks in hand specimen.
2. Study of minimum 15 igneous rocks in thin sections
3. CIPW Normative calculations

List of books recommended for references:

Bard, J P., (1986) Microtextures of Igneous and Metamorphic Rocks, D. Reidel Publishing Company.
Best, M.G., (2002) Igneous and Metamorphic Petrology, 2nd edn., Blackwell, Oxford

Bose, M.K., (1997) Igneous Petrology, The World Press, Kolkata

Cox, K G., Bell J D and Pankhurst R G., (1993) The Interpretation of Igneous rocks, Springer-Science+Business Media.

Frost B R and Frost C D., (2014) Essentials of Igneous and Metamorphic Petrology, Cambridge University Press.
Gill, R., (2010)Igneous rocks and process – A Practical Guide, Wiley-Blackwell

MacKenzie, W. S., Donaldson, C H., and Guilford, C., (1982)Atlas of Igneous Rocks and Their Textures, Wiley

Philpotts, A.R. and Ague, J.J., (2009) Principles of Igneous and Metamorphic Petrology, Cambridge University Press, Cambridge

Raymond, A. L., (1995) Petrology-The study of Igneous Sedimentary and Metamorphic rocks. Wm. C. Brown Communications, Inc.; USA.
Winter, J.D., (2009) Principles of Igneous and Metamorphic Petrology, Prentice Hall

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ELECTIVE COURSES

Paper Code: **GEL-V.E-9**
Paper Title: **STRATIGRAPHY OF INDIA- Part II**
Credits: **3 (45 contact hours)**
Marks: **75**
Prerequisite: **GEL-IV.E-6**

Course Objectives:
The course will help understanding the Indian stratigraphic units and to correlate International Geological Time Scale with Indian Stratigraphic Time Scale. Also to understand the geology, stratigraphy, fossil content, economic resources of the lithounits from the Phanerozoic Eon from the Indian context.

Learning Outcomes:

The student will gain knowledge about the stratigraphy and geology of India with emphasis on the Stratigraphy of India wrt Paleozoic, Mesozoic and Cenozoic Era which will help in understanding the different episodes on the earth during the geologic past.

MODULE I: **(15 Lectures)**

- Principles of stratigraphic analysis, Facies concept in stratigraphy
- Walther's Law of Facies.
- Concept of paleogeographic reconstruction
- Important Stratigraphic boundaries in India:
  a. Precambrian-Cambrian boundary
  b. Permian-Triassic boundary
  c. Cretaceous-Paleocene boundary
  d. Pleistocene-Holocene Boundary

MODULE II **(15 Lectures)**

- Triassic of Spiti
- Jurassic Formations of India
- Cretaceous Formations of India
- Deccan Flood Basalt (Age and Stratigraphy)

MODULE III **(15 Lectures)**

- Tertiaries of India
- Rise and evolution of Himalayas
- Siwaliks
- Plant and animal life in relation to glacial and interglacial cycles during Quaternary.

Practical: 1 Credit (30 contact hours = 15 practical sessions)
Maximum Marks: 25

1. Preparation of lithostratigraphic maps of India showing distribution of important geological formations.
2. Study of type hand specimens from their stratigraphic position and age.
3. Stratigraphic map of Goa

List of books recommended for references:

Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley.

Kumar, R., (1998) Fundamentals of Historical Geology and Stratigraphy of India, New Age International Publisher.

Ramakrishnan, M and Vaidynadhan, R., (1994) Geology of India, Geological Society of India Publication, Bangalore. Vol.I &II.

Nanda, H., (2014) Indian Stratigraphy, Anmol Publications Pvt. Ltd. New Delhi.

Nichols, G., (2009) Sedimentology and Stratigraphy, Wiley-Blackwell and Sons Ltd.
Sharma, R S., (2009) Cratons and Fold belts of India, Springer-Verlag Berlin Heidelberg.
Valdiya, K. S., (2010) The Making of India, Macmillan India Pvt. Ltd.

Paper Code: **GEL-V.E-10**
Paper Title: **PETROLEUM GEOLOGY**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives:
To provide the student essential and basic concepts of Petroleum Geology and to study the process and the operations involved in Petroleum exploration

Learning Outcomes:
A student will understand and learn about the basic concepts of Petrology Geology with respect to geology as to enable them to work as a Petroleum Geologist.

MODULE I **(15 Lectures)**

- Introduction and Aspects of Petroleum Geology, Characteristics of Hydrocarbons (Physical and Chemical properties), Petroleum System, Composition, Origin (Types of Kerogen), Occurrence, Migration and Accumulation of Petroleum; Petroleum traps (Stratigraphic and Structural); Reservoir rocks, conditions & mechanisms.
- Functions of Petroleum Geologist
- Understanding oil and gas: Exploration, Drilling and Completion, Production, Services

MODULE II **(15Lectures)**

- Surface indications and direct detection of Hydrocarbons
- Surface and Subsurface exploration techniques: Concept
- Geophysical methods of exploration: Gravity and Seismic methods
- Types of rigs and its selection
- Rotary drilling system and equipment's
- Drilling sequence: Coring; Casing and Cementation and Drilling fluids;

MODULE III **(15Lectures)**

- GeoLogging and Well logs (Electric, Radioactive and Acoustic);

- Formation evaluation and Testing
- Well Completion and Stimulation
- An outline of the oil belts of the world; Global geographic and stratigraphic distributions of oil and gas;
- Important Onshore and Offshore Petroliferous basins of India.
- Recent trends in Petroleum Geology.

Practical: 1 Credit (30 contact hours = 15 Practical sessions)
Maximum Marks: 25

- Plotting of Petroliferous basins on maps (World and India)
- Problems based on Well log interpretation
- Creation of carbonate isopachous maps
- Interpretation of petroliferous traps using seismic reflectance.
- Problems on mud circulation
- Observations of well cuttings and cores samples
- Demonstration/Determination of porosity

List of books recommended for references:

Hyne, N J., (2001) Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production, PennWell Corporation

Levorsen, A.I., (1967) Geology of Petroleum, W.H. Freeman and Company.

Morris, J., (1985) Practical Petroleum Geology, The University of Texas at Austin - Petroleum Extension Service

North, F.K., 1(986) Petroleum Geology, Allen &UnWin, 607p

Selley, R.C., (1998) Elements of Petroleum Geology, W.H. Freeman & Company, New York.

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Paper Code: **GEL-V. E-11**
Paper Title: **PRINCIPLES OF GEOPHYSICAL EXPLORATION AND MINING**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objective:

Mining being a key source of revenue generation for the Central as well as State governments, and an important job provider for Geologists, this course is designed to equip the undergraduate student with basic knowledge of key concepts of mining processes right from exploration to exploitation, together with an acquaintance of government regulations that control the mining and mineral conservation processes. In Geophysical exploration the student will gain first-hand knowledge dealing with the principles and their significance.

Learning Outcome:

By the end of this course the student will have learnt about techniques of mineral exploration and exploitation, estimation of ore reserves, environmental impact of mining, and the importance of conservation of mineral resources, thereby partly equipping himself/herself on the way to becoming a mining geologist.

MODULE I **(15Lectures)**

- Mining: Introduction and Mining Terminology
- Classification of mining methods
- Factors influencing choice of mining method
    - Open cast mining
    - Underground mining
        - Coal mining methods
        - Alluvial mining
- Ore Dressing or Beneficiation:
    - Principles and methods
    - Terminology of quantification of results
- Environmental Impact of Mining
- Brief outline of:

  National Mineral Policy
  Regulations and Acts
  Regulating Agencies

MODULE II **(15Lectures)**

Mineral Exploration: Sequence and phases

- Float ores and In situ ores
    - Pits, Trenches and Boreholes
        - Spacing
        - Drilling:
            - Core and non-core drilling
            - Equipment and accessories
            - Core drill sampling
            - core splitting
            - logging
            - Storage
            - Sludge
            - Combining Assay returns from sludge and core

- Categories of reserves
- Estimation of reserves
    - Cross-sectional method
    - Area of influence method
    - Triangular method
    - Weighted volume estimate method
    - Estimation of stockpiles by prismoidal formula

MODULE III **(15Lectures)**

Methods of Exploration: Geobotanical, Geochemical and Geophysical.

Geophysical Methods:

- Self-potential method: Introduction, mechanism, equipment, interpretation of anomalies.
- Gravity surveying: Introduction, basics, Gravity surveying, Interpretation
- Magnetic surveying: Introduction, concepts, Rock magnetism, Geomagnetic field, Magnetic anomalies, Instruments used, Corrections, Interpretation. Application.

Practical: 1 Credit (30hours = 15 practical sessions)
Maximum Marks: 25

1. Drawing cross - and longitudinal sections using bore-hole data
2. Problems based on estimation of ore reserves
3. Interpretation of bouguer gravity anomaly maps, and magnetic data.
4. Core logging

List of books recommended for references:

Arogyaswamy, R. N. P., (1973) Courses in Mining Geology, Oxford & IBH Publishing Co.
Babu S. K. & Sinha D. K., (1988) Practical Manual of Exploration and Prospecting, CBS Publishers and Distributors, New Delhi.
Keller, E. A., (2011) Environmental Geology, Pearson Prentice Hall.
McKinstry H. E., (1948) Mining Geology, Prentice-Hill Inc.
Marjoribanks, R., (1997) Geological Methods in Mineral Exploration and Mining, Springer-Science+Business Media
Peters, W C., (1987) Exploration and Mining Geology, Wiley
Sharma J. P., (2009) Environmental Studies, Laxmi Publications (P) Ltd, New Delhi.
Sinha, R. K & Sharma N. L., (1970) Mineral Economics, Oxford & IBH Publishing Co.
Indian Bureau of Mines (IBM) Publications.
Bhimasarikaram V.L.S., (1990) Exploration Geophysics - An Outline by Association of Exploration Geophysicists, Osmania University, Hyderabad.

Dobrin, M B and Savit C H., (1988) Introduction to Geophysical Prospecting, McGraw Hill Inc.

Lowrie, W., (2007) Fundamentals of Geophysics. Cambridge University Press
Ramachandra Rao and Prasaranga, M B, (1975) Outlines of Geophysical Prospecting - A Manual for Geologists by University of Mysore, Mysore.

Telford, W. M., Geldart, L. P., and Sheriff, R. E., (1990) Applied geophysics(Vol. 1).Cambridge University Press.

Paper Code: **GEL-V.E-12**
Paper Title: **REMOTE SENSING AND DIGITAL IMAGE PROCESSING**
Credits: **3 (45 Contact hours)**
Marks: **75**
Mandatory requirement: **Individual Laptop with MS Windows OS**

Learning Objectives:

This course is designed as an introduction to the use of remote imaging in geologic applications. The basic concepts of image production, processing and interpretations are covered. This course also introduces the basic principles and techniques of Geographic information Systems (GIS)

Learning Outcomes:

Student will be able to:

- Explain remote sensing basic principles, purposes, advantages and limitations.
- Define and describe basics of electromagnetic spectrum and interactions with various types of media.
- Describe basic characteristics of remote sensing imagery
- Describe sensors and image acquisition methods.
- Understand the application of digital imagery for interpretation of lithology, structure and geomorphology.
- Develop a working knowledge of GIS software (QGIS)
- Prepared for further study in GIS

MODULE I **(15 Lectures)**

Concepts of Remote Sensing and Satellite Sensors and Data

Energy Sources and Radiation Principles.

Energy interactions in the Atmosphere: Scattering, Absorption.

Energy interactions with earth surface features: Spectral Reflectance of Vegetation, Soil and Water, Spectral response patterns, Atmospheric Influences on Spectral Response Patterns.

Brief history of Remote Sensing from the advent of photography till today's aerial and space-based remote sensing systems.

The concept of resolution: Spatial, Spectral, Temporal and Radiometric.

Space Borne Imaging Systems- The Landsat, IRS, SPOT and High resolution Land Satellites (the characteristics of these satellites- their orbits, their sensors, and their resolutions)

Multispectral sensing

Across track scanning.

Along track scanning.

Operating principles of Across track Multispectral Scanners.

Across track Thermal scanning.

MODULE II **(15 Lectures)**

Introduction to Digital Image Processing

Introduction.

Image Rectification and Restoration.

Image Enhancement.

Contrast Manipulation.

Spatial Feature Manipulation.

Multi-Image Manipulation.

MODULE III **(15 Lectures)**

Digital Imaging classification

Image Classification: Unsupervised and Supervised Classification.
Supervised Classification:

The Training Stage.

The Classification Stage: Minimum-Distance to Means Classifier, Parallelepiped Classifier, Gaussian Maximum Likelihood Classifier.

Classification Accuracy Assessment.

Practical: 1 Credit (30 contact hours = 15 practical sessions)
Maximum Marks: 25

- Interpretation of Satellite Imagery for – landforms, geological structures, rock and soil types, man-made structures.
- Data Products and Meta data
- Digital Image Processing (using number matrix): enhancement, manipulation and classification.
- Digital image processing on Computer :
  - Display of various types of image formats
  - Pallets and Display elements,
  - Georeferencing,
  - Image enhancement,
  - Image classification

List of books recommended for references:

Burrough, P. A. and McDonnell, R. A., (2000) Principles of Geographical Information System, Oxford University Press.

C.P.Lo and Albert K. W. Yeung., (2002) Concepts and Techniques of Geographic Information System, Prentice –Hall, India.

Drury, S.A., (1993) Image Interpretation in Geology, 2nd ed., Chapman and Hall, London.

George Joseph., (2005) Fundamentals of Remote Sensing, University press Private Ltd, Hyderabad.

Harold, R W., (1969) Aerial Stereo Photographs, Hubbard Press, USA.

Heywood I, Sarah, Cornelius, Steve, Carver.,(2011) An Introduction to Geographical Information Systems, Pearson Education Pvt. Ltd., New Delhi.

Jensen John R., (2000) Remote Sensing of the Environment – An Earth Resource perspective, Pearson Education Series, Low Price Edition.

Kang – Tsung – Chang.,(2002) Introduction to Geographical Information System, , McGraw Hill.

Lillesand T.M. and Kiefer R.W., (2002) Remote Sensing and Image Interpretation, John Wiley and Sons, New Delhi.

Lillesand, T. M., Ralph W. Kiefer and Jonathan W. Chapman., (2004) Remote Sensing and Image Interpretation, 5th ed, Wiley

Mather Paul M., (2004) Computer Processing of Remotely Sensed Images- An Introduction, 3rd ed., John Wiley.

Narayan L.R.A. (1999) Remote Sensing and its Applications., Universities Press.

Ramasamy S.M., (2005) Remote Sensing in Geomorphology, New India Publishing Agency.

Schowengerdt Robert A., (2006) Remote Sensing – Models and Methods for Image Processing, 2nd ed., Elsevier (Academic Press).

Online resources

T. Sutton, O. Dassau, M. Sutton, A Gentle Introduction to GIS, Chief Directorate: Spatial Planning & Information, Department of Land Affairs, Eastern Cape, South Africa (ebook)
http://download.osgeo.org/qgis/doc/manual/qgis-1.0.0_a-gentle-gis-introduction_en.pdf
QGIS Tutorials http://www.dst-iget.in./

SEMESTER V

EVALUATION AND ASSESSMENT SCHEME

Each course (Core or Elective) = 4 Credits
75marks Theory and 25marks practical

Theory: 3 credits of 45 contact hours

i. Continuous Assessment (CA): 30 marks.
ii. Semester End Examination (SEE): 45 marks.

Practical: 1 Credit
15 Practical sessions of two contact hours each

i. Assessment in Practical's will be done by continuous assessment throughout the Semester.

ii. Practicals will be supported by appropriate field work.

CORE PROJECT: 4 Credits

SEMESTER

VI

CORE COURSE

Paper Code: **GEL-VI. C-8**
Paper Title: **SEDIMENTARY PETROLOGY**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course objectives:

- To provide an understanding of the origin of sedimentary rocks, the relationship of sedimentary processes to plate tectonics, and the use of sedimentary rocks in the study of the geological past.

Learning outcomes:

- The student will gain knowledge about the concepts of sedimentary processes and the respective rock types, which will enhance their knowledge of sedimentary petrology

MODULE I **(15Lectures)**

- The Origin of Sedimentary Rocks**:**
    - Erosion, transportation and deposition of sediments.
    - Hjulstrom's diagram
- Provenance

- Components of clastic sediments: Heavy, Clay, Quartz, Feldspars, other minerals
- Environment of deposition and sedimentary facies
- Basins - Plate tectonics and sedimentation
- Sedimentary Textures
  Grain Size, Udden-Wentworth Size Scale, Phi Scale, Roundness and Sphericity. Maturity: Textural, Mineralogical and Chemical
- Classification of Sedimentary rocks(Folk's and Dunham's, Okhadas)

MODULE II **(15Lectures)**
- Primary sedimentary structures
  - Depositional, Erosional
- Secondary sedimentary structures
  - Chemical, biogenic
- Soft sediment deformations

MODULE III **(15Lectures)**
- Clastic Sedimentary Rocks
  - Sandstones, Breccias and Conglomerates**:**

Textures, Structures, Mineral composition, Textural maturity,
  - Mudrocks:

Textures, Structures, Colour, Mineral composition;
- Non-clastic Sedimentary Rocks
  - Limestones and Dolomites:

Textures; Mineralogy; Structures; Diagenesis, Reefs and Palaeoclimate; Dolomites: Dolomitization.
  - Residual: (Laterite and Bauxite)

Origin and Climate.
  - Carbonaceous sediments:

Nature and form of organic residues; The Coal series

Practical: 1Credit (30 contact hours = 15 practical sessions)
Maximum Marks: 25

1. Study and identification of minimum 15 sedimentary rocks w.r.t textures, structures, their classification.
2. Study of minimum 15 sedimentary rocks in thin sections
3. Exercises in Grain size and shape analysis

List of books recommended for references:

Blatt H; Tracy R. J and Owens B. E., (2006) Petrology- Igneous Sedimentary and Metamorphic 3rd edition W H Freeman and Company New York.
Boggs S., (2009) Petrology of Sedimentary rocks (2nd edition), Cambridge University Press.

Boggs, Jr., (2005) Principles of Sedimentology and Stratigraphy (4 edition), Prentice Hall.
Colinson, J D & Thompson, (1982) Sedimentary Structures, Allen &Unwin

Ehlers G.E. and Blatt H., (1987) Petrology – Igneous, Sedimentary and Metamorphic, CBS Publishers, New Delhi.

Greensmith, J. (1989) Petrology of the Sedimentary rocks (7th Edition), CBS Publishers, New Delhi.

Pettijohn F.J., (1984) Sedimentary Rocks (3rd Edition), CBS Publishers, New Delhi.
Prothero, D. R., and Schwab, F.; (2004) Sedimentary Geology. Macmillan.
Raymond A L (1995) Petrology-The study of Igneous Sedimentary and Metamorphic rocks.Wm. C. Brown Communications, Inc.; USA.

Tucker E.M. (2001) Sedimentary Petrology (3rd Edition), Blackwell Science Ltd.

ELECTIVE COURSES

Paper Code: **GEL-VI. E-13**
Paper Title: **METAMORPHIC PETROLOGY**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives:

- To provide essential concepts of metamorphism and metamorphic rocks.
- To study metamorphic rocks w.r.t fabrics and types.
- To understand the concept of facies.
- Also to understand how metamorphism is related to plate tectonics

Learning Outcomes:

- The student will gain knowledge about the concepts of metamorphism and metamorphic rocks which will strength their knowledge of metamorphic petrology

MODULE I **(15Lectures)**

Definition and explanation of metamorphism (*upper and lower limits*) and metamorphic rocks.
Factors responsible for metamorphism:

Heat (T) : Geothermal gradient (in different crustal regions), Radioactivity, magmatic intrusions, tectonics;
Pressure (P): Deviatoric, Lithostatic, Hydrostatic, Fluid pressure
Chemically active fluids (X_f)*:* H_2O and CO_2
Composition of the parent rocks (X): pelites, mafites, ultramafites, quartzofeldspathic, carbonate rocks, sandstones and greywackes.
Time (δt): Role of time in metamorphism

Phase Rule, Graphical representation of metamorphic rocks
Protoliths
Types of metamorphism: *Regional metamorphism* its characteristics and products, *burial metamorphism* its characteristics and products, *contact metamorphism* its characteristics and

products

Relationship of brittle and ductile deformation with grade of metamorphism metasomatism, cataclastic metamorphism and their products, impact/shock metamorphism

Metamorphism in relation to plate tectonics:

Divergent(constructive) boundary
Convergent (*Destructive) boundary:* subduction zone (*sensulato*)
Continent-Continent Collision zones
Intra-plate environments

MODULE II **(15Lectures)**

Metamorphic textures: Inherited/Relict fabric, Cataclastic, lepidoblastic, Nematoblastic, granoblastic, equigranular mosaic, Porphyroblastic.
Pretectonic, syntectonic and post tectonic garnets

Idioblastic/Crystalloblastic Series; Riecke's Principle

Nomenclature and classification based on mineralogy and fabric

Field characters of metamorphic rocks:

Variations in mineralogy and fabric. Prograde and Retrograde metamorphism
metamorphic zones and index/critical minerals, their significance in mapping and understanding tectonic history.

MODULE III **(15Lectures)**

Facies: Concept after Goldschmidt and Eskola; Zonation in mineralogy – Buchanan (Low pressure) Barrovian (high pressure)

Facies of progressive contact metamorphism: characteristic mineral assemblages in pelites and carbonates (pure and impure) protolith

Facies of progressive regionalmetamorphism – characteristic mineral assemblages wrt facies (Zeolite, Prehnite-Pumpellyite, Greenschist, Amphibolite, Granulite, Blueschist, Eclogite) in pelitic, mafic and ultramafic protolith.

Paired Metamorphic Belts

Practical: **1 Credit (30 contact hours = 15 practical sessions)**
Maximum Marks: 25

Megascopic study and identification of minimum 15 metamorphic rocks w.r.t mineralogy, texture, type of metamorphism, facies, protolith.

Microscopic study and identification of minimum 15 metamorphic rocks wrt to mineralogy, texture type of metamorphism, facies and protolith.

Solving and plotting ACF and AFM analysis

List of books recommended for references:

Bard, J P., (1986) Microtextures of Igneous and Metamorphic Rocks, D. Reidel Publishing Company.
Best, M., (2003). Igneous and Metamorphic Petrology, Blackwell Publishing.
Blatt, H; Tracy R. J and Owens B. E., (2006) Petrology- Igneous Sedimentary and metamorphic 3rd edition W H Freeman and Company New York.
Bucher, K and Grapes, R., (2010) Petrogenesis of Metamorphic rocks, Springer-Heidelberg Dordrecht, London NY.
Ernst, W G and Rumble D., (2008) Metamorphic Conditions along Convergent Plate Junctions: Mineralogy, Petrology, Geochemistry and Tectonics, Geological Society of Amer.
Frost B R and Frost C D., (2014) Essentials of Igneous and Metamorphic Petrology, Cambridge University Press.
Miyashiro, A., (1994) Metamorphic Petrology, CRC Press.
Miyashiro, A, (1978) Metamorphism and Metamorphic belts, The Greshman Press Old Woking, Surrey
Philpotts, A & Ague, J (2010) Principles of Igneous and Metamorphic Petrology. Cambridge University Press, New York
Raymond, A. L., (1995) Petrology-The study of Igneous Sedimentary and Metamorphic rocks. Wm. C. Brown Communications, Inc.; USA.
Roger, M., (1990). Petrology of the Metamorphic Rocks.Unwin Hyman Ltd, UK
Turner, F., (1980) Metamorphic Petrology: Mineralogical, Field and Tectonic Aspects, CRC Press.
Vernon, R H., (2008) Principles of Metamorphic Petrology, Cambridge University Press
Winter J D., (2011) Principles of Igneous and Metamorphic Petrology. PHI Learning Pvt. Ltd.
Winkler, G. F., (1987) Petrogenesis of Metamorphic rocks 5th edition Narosa Publishing House, New Delhi.
Yardley, B W. D., (1989) An introduction to Metamorphic Petrology, Longman Group Publishers Pvt. Ltd.

Paper Code: **GEL-VI. E-14**
Paper Title: **ROCK DEFORMATION MICROSTRUCTURES**
Credits: **3 (45 Contact hours)**
Marks: **75**
Prerequisite: GEL-VI. E-13

Learning Objectives:
The course will help to study deformational history of rocks. This study includes the understanding of the deformation and metamorphic processes the rock has undergone with the aim to reconstruct its structural and metamorphic history.

Learning Outcomes:
On completion of the course the students:
i. Will understand the process of deformation and its resulting features.
ii. It will enhance their application of skills in understanding deformation history and

tectonics in field and in microsections..

MODULE I **(15 Lectures)**
Introduction to microstructures and terminology; Deformation mechanisms and processes– Brittle fracturing, Dissolution, Intracrystalline deformation; Twinning and kinking; Recovery; Recrystallization; Solid state diffusion, Grain Boundary Area Reduction (GBAR), Static recrystallization.

MODULE II **(15 Lectures)**
Foliation and its significance; Lineation and its significance; Mylonites, Shear sense indicators in mylonites; Strain shadows; Deformation of rock-forming minerals; Deformation of polymineralic rocks.

MODULE III **(15 Lectures)**
Microstructures of – igneous rocks (porphyritic rocks, mineral intergrowth, zoning); sedimentary rocks (sandstone); metamorphic rocks (isotropic fabrics, growth of porphyroblasts, twinning, sympectite intergrowth) and deformed rocks (deformation twinning, stylolites, GBM).

Practical:1 Credit (30 contact hours = 15 practical sessions)
Maximum Marks: 25

Study of minimum 15 rock slides exhibiting various microstructures:
- Cuspate and lobate sutured boundaries,
- GBAR (Grain Boundary Area Reduction),
- Bulging (BLG), Subgrain Rotation (SGR); Grain boundary migration (GBM)
- Displaced twin lamellae (brittle deformation),
- Bending of cleavage planes, spaced and continuous cleavage
- Mineral (mica) fish,
- Porphyroclasts, asymmetric porphyroclasts depicting shear sense,
- Pressure shadows,
- Warping of foliation around porphyroclasts,
- S-C fabric.

List of books recommended for references:
Blenkinsop, T. (2002) Deformation microstructures and mechanisms in minerals and rocks, Kluwer Academic Publishers.
Mukherjee, S., (2013) Deformation Microstructures in rocks.Springer-Verlag Berlin Heidelberg
Passchier, C. W and Trouw, R A., (2005) Microtectonics, Springer-Verlag Berlin Heidelberg
Trouw, R A., Passchier, C W and Wiersma, D J., (2010) Atlas of Mylonites - and related microstructures, Springer-Verlag Berlin Heidelberg
Vernon, R H., (2004) A Practical Guide to Rock Microstructures, Cambridge University Press.
Winter, J D., (2014) Principles of Igneous and Metamorphic Petrology, Pearson Education Limited.

Paper Code: **GEL-VI. E-15**

Paper Title: **SURVEYING AND FIELD GEOLOGY**
Marks: **75**
Credits: **3 (45 Contact hours)**

Course Objectives:

--- To Provide basic knowledge of surveying techniques

--- To upgrade and relate the theoretical knowledge of Geological aspects to field observations.

Learning outcomes :

---Students will be expected to understand how preliminary surveys are carried out specially in mining areas.

--- They would be trained to work independently in the field of geology.

MODULE I **(15Lectures)**

Definitions of Surveying and Levelling, Objectives of Survey;

Primary divisions of Surveying – Geodetic and Plane Surveys uses and Principles of Surveying.

Methods of locating a point

Plane Table Survey: Instruments, Procedures of Plane table surveys; Methods (Demonstrative): Radiation and Intersections, advantages and disadvantages of Plane Tabling.

MODULE II **(15Lectures)**

Levelling: Definitions of Terms used in Levelling, characteristics of land surveying instruments, Bench Marks, Change Points.

Levelling operations and steps in Levelling: Demonstration with exercises in the field.

Principles of Levelling: Simple and Differential,

Reduction of Levels: The Collimation, and Rise and Fall systems of Computation.

Theodolite survey: Principles and working, Procedures

MODULE III **(15Lectures)**

Field Geology:

General basis of Field Geology.

SOIToposheet Indexing scheme, Map symbol reading and Scale,

Geological map reading: Geological symbols for lithology and structure

Understanding map reliability

Geological mapping and preparation of lithological maps

GPS surveys

Basic field gear

Planning a field Project: Preparations for the field, Taking geologic notes in the field: Basic procedures at outcrops – noting characters of igneous, sedimentary and metamorphic rocks, Measuring strike and dip (attitude) of planar and linear features using a clinometer compass, a Brunton Compass.

Practical: 1 Credit (30 contact hours = 15 practical sessions)

Maximum Marks: 25

- The evaluation is to be based on preparation of portfolio that should include plans drawn using Plane table, a Levelling Exercise.
- Assessment to be based on presentation of Field diary, Field report, and field based viva voce on the localities visited for field work.

List of books recommended for references:

Arora, K R., (2015) Surveying Vol-2 (13^{th} edition).Standard Book House Unit of Rajsons Publication Pvt. Ltd.

Barnes, J W and Lisle, R J., (2004) Basic Geological Mapping, John Wiley and Sons

Basak, N N., (2014) Surveying and Levelling, McGraw Hill Education.

Coe, A, L., Argles, T W., Rothery, D A and Spicer, R A., (2010) Wiley-Blackwell, The Open University.

Compton, R R., (1985) Geology in the Field, John Wiley & Sons, Inc.

Compton, R R., (1962) Manual of Field Geology, John Wiley & Sons, Inc.

Gokhale, N W., (2001) A Guide to Field Geology, CBS Publishers & Distributors.

Kanetkar, T P & Kulkarni, S V., (1988) Surveying & Levelling (Part I), Pune VidyarthiGrihaPrakashan.

Lahee, F H. (1962) Field Geology, McGraw – Hill Book Company, Inc.

Lambert, D A., (1998) Field Guide to Geology, Facts on File Inc.

Lisle R., Brabham P and Barnes J., (2011) Basic Geological Mapping (Geological Field Guide), Wiley Blackwell.

McClay, K R., (2007) The Mapping of Geological Structures, John Wiley and Sons.

Penning, W H. and Jukes-Browne., (2011) A Textbook of Field Geology, Nabu Press.

Robinson W F and Tallack., (2016) Surveying and Levelling Instruments Theoretically and Practically Described for construction, Qualities, Selection, Preservation, Adjustments and Uses: With other apparatus and Appliances used by Civil Engineers and Surveyors in the Field,

Wentworth Press.

Paper Code: **GEL-VI. E-16**
Paper Title: **GEM TESTING AND EVALUATION**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives:

- The course covers the various aspects of gem testing using both theoretical as well as practical by dealing with basics to the advanced techniques of gemstone identification.
- Further it deals with the methods employed by diamond industry in cutting a rough diamond into a sparkling gem and how diamonds are graded internationally.
- Why synthetic gemstones have flooded the market and how they are manufactured is then next topic, including their detection.

Learning Outcomes:

- The students will get a direction which will be useful to them in the gem industry.
- The basic idea thus, is to make students well versed with the different terminologies used in the gem sector to become a successful gemmologist.

MODULE I **(15Lectures)**
Introduction; Formation of gemstones: Igneous rocks, Sedimentary rocks, Metamorphic rocks; Crystalline, Amorphous and Metamict gemstones, Formation of natural diamond.
Essential qualities in a gemstone: Beauty – Colours, Cut, Clarity, Carat; Rarity; Durability
Causes of colour: Transition metal elements; Idiochromatic gemstones, Allochromatic gemstones, Psueudochromatic gemstones – Colour changing gemstones, lattice defects, dispersion, scattering of light, interference of light
MODULE II **(15Lectures)**
Specific Gravity: Definition, Heavy Liquid method, Floatation method, Hydrostatic weighing method, Pycnometer
Cleavage, fracture, parting; Hardness: Significance of hardness test in gem testing, Hardness pencils, Hardness plates
Properties based on reflection of light in gemstones: Reflection of light; Lustre; Chatoyancy; Asterism; Aventurescence; Labradoresence
Use of 10X/hand loupe
Need and objective of faceting and polishing; steps in diamond cutting; Styles of cut.
MODULE III **(15Lectures)**
Synthesis of gemstones: Flame fusion method, Hydrothermal process, Flux fusion process, Synthesis of diamond
Grading of Diamonds
Enhancement and Treatments and its detection: Bleaching, Coating, spraying, foiling, Coloured impregnation, Colourless impregnation, Heat treatment, Irradiation, Diffusion treatment, Laser drilling, Surface modifications
Composites: Types of composites and Detection
Practical: 1 Credit (30 contact hours = 15 Practical sessions)

Maximum Marks: 25

- Visual observation of gemstones
- Identification of natural crystals
- Use of Dichroscope in gem testing
- Use of Polariscope in gem testing
- Use of Refractometer in gem testing
- Use of Spectroscope in gem testing
- Use of Ultra violet lamp in gem testing
- Determination of Specific Gravity
- Identification of different types of cuts

List of books recommended for references:

Read, P G; (1991) Gemmology, Butterworth-Heinemann Ltd.
Sinkankas, J; (1969) Mineralogy: A First Course, Van Nostrand Reinhold Company.
Webster, R and edited by Anderson, B, W; (1983) Gems: Their Sources, Descriptions and Identification, Butterworth-Heinemann Ltd.
Fernandes S. and Choudhary G., (2010) Understanding Rough Gemstones, Indian Institute of Jewellery.
Karanth, R V; (2000) Gem and Gem deposits of India, Geological Society of India.

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SEMESTER VI

EVALUATION AND ASSESSMENT SCHEME

Each course (Core or Elective) = 4 Credits
75marks Theory and 25marks Practical

Theory: 3 credits of 45 contact hours each

i. Continuous Assessment (CA): 30 marks.

ii. Semester End Examination (SEE): 45 marks.

Practical: 1 Credit
15 practical sessions of two contact hours each

i. Assessment in Practical's will be done by continuous assessment throughout the Semester.

ii. Practicals will be supported by appropriate field work.

CORE PROJECT : **4 Credits**

Revised Course Structure and List of Core and Elective Courses

COMPONENT A

SEMESTER	CORE COURSES		ELECTIVE COURSES			
I	**GEL-I.C-1** Fundamentals of Mineralogy	**GEL-I.C-2A** Earth's Dynamics and Tectonics	-----	-----	-----	-----
II	**GEL-II.C-3A** Elementary Petrology	**GEL-II.C-4** Principles of Stratigraphy and Paleontology	-----	-----	-----	-----
III	**GEL-III.C-5A** Advanced Mineralogy and Geochemistry		**GEL-III.E-1** Physical Geology	**GEL-III.E-2** Groundwater and Hydrogeology	**GEL-III.E-3A** Ore Genesis	**GEL-III.E-4** Marine Geology
IV	**GEL-IV.C-6A** Structural Geology		**GEL-IV.E-5A** Engineering Geology	**GEL-IV.E-6A** Optical Mineralogy	**GEL-IV.E-7** Natural Hazards and Management	**GEL-IV.E-8** Geotectonics
V	**GEL-V.C-7A** Sedimentary Petrology	**GEL-V.CP** Core Project	**GEL-V.E-9A** Stratigraphy of India – Part I	**GEL-V.E-10** Petroleum Geology	**GEL-V.E-11A** Metamorphic Petrology	**GEL-V.E-12** Remote Sensing and Digital Image Processing
VI	**GEL-VI.C-8A** Igneous Petrology	**GEL-VI.CP** Core Project	**GEL-VI.E-13A** Stratigraphy of India – Part II	**GEL-VI.E-14A** Rock Structures and Deformation Microstructures	**GELVI.E-15** Surveying and Field Geology	**GEL-VI.E-16A** Principles of Geophysical Exploration and Mining

Core Courses for students offering **Geology as the Minor**

SEMESTER I GEL-I.C-1: FUNDAMENTALS OF MINERALOGY
SEMESTER II GEL-II.C-3A: ELEMENTARY PETROLOGY
SEMESTER III GEL-III.C-5A: ADVANCED MINERALOGY AND GEOCHEMISTRY
SEMESTER IV GEL-IV.C-6A: STRUCTURAL GEOLOGY
SEMESTER V GEL-V.C-7A: SEDIMENTARY PETROLOGY
SEMESTER VI GEL-VI.C-8A: IGNEOUS PETROLOGY

REVISED SYLLABUS OF THE UNDERGRADUATE DEGREE PROGRAMME IN GEOLOGY FOR SEMESTERS I, II,III,IV,V AND VI

(IMPLEMENTED FROM JUNE 2018 ONWARDS)

SEMESTER I

Course Title: **FUNDAMENTALS OF MINERALOGY**
Course Code: **GEL-I. C-1**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives
The course deals with the study of minerals, their chemistry and identification in hand specimen. Further, it also deals with the study of crystals w.r.t their morphology, symmetry and the normal crystal classes.

Learning Outcomes
Studying the basics of mineralogy and crystallography helps in understanding and building the overall knowledge in Geology.

Module I **(15 hours)**
Minerals: Rock-forming minerals and ore minerals.
Common physical properties of minerals including electrical and magnetic properties.
Isomorphism, Polymorphism, Pseudomorphism
silicate structures: (sorosilicate/ cyclosilicate/ nesosilicate/ inosilicate/ phyllosilicate/tectosilicate)
Introduction to rock-forming mineral Olivine, Pyroxene, Amphibole, Mica, Feldspar, Quartz and its varieties
Important and abundant mineral groups: aluminosilicates, sulfides, sulfates, carbonates; oxides; halides; native metals (with three examples each)

Module II **(15 hours)**
Elemental and major oxide composition of the earth's crust -
Types of Atomic bonds (Ionic/Covalent/Metallic/ Van der Waal).
Radius Ratio, Ionic Radius,
Co-ordination Number.Types of co-ordination.
Atomic arrangement (HCP/CCP)

Module III **(15 hours)**
Space lattice.Unit cell.External morphology of a crystal. Crystal Forms with examples.
Crystallographic axes and Crystal systems.
Symmetry in crystals. (Axis, Plane, Center)
Interfacial angles and Contact Goniometer.

Parameters and Indices

Practical: 1 credit
Maximum Marks: 25

1. Identifying and determining the crystal symmetry, class, system and forms in the normal class of the six systems.
2. Identification and study of minerals w.r.t their physical properties, occurrence, chemical composition and use.

List of books recommended for reference
Mandatory Reading

Dana's Manual of Mineralogy (2010), Dana J. D and Ford W. E.(J. Wiley & Sons)
The Manual of Mineral Science (2007), Klein, C. and B. Dutrow (John Wiley & Sons, Inc.)
Mineralogy (3^{rd} edition), Perkins, D (PHI learning Private Limited, New Delhi)
Rutley's elements of Mineralogy (1988), Read, H. H (CBS Publications)
Battey, M H. Mineralogy for students.

Supplementary Reading

An Introduction to the rock forming minerals, Deer W A, Howie R.A and Zussman J.(John Wiley and Sons).

Course Title: **EARTH'S DYNAMICS AND TECTONICS**
Course Code: **GEL-II. C-2A**
Credits: **3 (45 contact hours)**
Marks: **75**

Course Objectives

Structural Geology is a core branch of earth science which deals with basic concepts of natural internal forces shaping the earth. Further, the course deals with geological structures resulting from the action of these forces on rocks. Also, presents an understanding of the processes in action on the earth's surface and their impact on man and his institutions.

Learning Outcomes

The study of this paper strengthens students' knowledge w.r.t understanding the essentials of the structural dynamics of the earth.

Module I **(15 hours)**

Origin of Solar System (Nebular Concept) and formation of a layered Earth.
Size and shape of the Earth.
Internal structure of the Earth: Geosphere asthenosphere, lithosphere, hydrosphere, biosphere, atmosphere (anoxic to oxic conditions) wrt to earth dynamic
Earth's Gravity : Acceleration due to gravity, change with latitude and altitude.
Earth's Magnetism: Earth as a magnet; lines of force, Source of Earth's Magnetic field, Declination and inclination, Geomagnetic axis and Geographic axis.

Module II **(15 hours)**

Introduction to Plate Tectonics:
Concept of isostacy
Lithostatic or confining pressure, Differential forces: tension, compression, couple.
Concept of stress and strain: stages of deformation: Elastic, Plastic and Rupture.
Brittle and ductile substances.
Introduction to geological hazards: exogenous (floods, drought and cyclones) and endogenous (volcanic hazards, earthquakes and tsunamis, mass wasting)

Module III **(15 hours)**

Map and Scales
Stratification, Strike and dip (true and apparent dip) strike and dip symbols.
Outcrop patterns of Horizontal, Inclined & vertical strata on various types of grounds (horizontal ground, valley and spur).
Folds: Terminology, causes, types of folds; symmetrical, asymmetrical, overturned, recumbent, isoclinal, fan, chevron, monocline, structural terrace, plunging and non-plunging; significance. Outcrop pattern of folds on horizontal ground, valley and spur.
Faults: Definition & terminology, geometric classification, significance; horst and graben.
Joints: Geometric classification, map symbols, columnar joints and sheet structure, significance.
Unconformities: Stages of development, types, significance; outliers and inliers; overlap and offlap.

Practical: 1 credit
Maximum Marks: 25

1. Drawing cross-section and description of structural maps involving single series (Horizontal and Inclined)
2. Graphical solution to structural problems.

List of books recommended for reference

Mandatory reading

Living with Earth (2012), Hudson Travis, Phi Learning Pvt. Ltd., New Delhi.

Physical Geology, Charles C. Plummer and David McGeary (4th edition), Wm C. Brown Publishers.

Understanding the Earth (4th edition), Press, Siever, Grotzinger and Jordan.

The Changing Earth: Exploring Geology and Evolution (3rd edition), Monroe and Wicander.

Jain, A k structural geology, GSI

Holmes' Principles of Physical Geology edited by P.McL.D.Duff (ELBS).

Elements of Structural Geology, E.S. Hills (Methuen)

A Textbook of Geology, P K Mukherjee (World Press)

Supplementary Reading

Elements of Geology (3rd edition), Zumberge J.H. & Nelson C.A. John Wiley & Sons, New York.

SEMESTER II

Course Title: **ELEMENTARY PETROLOGY**
Course Code: **GEL-I.C-3A**
Marks: **75**
Credits: **3** (**45 contact hours)**

Course Objectives
Petrology is the science of rocks. The course will help the students to exhibit an improved understanding of fundamental petrologic processes and common rock types. In practical's, students learn to identify, describe and classify rocks using hand specimens.

Learning Outcomes
On completion of the course the students:
(i) Will have gained an understanding of the processes involved in the formation of a rock, their textures, structures, classifications and their importance.
(ii) Will have learned to differentiate between the different rock types based on their properties.

Module I **(15hours)**

- Rocks and rock cycle
  - Magma: Definition, formation, composition,
    - Properties: temperature, density, viscosity
    - Bowen's Reaction Series
  - Mode of occurrences of Igneous rocks
  - Plutonic: Batholiths (stocks, bosses and roof - pendants),Multiple and Composite intrusions.
  - Hypabyssal: Dykes (Radiating, Arcuate, Ring dykes,), Sills, Laccoliths, Lopoliths
  - Extrusive forms: pyroclastics, lava flows and Volcanic necks,
  - Central and Fissure type of eruptions
  - Structures of Igneous rocks : layering, flow banding
  - Textures of Igneous rocks aphanitic (glassy), : phaneritic: porphyritic, poikilitic, ophitic, sub ophitic; holocrystalline
    - Classification: Based on chemical composition (TAS diagram)

Module II **(15 hours)**
Weathering (, types – Chemical and Physical, and products), Erosion, Transportation and Deposition
Diagenesis
Udden-Wentworth classification based on grain size
Sedimentary structures: Primary (stratification), chemogenic and biogenic
Textures: clastic and non clastic
Sedimentary environments: aeolian, fluvial, glacial and marine

Module III **(15 hours)**

Factors controlling metamorphism.
Types of metamorphism: burial, regional and contact,
Metamorphic grade
Metamorphic textures and structures: Foliated and non-foliated.
Index minerals and Isograds
Nomenclature of metamorphic rocks
Protolith: recognition and types (Mafic, Quartzofeldspathic, Pelitic, Calcareous,)
Metasomatism

Practical: 1 credit

Maximum Marks: 25

- Megascopic study of Igneous, Sedimentary and Metamorphic rocks.

List of books recommended for reference

Mandatory Reading

- Winter, J D., (2014) Principles of Igneous and Metamorphic Petrology, Pearson Education Limited.
- Best, M., (2003). Igneous and Metamorphic Petrology, Blackwell Publishing.
- Tucker E.M. (2001) Sedimentary Petrology (3rd Edition), Blackwell Science Ltd.
- Pettijohn F.J., (1984) Sedimentary Rocks (3rd Edition), CBS Publishers, New Delhi.
- Prothero, D. R., and Schwab, F.; (2004) Sedimentary Geology. Macmillan.
- Boggs S., (2009) Petrology of Sedimentary rocks (2nd edition), Cambridge University Press.
- Gill, R., (2010) Igneous rocks and process – A Practical Guide, Wiley-Blackwell

Supplementary Reading

- Ehlers, E.G. and H. Blatt (1982), Petrology, Igneous, Sedimentary and Metamorphic, W.H Freeman, San Francisco.
- Mahapatra G B. A Textbook of Geology, CBS
- Parbin Singh. A Textbook of Engineering and General Geology (Seventh Ed),
- Mukerjee, P K. A Textbook of Geology, World Press.
- Gill, R., (2010)Igneous rocks and process – A Practical Guide, Wiley-Blackwell

Course Title: **PRINCIPLES OF STRATIGRAPHY AND PALEONTOLOGY**
Course Code: **GEL-II. C-4**
Marks: **75**
Credits: **3 (45 Contact hours)**

Course Objectives

Stratigraphy and Paleontology, the two branches of Geology work together to unearth the secrets of age from rocks of the earth's crust. Stratigraphers study the composition and arrangement of layered or stratified rocks. Paleontologists study the remains of plants and animals which have been preserved in the earth's crust by natural processes. With these objectives in mind it becomes pertinent to understand the basic concepts of Stratigraphy and Palaeontology.

Learning Outcomes

The study of stratigraphy and Paleontology encompasses the aspects of the age of the earth, chronological arrangement of rocks and appearance and evolution of life through the geologic time.

The knowledge of the concepts in stratigraphy, correlation, and paleontology would enable the students to understand the changes that occurred in the history of the earth and relate them to their field observations and also, in understanding the framework of the stratigraphy of India.

Module I **(15 hours)**

Principles of stratigraphy: Uniformitarianism, Original horizontality, Order of superposition, Faunal succession, Cross-cutting relationship, Inclusions.
Principles of stratigraphic analysis, Facies concept in stratigraphy
Walther's Law of Facies.
Age of the earth:, radiometric dating; Principles.
Measurement of geologic time:
- Time Units: Eon-Era-Period-Epoch-Age
- Lithostratigraphic/ Rock Units: Group-Formation-Member-Bed
- Chrono-/ Time stratigraphic units: Erathem-System-Series-Stage
- Standard Stratigraphic Scale.

Correlation and methods of Correlation:
- Paleontological Criteria : Index/ Zone fossils
- Lithological Similarity: Marker/ Key bed
- Structural relations: Tectonic criteria

Brief account of the Geological Formations of Goa.

Module II **(15 hours)**

Fossils: Mega- Micro-Ichnofossils
Conditions for fossilization; Favourable environments for fossilization.
Modes of fossilization: Petrification, Carbonization, Natural moulds and casts

Frozen and mummified fossils.
Uses of fossils in locating coal and petroleum deposits.

Module III **(15 hours)**

Binomial Nomenclature of Organisms and Taxonomy
Morphology of the hard parts and geological time range of the following:
Phyllum: Arthropoda- Class: Trilobita
Phyllum: Mollusca- Class :Pelecypoda
:Gastropoda
:Cephalopoda- Nautiloidea
Ammonoidea
Belemnoidea
Phyllum: Brachiopoda
Phyllum:Echinodermata- Class: Echinoidea

Practical: 1 credit
Maximum Marks: 25

- Map reading
- Use of clinometer compass and exercises on Bearings
- Study of fossils/casts/shells w.r.t their morphology and geological age.

List of books recommended for reference

Mandatory Reading

- Spencer, E, W, Basic concepts of Historical Geology, Oxford & IBH Publishing Co.
- Dana, J.D., Manual of Geology, Anmol Publications.
- Koregave, M A., Fundamentals of Invertebrate Palaeontology, Book World Enterprises.
- Monroe and Wicander, The Changing Earth: Exploring Geology and Evolution (3rd edition.
- Black. R M., The Elements of Palaeontology, Cambridge University Press.

Supplementary Reading

- A Textbook of Geology, P.K Mukherjee (World Press).

SEMESTER III

Course Title**: ADVANCEDMINERALOGY AND GEOCHEMISTRY**
Course Code: **GEL-III.C-5A**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

- The course covers geoscientific studies of mineralogy. The knowledge of mineralogy will be applied in understanding the genesis of minerals.

Learning Outcomes

- The course will enable the students to understand how minerals originate and associate with each other in a rock.

Module I **(15 hours)**

Introduction to mineral chemistry, Gibbs Phase Rule, Phase diagram.

Structure, mineral chemistry, paragenesis, and Phase diagrams of the following silicate group of minerals:

Olivine group (Forsterite-Fayalite System)
Pyroxene group (Diopside-Anorthite System)
Feldspar group (Albite-Anorthite System; Orthoclase-Albite System)

MODULE II **(15 hours)**

Structure, mineral chemistry, paragenesis, and stability relations of the following silicate group of minerals:

- Feldspathoid group (Leucite-Silica System)
- Silica
- Amphibole
- Mica

MODULE III **(15 hours)**

- Whole rock analysis (major, trace REE)
- Concept of compatible and incompatible elements,
- Use of geochemistry in deducing tectonics.
- Primitive mantle normalized diagram and their significance in petrogenesis.

Practical: 1 credit
Maximum Marks: 25

1. Calculation of end-members for olivine, pyroxene and feldspar group of minerals.
2. Plotting of major oxides in tectonic discriminant diagrams

List of books recommended for reference

Mandatory Reading

- Ford, W. E., 2006. Dana's Textbook of Mineralogy (with extended treatise Crystallography and Physical Mineralogy). CBS Publishers, New Delhi.
- Deer, W. A, Howie, R. A and Zussman. J., 2013, An Introduction to Rock-Forming Minerals, Mineralogical Society.
- Griffen, D. T, Phillips, W. R and William, R. Phillips., 2004. Optical Mineralogy: The Nonopaque Minerals. CBS Publishers, New Delhi.
- Mason and Berry, 2004. Mineralogy, CBS Publishers, New Delhi.
- Mason and Moore
- White, W M (1997) Geochemistry.
- Pearce 1976.

Supplementary Reading

- Krauskopf, K B and Bird, D K (1995) Introduction to Geochemistry. McGraw-Hill
- Faure, G (1998) Principles and Applications of Geochemistry. Prentice Hall

Course Title: **PHYSICAL GEOLOGY**
Course Code: **GEL-III.E-1**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives: The natural agencies like wind, rivers, glaciers have been moulding and remoulding the surface of the earth over millions of years. This paper aims at the understanding of the processes and the physical forces responsible in developing the surficial features and highlighting the role of these natural agencies in grading and degrading the land surface.

Learning Outcomes: The students are expected to relate the activity of the various natural agents to the existence of different types of physical features on the earth's surface and, will be able to understand the dynamism in their creation.

Module I **(15 Hours)**

Weathering and erosion

- Earth Systems Affecting Weathering
- Mechanical Weathering – Pressure Release, Frost Action, Thermal Expansion and Contraction, Salt Growth, Impact of Organism
- Chemical Weathering – Organisms Role, Oxidation, Acid Action, Dissolution/Leaching, Hydrolysis, Spheroidal Weathering
- Factors Affecting rate of Weathering.
- Rate of Weathering versus Stability of Minerals

Weathering versus Erosion

Transportation and deposition

- Laminar and Turbulent Flow
- Agents of Transportation – Wind, Water, Glaciers, Gravity
- Modes of transportation – Bed Load (sliding, rolling, saltation), Suspension, dissolved load
- Factors Affecting Depositions

Action of Wind

- Generation of Winds,
- Characteristics of Desert.
- Problems Associated with Desertification.
- Sediment Transport – Lifting Mechanism, Bed Load and Suspended Load

Desert Landforms:

Depositional: sanddunes, Sand Seas/Ergs, Playa, sabkha

Erosional: Grooves, Ventifacts & Yardangs mushroom rock, Inselbergs, Mesas and Buttes,

Deflation Basin, Desert Pavement and Lag Gravel

Module II **(15 Hours)**

Drainage Basin and River System –, Drainage Patterns –

Dynamics of Stream Flow – Discharge, Gradient, Velocity, Sediment Load, Base Level

Concept of Graded Stream

River System and Plate Tectonics

Geological Action of Rivers

Erosion by River

Process of Stream Erosion – Removal of Regolith, Downcutting, Headward Erosion.

Bradshaw Model

Erosional Feature in Upper Course - Steep Valleys, Gorges, Interlocking Spurs, Potholes, Waterfall and Rapid

Erosional Features in Middle and Lower Course – Meander, Ox Bow Lake, Hogbacks, Cuestas

Depositional Landforms by River

Floodplains – Meanders, Point Bars, Natural Levees, Backswamps, Braided Stream

Alluvial Valleys – Step Terraces

Deltas – Formation and Types

Alluvial Fans

Erosion by Groundwater

Karst Topography – Caves, Sinkholes, Solution Valleys, Disappearing Streams, Tower Karst

Deposition by Groundwater

Speleothems – Stalactites, Stalagmites

Module III **(15 Hours)**

Types of glaciers and Glacial Budget

Glacier Flow – Surging Glacier, Crevasses

Ablation – Melting, Evaporation, Calving

Geological Work of Glaciers

Erosional Features of Glaciers

Erosion Process– and erosional landforms related to valley and continental glaciation.

Depositional Features of Glaciers

Glacial Drift – Till and Stratified Drift

Action of Sea Waves

Erosional and depositional features of the coast.

PRACTICAL MODULE: 1 Credit

- Basin Morphometry Perimeter Calculation using rotameter
- Area Calculation – Square Grid/Strip Method
- Stream Ordering (Strahler's Method)
- Drainage Network Morphology – Bifurcation and Length ratio
- Basin Geometry – Basin CircularityIntensity of Dissection – Drainage Density, Stream Frequency Hypsometric Curve
- Draw Inference for the Basin based on the result
- Long Profile and Cross Profile of River – Upper Course, Middle Course, Lower Course of river from SOI Toposheet Field visit to nearby area to understand and describe the various physical geology features.

REFERENCE BOOKS:

- Monroe, S. J and R. Wicander., 2014. The Changing Earth: Exploring Geology and Evolution. Brooks Cole Publishers.
- Monroe, J.S., Wicander, R., Hazlett, R., 2007. Physical geology – Exploring the Earth (6^{th} Ed.) Thomson Brooks/Cole.
- Carlson, D.H., Plummer, C.C., McGeary, D., 2008. Physical Geology: Earth revealed. Higher Education.
- McConnell, D., Steer, D., Knight, C., Owens, K., Park, L., 2008. The Good Earth – Introduction to Earth Science. Higher Education.
- Mathur, S. M., 2012. Physical Geology of India. National Book Trust
- Thornbury Principles of geomorphology John Wiley and Sons, Inc. and Chapman & Hall, ltd.

Course Title: **GROUNDWATER AND HYDROGEOLOGY**
Course Code: **GEL-III.E-2**
Credits: **3(45 contact hours)**
Marks: **75**

Course Objectives
To impart knowledge about groundwater, its movement, methods of its exploration, the criteria of its quality, methods of its conservation, recharge of groundwater, monitoring of groundwater quality and quality.

Learning Outcomes
On completion of the course, the student will have gained an understanding of:
- Hydrogeological concepts, exploration, exploitation and recharge of groundwater
- Methods of monitoring groundwater quality and sources of pollution

Module I **(15 hours)**
Hydrologic cycle and its components
Factors controlling all the components: Evaporation, precipitation, runoff, Infiltration
Hydrologic budget
Vertical distribution of ground water
Types of Groundwater: soil water, vaddose, capillary water, Meteoric water
Rock properties affecting movement of ground water:
1) Porosity(primary and secondary), effective porosity, specific retention, controlling factors of porosity
2) Permeability: Darcy's law, laboratory methods of measurement of permeability (constant head, falling head), specific yield, Relation between grain size, porosity, specific yield and specific retention.
Definition of an aquifer, aquiclude, aquitard, aquifuge, and types of aquifers: Unconfined, Confined (Artesian), Perched aquifer.

Module II **(15 hours)**
Groundwater Exploration: Resistivity methods
Groundwater levels and Flow nets
Aquifer parameters: 1) Transmissivity, 2) Storativity,3) Hydraulic conductivity: methods of determination (pumping test and tracer test)
Drawdown and cone of depression
Groundwater quality:
  - Parameters :physical ,chemical and biological
  - Major, minor and trace constituents.
  - I.S.I standards for drinking water

Module III **(15 hours)**

Effects of withdrawal, effects of waterlogging
Artificial recharge
Saline water intrusion in aquifer
Ghyben-Hertzberg relation
Pollution of ground water: Arsenic and Fluoride

Practical: 1 credit
Maximum Marks: 25

- Drawing flow nets
- Determination of depth to water table from bore hole data.
- Numerical problems on determinationof porosity, bulk density, saturation percentage and void ratio of sample
- Problems based on Ghyben –Hertzberg formulae
- Graphical presentation of chemical data of water
- Resistivity survey (demonstration)

List of books recommended for reference

Mandatory Reading

- Todd , D.K and Mays, L.W., 3rd edition , 2012. Groundwater Hydrology, Wiley India Pvt. Ltd.
- Hiscock, K and Bense, V F. Hydrogeology: Principles and Practice.
- Valdiya K.S., 1987, Environmental Geology: Indian Context, Tata-McGraw Hill
- Ragunath H.M., 1983, Groundwater, Wiley Eastern Ltd, New Delhi.
- Keller, E.A., 4th edition, 2011. Environmental Geology, CBS Publishers, New Delhi.

Course Title**: ORE GENESIS**
Course Code**: GEL-III.E-3A**
Credits**: 3 (45 contact hours)**
Marks: **75**

Course Objectives: The course deals with the study of various processes of formation of ore deposits. It also deals with the study of various mineral deposits with respect to their mode of occurrence, geologic and geographic distribution, classification and their genesis. Furthermore, it also deals with the identification of economic minerals in hand specimens.

Learning Outcome: On completion of the course, the student will have gained sufficient knowledge regarding the formation of various ore deposits and also be able to differentiate between economic minerals and identify them. Furthermore, the student will gain an idea about the mineral wealth of our country.

Module I (15 hours)

Goldsmith geochemical Classification

Tenor, Prospects, Resource & Reserves of ore minerals

Classification of Ore Deposits:

- Modified Lindgren's Scheme; Bateman Scheme; Based on Tectonic Setting

Processes Forming Mineral Deposits

- Requirements for Ore deposit formation
- Syngenetic & Epigenetic deposits

Magmatic Ore Forming Processes

- Orthomagmatic ore formation (Bushveld; Sudbury)
- Ore deposits at mid-ocean ridges (Black & White Smokers) and in ophiolites (podiformchromites)
- Ore formation related to alkaline magmatic rocks, carbonatites and kimberlites
- Ore deposits in pegmatites

Module II (15 hours)

Magmatic-Hydrothermal Ore Forming Systems

- Hydrothermal ore formation (Source of Hydrothermal Solutions; Textures & Structures; Host rock alteration)
- Volcanogenic ore deposits (VMS; Terrestrial epithermal gold, silver and base metal)
- Porphyry copper (Mo-Au-Sn-W) deposits
- Hydrothermal-metasomatic ore deposits
- Skarn, Greisen

Supergene Ore Formation Systems

- Residual (eluvial) ore deposits
- Supergene enrichment by descending (vadose) solutions

Sedimentary Ore Formation Systems

- Black shales in metallogenesis (European Copper Shale)

Autochthonous iron and manganese Deposits
Sediment-hosted & submarine-exhalative (sedex) base metal deposits
Mississippi Valley type (MVT) Lead-Zinc deposits
Placer deposits

Metamorphic Ore Forming System
Orogenic Cu-Zn-Au deposits

Ore Deposits in Space and time
Metallogenic Epochs
Plate Tectonic Setting of Ore Deposits

Module III **(15 hours)**

Indian occurrences of
Metallic Deposits:
Iron
Manganese
Chromium
Copper-Lead-Zinc
Gold
Non metallic Deposits:
Diamond, Baryte, Bauxite,
Nuclear Minerals
Industrial Minerals (Refractory, Abrasives, Cement, Fertilizer, Electrical and Electronics).

PRACTICAL MODULE = 1 Credit

- Descriptive evaluation of ore minerals in hand sample
- Introduction to reflected light microscopy of ore minerals (demonstration) Site visits to local mineralized geology

REFERENCE BOOKS

For Ore Forming Process: (E-books Available of All)

1. Pohl, L.W., 2011. Economic Geology – Principles and Practice. Wiley-Blackwell
2. Robb, L., 2005. Introduction to Ore-Forming Processes. Blackwell Publishing
3. Evans, A.M., 1993. Ore Geology and Industrial Minerals – An Introduction (3rd Ed.) Blackwell Publishing
4. Edwards, R. & Atkinson, K., 1986. Ore Deposit Geology and its influence on Mineral Exploration. Chapman and Hall Ltd.
5. Hutchison, C., Economic Deposits and their Tectonic Setting.

For Ore Deposits in Indian Context:

1. Prasad, U., 2014. Economic Geology: Economic Mineral Deposits (2nd Ed.), CBS Publishers, New Delhi

2. Srivastav, J.P., 2012. Introduction to Ore Microscopy. Prentice Hall India Learning Private Limited
3. Tiwari, A.K., 2010. Ore Geology, Economic Minerals and Mineral Economics. Atlantic
4. Gokhale, G.V.G.K., 1983. Ore Deposits of India. CBS Publishers, New Delhi

Mandatory Reading

Principle Reference books used for course preparation will be Economic Geology by Walter Pohl and Economic Geology by Umeshwar Prasad.

Course Title: **MARINE GEOLOGY**
Course Code: **GEL-III.E-4**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives:
To provide essential concepts of oceanography.
To study the tectonics, geology, economic resources w.r.t. the oceans.

Learning Outcomes:
A student will understand and learn about the basic concepts of marine science with respect to geology as to enable them to work as a marine researcher.

Module I **(15 hours)**
Ocean basins: Shape, size of the Pacific, Atlantic and Indian Oceans
Coriolis Effect
Ocean circulation
Ocean salinity
Techniques used to study ocean bathymetry
Concept of Plate Tectonics and ocean floor spreading,
Magneto stratigraphy

Module II **(15 hours)**
Marine Provinces
Morphological features of the ocean floor;
- Mid Oceanic Ridges and its features;
- Abyssal plains and its features
- Ocean trench and its features
- Continental slope and shelf and their features
- Ocean islands: Hot spot, Atolls

Module III **(15 hours)**
Clastic Sedimentation in different marine environments:
- Biogenic sedimentation
- Chemogenic sedimentation

Near coastal geological processes
Coastal Zone Regulations (CRZ), Exclusive Economic Zone (EEZ); Minerals in the EEZ of India.
Mineral deposits

Practicals = 1 credit

- Preparation of salinity and ocean current map.
- Drawing and labeling of ocean profile.
- Preparation of ocean resource distribution maps
- Visits to National Laboratories engaged in Ocean Research such as NIO and NCAOR.

List of books recommended for references:

- Trujillo, A. P and Thurman H., 2013. Essentials of Oceanography, Eastern Economy Edition, PHI Learning Pvt. Ltd, New Delhi.
- Kennett J P., 1981. Marine Geology, Prentice Hall.
- Pinet Invitation to Oceanography
- Qasim, S.Z., 1996, India's Exclusive Economic Zone, Omega Scientific Roonwal, G.S. Publishers.
- Thurman, H V. and Trujillo A., 2003, Introductory Oceanography, Prentice Hall.

SEMESTER IV

Course Title: **STRUCTURAL GEOLOGY**
Course Code: **GEL-IV.C-6**
Marks: 75
Credits: 3 (45 Contact hours)

Course Objectives

The course is designed for the students to understand the geometry and mechanics of the various geological structures that result through the deformative processes operative within the earth.

Learning Outcomes

The student will

- Gain knowledge of the geometry of the rock structures.
- Understand the mechanism of the evolution of rock structures and its application in the field.

Module I **15 hours**

Primary and secondary structures.
Concept of rock deformation.
Stress and Strain in rocks, 2-D stress and strain analysis;
Strain ellipses of different types and their geological significance.

Module II **15 hours**

Unconformities.
Joints: Joints and fracture mechanics, classification of joints.
Faults: Terminology, classification, criteria for faulting.
Diapirs (salt domes)

Module III **15 hours**

Cleavage and foliation: types, origin and relation to major structures.
Lineations- Description and origin of lineation.
Folds- morphology; Geometric and genetic classification; Mechanics and causes of folding
Lineation and relationship with folds

Practicals : Credit 1
Maximum Marks: 25

Solving Geological Maps
Completion of Outcrops
Stereographic Projection of Structural Data
Graphical Solution for Structural Problems

List of recommended reference books:
Mandatory Reading

- Twiss, R. J and Moores, E. M., 2006. Structural Geology, W H Freeman and Company.
- Davis, G. H., 1996. Structural Geology of Rocks and Regions, Wiley
- Pollard, D. D and Fletcher, R. C., 2005.Fundamentals of Structural Geology, Cambridge University Press.
- Marshak, S and G. Mitra., 1988. Basic Methods of Structural Geology, Prentice Hall.
- Hobbs, B and Alison, O. R. D., 2014. Structural Geology: The Mechanics of Deforming Metamorphic Rocks, Elsevier Science Publishing Co. Inc
- Fossen, H., 2010. Structural Geology, Cambridge University Press.
- Robert D hatcher, Structural geology: Principles, concepts and problems. Pearson (1995)
- Ramsays Techniques of Modern Structural geology

Course Title: **ENGINEERING GEOLOGY**
Course Code: **GEL-IV.E-5A**
Marks: **75**
Credits: **3 (45 contact hours)**

Course Objective

To impart sufficient knowledge of engineering geology so as to be able to anticipate the technical problems related to geology of various engineering sites and suggest possible remedial measures.

Learning Outcome

Upon completion of the course the student will become aware of the importance of geological studies and its applicability to various engineering problems.

Module I **(15 hours)**

Aim of engineering geology

Porosity and permeability of rocks

Principles of mechanical behaviour of rock materials

Engineering properties of rocks; specific gravity, compressive strength, hardness, toughness,

Soil profile and Engineering properties of soil;

Role of structures (joints, fractures, folds, faults) and water/fluids in engineering geology

Use of rocks / aggregates in construction

Module II **(15 hours)**

Role of engineering geologists in planning, design and construction of major man-made civil structural features.

Methods of site investigation

Introduction to core logging

Geological investigations/geotechnical problems related to groundwater occurrence,

Module III **(15 hours)**

Geological investigations for landslides, bridges and tunnels -design and construction.

Geological investigations in dams and reservoirs.
Case studies of dam failures
Site improvement methods

Practical: 1 credit
Maximum Marks: 25

- Site feasibility based on geological map.
- Physical and mineralogical descriptions of cores,

- Relationship of core log to RQD values
- Computation of reservoir area, catchment area, reservoir capacity
- Numerical problems on ultimate strength of rocks

List of recommended reference books.

- Bell, .F.G, 2007. Engineering Geology, Butterworth-Heineman
- Blyth, F.G.H and De Freitas., 7th edition, Geology for Engineers, ELBS.
- Billings, M.P., 3rd Edition, Structural Geology, CBS Publishers, New Delhi.
- Sathya, N S., 2nd edition, Engineering Geology, B.S, Dhanpat Rai and Co. Pvt Ltd.
- Gupte R.B. (1992)., A Textbook of Engineering Geology., Pune VidyarthiGrihaPrakashan.
- Narayanswami S.B.S. (2000), Engineering Geology, Dhanpat Rai & Co, India.
- Price, D.G.,(2009), Engineering Geology Principles and Practice, Springer.

Course Title: **OPTICAL MINERALOGY**
Course Code: **GEL-IV.E-6A**
Marks: **75**
Credits: **3 (45 Contact hours)**

Course Objectives

- The course covers the basics of geoscientific studies in Mineralogy. The knowledge of optics is applied in understanding and identification of minerals.

Learning Outcomes

The course will enable the students to gain knowledge in identifying minerals based on their optical properties and optical methods using a petrological microscope.

Module I **(15 hours)**

Introduction: Nature of light, Polarized light, Refractive Index, Critical angle and Total Internal reflection, Wave Surface, Double Refraction.

Parts and working of a Polarizing / Petrological microscope

Properties of minerals in Plane Polarised Light (PPL): Colour, Form, Cleavage/Cracks; Relief, Twinkling; Pleochroism,

Pleochroic halos.

Module II **(15 hours)**

Optical characters of minerals: Isotropism and Anisotropism

Properties of minerals Between Crossed Polars (BXP): Interference colours: Formation, Newton's Scale, Anomalous interference colours;

Extinction and Extinction types.

Twinning and Zoning

Alteration, Inclusions.

Module III **(15 hours)**

Optical accessories

Uniaxial indicatrix

Biaxial indicatrix

Convergent Light: Principle

Uniaxial Interference Figure

Biaxial Interference Figure

Optic sign of Uniaxial and Biaxial Minerals

2V and 2E

Practical: 1 credit
Maximum Marks: 25

- Identification of common rock forming minerals based on optical properties
- Interference figures (Demonstration)
- Determination of optic sign (demonstration)
- Determination of An-content using extinction angles (demonstration)

List of books recommended for reference

Mandatory Reading

- Kerr, P., 1977, Optical Mineralogy, McGraw Hill Publishers.
- Nesse, D. W., 2012, Introduction to Optical Mineralogy, Oxford University Press.
- Perkins, Dexter. Mineralogy. Pearson New International Edition

Supplementary reading

- Klein, Cornelis and Hurlbut, Cornelis. Manual of Mineralogy

Course **Title: NATURAL HAZARDS AND MANAGEMENT**
Course **Code:GEL-IV.E-7**
Marks: 75
Credits: 3 (45 Contact hours)
Prerequisites: GEL-III.E-1

Course Objectives
The course is designed with an aim to give the student an understanding about: various natural hazards; stages in management aimed at avoiding and /or reducing loss to life and property; and Agencies involved in mitigation and management of damage due to hazards.

Learning Outcomes
On completion of the course, the student will become aware of the nature and effects of various natural hazards, and know about how to cope with them. The student will also come to know about different agencies and other resources available to deal with the effects of natural hazards.

Module I **(15 hours)**
Natural and man-made disasters
Natural Disasters:
Exogenous
Droughts: **types, causes, mitigation**
Floods: **causes and effects, prediction, Cloud burst/Flashfloods, remedial measures**
Cyclones: **Structures, origin, effects, prediction, path tracking and early warning systems.**

Module II **(15 hours)**
Endogenous:
Volcanic eruption: **Types, localization, volcanic hazards and mitigation**
Earthquakes: **Causes, Magnitude and intensity, Recording, effects and preparedness, Earthquake Zonation Map.**
Tsunamis: **relation of Tsunamis to tectonics; Damage due to tsunamis, Co-ordinated approach to early warning of tsunamis.**
Landslides and Avalanches: **Classification of mass wasting, mechanics, causes of landslides and stabilizing methods of slopes; civil engineering measures.**
Subsidence: **Causes, slow and brisk types**

Module III **(15 hours)**
Salinity hazards: Inland and coastal

Coastal erosion and mitigatory measures
CRZ act and its impact on disaster mitigation
National Disaster Management: national and international support
Planning strategy: co-operative plan, identifying resources, setting priorities.
Hazard coping operations and rehabilitation
Proposed operational processes for individual Natural Disasters mentioned above.
Case study of Parvatibai Chowgule College Disaster Plan

Practical: 1 credit
Maximum Marks: 25

- **Hazard zonation map of India: ,earthquakes, floods droughts, landslides and Cyclone**
- **Discussing disaster management plan for Parvatibai Chowgule College**
- **Land-use land cover mapping**

List of books recommended for reference
Mandatory reading

- Paul, K, B., 2011, Environmental Hazards and Disasters: Context, Perspectives and Management, Wiley-Blackwell, West Sussex.
- National policy on disaster management 2009, Government of India, Ministry of Earth science
  http://ndma.gov.in/images/guidelines/national-dm-policy2009.pdf

- **Sethi, V. K., 2009, Disaster Management, Essential Books PW, New Delhi.**
- **Hess, D., 2012, Mc Knight's Physical Geography, PHI learning, Pvt Ltd, New Delhi.**
- **Krynine, D. and Judd W., 1998, Principles of Engineering Geology and Geotectonics, McGraw Hill.**
- **Holmes, A., edited by Duff P.M.D., 4th edition, Physical Geology, E.L.B.S Publications.**
- **Valdiya K.S., 1987, Environmental Geology: Indian Context, Tata-McGraw Hill**
- **Keller, E. A., 2011, Environmental Geology, Santa Barbara Prentice Hall.**
- **Joshi M.V., 2004, Environmental Disaster, Causes, Impacts and Remedies, Adhyayan Publishers.**

Course Title**: GEOTECTONICS**
Course Code: **GEL-IV.E-8**
Marks: **75**
Credits: **3 (45 Contact hours)**

Course Objectives

Ever since the creation of the earth, there have been marked changes in the distribution of land and sea. The dynamics of these changes are stupendous. Several theories have come forth to explain and understand the mechanism of such changes. Each great mountain chain in the world was created by intense tectonic forces. The subject of Geotectonics deals with the structure of the earth and the processes responsible for the movement and redistribution of continents and seas.

Learning Outcomes

The students will gain an insight into the operating processes leading to the global changes in the positioning of continents and seas, and the creation of great mountain chains.

Module I **(15 hours)**

Interior of the earth:

Clues from the study of earthquake and density;
The earth's layers; the crust-continental crust and oceanic crust;
Crust-mantle boundary
Structure of the mantle
Low Velocity Zone (LVZ)
Core-mantle boundary; P wave shadow zone,
Nature of the core; S wave shadow zone.

Earth's Magnetic field:

Origin and nature
Dynamo hypothesis and Herndon's Georeactor Theory.
Geocentric axial dipole,
Paleomagnetism,
Marine magnetic anomalies,
Magnetic reversals and magnetic stripes

Module II ***(15 hours)***

Continental drift:

Wegener's hypothesis.

- Evidences: Continental fit; similarity of rock sequences and mountain ranges; glacial evidence, fossil evidence;

Paleomagnetism and Polar wandering.

Plate tectonics:

Plate margins, plate boundaries and associated activities,
Triple junctions;
Divergent, Oceanic Ridges, Sea floor spreading, transform faults; hotspots.
Convergent: oceanic–oceanic, oceanic-continental, continental-continental; oceanic trenches, subduction zones
Transform boundaries;
Wilson Cycle (Rift valleys, the Red sea and the Gulf of Aden)

Geometrical aspects and mechanism of plate motion.

Module III ***(15 hours)***

Mountain building: Orogenesis

Plate boundaries and orogenesis: Orogenesis at oceanic-oceanic plate boundaries, oceanic-continental plate boundaries and continental-continental plate boundaries.

Case study: Tracking the rise of Himalayas.

Case study: Frequency of Earthquakes in North India

Case Study: Occurrence of Tsunami in SE Asia

Practical: 1 credit

Maximum Marks: 25

- Plotting of oceanic ridges, trenches, subduction zones, sea mounts, plate boundaries
- Exercises in plate tectonics.

List of books recommended for reference

Mandatory reading

- Marshak, S., 2011. Earth: Portrait of a Planet, W. W. Norton & Company.
- *Duff, D and Holmes, A., 1993, Holmes Principles of Physical Geology, Springer.*
- Monroe, S. J and R. Wicander., 2014. The Changing Earth: Exploring Geology and Evolution, Brooks Cole Publishers.
- Skinner, J. B and S, C. Porter., 2003. The Dynamic Earth: An Introduction to Physical Geology, John Wiley and Sons.
- Condie, K. C., 1997. Plate Tectonics and Crustal Evolution, Butterworth-Heinemann.
- Prasad, C. V. R. K., 2005. Elementary Exercises in Geology, Universities Press.

SEMESTER V

Course Title: **SEDIMENTARY PETROLOGY**
Course Code: **GEL-V. C-7A**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

To provide an understanding of the origin of sedimentary rocks, the relationship of sedimentary processes to plate tectonics, and the use of sedimentary rocks in the study of the geological past.

Learning Outcomes

The student will gain knowledge about the concepts of sedimentary processes and the respective rock types, which will enhance their knowledge of sedimentary petrology.

Module I **(15 hours)**

The Origin of Sedimentary Rocks**:**

Erosion, transportation and deposition of sediments.

Hjulstrom's diagram

Provenance

Components of clastic sediments: Heavy, Clay, Quartz, Feldspars, other minerals

Environment of deposition and sedimentary facies

Basins - Plate tectonics and sedimentation

Sedimentary Textures

Grain Size, Udden-Wentworth Size Scale, Phi Scale, Roundness and Sphericity.

Maturity: Textural, Mineralogical and Chemical

Classification of Sedimentary rocks (Folk's and Dunham's, Okhadas)

Module II **(15 hours)**

Primary sedimentary structures

Depositional, Erosional

Secondary sedimentary structures

Chemical, biogenic

Soft sediment deformations

Module III **(15 hours)**

Clastic Sedimentary Rocks

Sandstones, Breccias and Conglomerates**:**

Textures, Structures, Mineral composition, Textural maturity, Mudrocks:

Structures, Colour, Mineral composition;

Non-clastic Sedimentary Rocks

Limestones and Dolomites:

Textures; Mineralogy; Structures; Diagenesis, Reefs and Palaeoclimate; Dolomites: Dolomitization.

Residual: (Laterite and Bauxite)

Origin and Climate.

Carbonaceous sediments:

Nature and form of organic residues; The Coal series

Practical Course: 1credit
Maximum Marks: 25

- Study and identification of sedimentary rocks w.r.t textures, structures, their classification.
- Study of sedimentary rocks in thin sections
- Exercises in grain size and shape analysis.

List of books recommended for reference

- Blatt H; Tracy R. J and Owens B. E., (2006) Petrology- Igneous Sedimentary and Metamorphic 3rd edition W H Freeman and Company New York.
- Boggs S., (2009) Petrology of Sedimentary rocks (2nd edition), Cambridge University Press.
- Boggs, Jr., (2005) Principles of Sedimentology and Stratigraphy (4 edition), Prentice Hall.
- Colinson, J D & Thompson, (1982) Sedimentary Structures, Allen &Unwin.
- Ehlers G.E. and Blatt H., (1987) Petrology – Igneous, Sedimentary and Metamorphic, CBS Publishers, New Delhi.
- Greensmith, J. (1989) Petrology of the Sedimentary rocks (7th Edition), CBS Publishers, New Delhi.
- Pettijohn F.J., (1984) Sedimentary Rocks (3rd Edition), CBS Publishers, New Delhi.
- Prothero, D. R., and Schwab, F.; (2004) Sedimentary Geology. Macmillan.
- Raymond A L (1995) Petrology-The study of Igneous Sedimentary and Metamorphic rocks.Wm. C. Brown Communications, Inc.; USA.
- Tucker E.M. (2001) Sedimentary Petrology (3rd Edition), Blackwell Science Ltd.

CourseTitle: **STRATIGRAPHY OF INDIA- Part I**
Course Code: **GEL-V.E-9A**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

To understand the stratigraphic units.

To correlate International Geological Time Scale with Indian Stratigraphic Time Scale.

To understand the geology, stratigraphy, fossil content, economic resources of the lithounits from the Peninsular India.

Learning Outcomes

The student will gain knowledge about the stratigraphy and geology of India with emphasis on the Peninsular India which will help in understanding the different episodes on the earth during the geologic past.

Module I **(15 hours)**

Physiographic subdivisions of India and their distinctive characters.

Geology of India

Cratonic provinces of Peninsular India shield: (Dharwar craton/ Singhbhum craton,/Bundelkhand craton/, Aravalli craton,/ Bastar craton) and their economic importance, with emphasis on the Dharwar craton.

Mobile Belts of Peninsular India: Eastern Ghat Mobile Belt, Satpura Mobile Belt, Pandayan Mobile Belt

Module II **(15 hours)**

Gorur Gneiss

Sargur Supracrustals

Dharwar craton: Eastern Dharwar Craton (Deccan Batholith) and Western Dharwar Craton (Peninsular Gneiss)

Greenschist/Greenstone Beltsof Peninsular India:

Dharwar type Greenstone Belt: Dharwar Supergroup: Bababudan Group, Chitradurga Group

Goa Group of rocks

Kolar type greenstone Belt: Kolar

Module III **(15 hours)**

Proterozoic Basins of Peninsular India:

Vindhyan Supergroup;

Cuddapah Supergroup;

Kaladgi Supergroup.

Outline of Bhīma Supergroup, Delhi Supergroup, Kurnool Supergroup

Practical: 1 credit
Maximum Marks: 25

- Study of specimens representing rock formations of Goa.
- Assigning stratigraphy Formations based on fossils.
- Maps related to Indian Geology/ Problems in stratigraphic correlation.

List of books recommended for reference

Mandatory Reading

- Ramakrishnan, M and R Vaidynadhan. 1994, Geology of India, Geological Society of India Publication, Bangalore. Vol. I and II.
- Mascarenhas, A and Kalavampara, G., 2015. Natural Resources of Goa: A Geological Perspective. Geological Society of Goa.
- Dessai, A G 2018. Geology and Mineral resources of goa. New Delhi Publishers

Supplementary Reading

- Nanda, H., 2014, Indian Stratigraphy, Anmol Publications Pvt. Ltd. New Delhi.
- Valdiya. The making of India: Geodynamic evolution. 2010
- Cratons and fold belts of India. R S Sharma. 2009. Springer

Course Title: **PETROLEUM GEOLOGY**
Course Code: **GEL-V.E-10**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

To provide the student essential and basic concepts of Petroleum Geology and to study the process and the operations involved in Petroleum exploration

Learning Outcomes

A student will understand and learn about the basic concepts of Petrology Geology with respect to geology as to enable them to work as a Petroleum Geologist.

Module I **(15 hours)**

Introduction and Aspects of Petroleum Geology, Characteristics of Hydrocarbons (Physical and Chemical properties), Petroleum System, Composition, Origin (Types of Kerogen), Occurrence, Migration and Accumulation of Petroleum; Petroleum traps (Stratigraphic and Structural); Reservoir rocks, conditions & mechanisms.
Functions of Petroleum Geologist
Understanding oil and gas: Exploration, Drilling and Completion, Production, Services

Module II **(15 hours)**

Surface indications and direct detection of Hydrocarbons
Surface and Subsurface exploration techniques: Concept
Geophysical methods of exploration: Gravity and Seismic methods
Types of rigs and its selection
Rotary drilling system and equipment's
Drilling sequence: Coring; Casing and Cementation and Drilling fluids;

Module III **(15 hours)**

GeoLogging and Well logs (Electric, Radioactive and Acoustic);
Formation evaluation and Testing
Well Completion and Stimulation
An outline of the oil belts of the world; Global geographic and stratigraphic distributions of oil and gas;
Important Onshore and Offshore Petroliferous basins of India.
Recent trends in Petroleum Geology.

Practical Course**: 1 credit**
Maximum Marks**: 25**

- Plotting of Petroliferous basins on maps (World and India)
- Problems based on Well log interpretation
- Creation of carbonate isopachous maps
- Interpretation of petroliferous traps using seismic reflectance.
- Problems on mud circulation

- Observations of well cuttings and cores samples
- Demonstration/Determination of porosity

List of books recommended for reference

- Hyne, N J., (2001) Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production, PennWell Corporation.
- Levorsen, A.I., (1967) Geology of Petroleum, W.H. Freeman and Company.
- Morris, J., (1985) Practical Petroleum Geology, The University of Texas at Austin - Petroleum Extension Service.
- North, F.K., 1(986) Petroleum Geology, Allen &UnWin, 607p
- Selley, R.C., (1998) Elements of Petroleum Geology, W.H. Freeman & Company, New York.

Course Title: **METAMORPHIC PETROLOGY**
Course Code: **GEL-V. E-11A**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

To provide essential concepts of metamorphism and metamorphic rocks.
To study metamorphic rocks w.r.t fabrics and types.
To understand the concept of facies.
Also to understand how metamorphism is related to plate tectonics

Learning Outcomes

The student will gain knowledge about the concepts of metamorphism and metamorphic rocks which will strength their knowledge of metamorphic petrology

Module I **(15 hours)**

Definition and explanation of metamorphism (upper and lower limits) and metamorphic rocks.
Factors controlling metamorphism:

Heat (T): Geothermal gradient (in different crustal regions), Radioactivity, magmatic intrusions, tectonics;
Pressure (P): Deviatoric, Lithostatic, Hydrostatic, Fluid pressure
Chemically active fluids (X_f): H_2O and CO_2
Composition of the parent rocks (X): pelites, mafites, ultramafites, quartzofeldspathic, carbonate rocks, sandstones and greywackes.
Time (δt): Role of time in metamorphism.

Phase Rule and Phase diagrams Graphical representation of metamorphic rocks.
Protoliths.
Types of metamorphism: Regional metamorphism its characteristics and products, burial metamorphism its characteristics and products, contact metamorphism its characteristics and products.
Relationship of brittle and ductile deformation with grade of metamorphism metasomatism, cataclastic metamorphism and their products, impact/shock metamorphism.
Metamorphism in relation to plate tectonics:

Divergent(constructive) boundary
Convergent (Destructive) boundary: subduction zone (sensu lato)
Continent-Continent Collision zones
Intra-plate environments

Module II **(15 hours)**

Metamorphic textures: Inherited/Relict fabric lepidoblastic, nematoblastic, granoblastic, equigranular mosaic, Porphyroblastic; cataclastic and mylonitic textures.

Kinematic stress indicators and their role in interpreting tectonic history

Nomenclature and classification based on mineralogy and fabric

Field characters of metamorphic rocks:

Variations in mineralogy and fabric. Prograde and Retrograde metamorphism metamorphic zones and index/critical minerals, their significance in mapping and understanding tectonic history.

Module III **(15 hours)**

Facies: Concept after Goldschmidt and Eskola; Zonation in mineralogy – Buchanan (Low pressure) Barrovian (high pressure).

Facies of progressive contact metamorphism: characteristic mineral assemblages in pelites and carbonates (pure and impure) protolith

Facies of progressive regional metamorphism – characteristic mineral assemblages wrt facies (Zeolite, Prehnite-Pumpellyite, Greenschist, Amphibolite, Granulite,) in pelitic, mafic protolith.

Facies of burial metamorphism: Blueschist, Eclogite

Paired Metamorphic Belts

Practical Course: **1 credit**
Maximum Marks: 25

- Megascopic study and identification of metamorphic rocks w.r.t mineralogy, texture, type of metamorphism, facies, protolith.
- Microscopic study and identification of metamorphic rocks wrt to mineralogy, texture type of metamorphism, facies and protolith.
- Plotting ACF diagrams and commenting on the protolith.

List of books recommended for reference
Mandatory Reading

- Winter J D., (2011) Principles of Igneous and Metamorphic Petrology. PHI Learning Pvt. Ltd.
- Winkler, G. F., (1987) Petrogenesis of Metamorphic rocks 5th edition Narosa Publishing House, New Delhi.
- Yardley, B W. D., (1989) An introduction to Metamorphic Petrology, Longman Group Publishers Pvt. Ltd.
- Turner, F., (1980) Metamorphic Petrology: Mineralogical, Field and Tectonic Aspects, CRC Press.
- Vernon, R H. and Clarke, G.L., (2008) Principles of Metamorphic Petrology, Cambridge University Press
- Best, M., (2003). Igneous and Metamorphic Petrology, Blackwell Publishing.

- Raymond, A. L., (1995) Petrology-The study of Igneous Sedimentary and Metamorphic rocks. Wm. C. Brown Communications, Inc.; USA.

Supplementary Reading

- Ernst, W G and Rumble D., (2008) Metamorphic Conditions along Convergent Plate Junctions: Mineralogy, Petrology, Geochemistry and Tectonics, Geological Society of Amer.
- Frost B R and Frost C D., (2014) Essentials of Igneous and Metamorphic Petrology, Cambridge University Press.
- Miyashiro, A., (1994) Metamorphic Petrology, CRC Press.
- Miyashiro, A, (1978) Metamorphism and Metamorphic belts, The Greshman Press Old Woking, Surrey
- Philpotts, A & Ague, J (2010) Principles of Igneous and Metamorphic Petrology. Cambridge University Press, New York
- Roger, M., (1990). Petrology of the Metamorphic Rocks.Unwin Hyman Ltd, UK
- Blatt, H; Tracy R. J and Owens B. E., (2006) Petrology- Igneous Sedimentary and metamorphic 3rd edition W H Freeman and Company New York.
- Bucher, K and Grapes, R., (2010) Petrogenesis of Metamorphic rocks, Springer-Heidelberg Dordrecht, London NY.

Course Title: **REMOTE SENSING AND DIGITAL IMAGE PROCESSING**
Course Code: **GEL-V.E-12**
Credits: **3 (45 Contact hours)**
Marks: **75**
Mandatory requirement: **Individual Laptop with MS Windows OS**

Learning Objectives

This course is designed as an introduction to the use of remote imaging in geologic applications. The basic concepts of image production, processing and interpretations are covered. This course also introduces the basic principles and techniques of Geographic information Systems (GIS)

Learning Outcomes

Student will be able to:

- Explain remote sensing basic principles, purposes, advantages and limitations.
- Define and describe basics of electromagnetic spectrum and interactions with various types of media.
- Describe basic characteristics of remote sensing imagery
- Describe sensors and image acquisition methods.
- Understand the application of digital imagery for interpretation of lithology, structure and geomorphology.
- Develop a working knowledge of GIS software (QGIS)
- Prepared for further study in GIS

Module I **(15 hours)**

Energy Sources and Radiation Principles.
Electromagnetic Spectrum
Energy interactions in the Atmosphere: Scattering, Absorption.
Atmospheric windows
Energy interactions with earth surface features: Spectral Reflectance of rock, Soil water, and vegetation.
Photo recognition elements
The concept of resolution: Spatial, Spectral, Temporal and Radiometric.
Space Borne Imaging Systems- The Landsat, IRS, SPOT and High resolution Land Satellites (the characteristics of these satellites- orbits, sensors, and their resolutions)
Multispectral remote sensing and hyper spectral remote sensing

Module II **(15 hours)**

Concept of Digital numbers
Georeferencing
Image Rectification and Restoration.
Image Enhancement.: Low and high pass filter, directional filters
Contrast Manipulation.

Spatial Feature Manipulation.
Multi-Image Manipulation.

Module III **(15 hours)**

Image Classification: Unsupervised and Supervised Classification.
Supervised Classification:
    The Training Stage.
    The Classification Stage: Minimum-Distance to Means Classifier, Gaussian Maximum Likelihood Classifier.
Classification Accuracy Assessment and ground truth verification
Raster to vector conversions
Elements of GIS, Point, line, polygon, layers
Integration with Remote Sensing and GIS

Practical Course: 1 credit
Maximum Marks: 25

- Interpretation of Satellite Imagery for – landforms, geological structures, rock and soil types, man-made structures.
- Data Products and Meta data
- Digital Image Processing (using number matrix): enhancement, manipulation and classification.
- Digital image processing on Computer (demonstration)

List of books recommended for reference

- Burrough, P. A. and McDonnell, R. A., (2000) Principles of Geographical Information System, Oxford University Press.
- Gupta, R P., (2003) Remote Sensing Geology. Springer-Verlag
- C.P.Lo and Albert K. W. Yeung., (2002) Concepts and Techniques of Geographic Information System, Prentice –Hall, India.
- Drury, S.A., (1993) Image Interpretation in Geology, 2nd ed., Chapman and Hall, London.
- George Joseph., (2005) Fundamentals of Remote Sensing, University press Private Ltd, Hyderabad.
- Harold, R W., (1969) Aerial Stereo Photographs, Hubbard Press, USA.
- Heywood I, Sarah, Cornelius, Steve, Carver.,(2011) An Introduction to Geographical Information Systems, Pearson Education Pvt. Ltd., New Delhi.
- Jensen John R., (2000) Remote Sensing of the Environment – An Earth Resource perspective, Pearson Education Series, Low Price Edition.
- Kang – Tsung – Chang.,(2002) Introduction to Geographical Information System, , McGraw Hill.
- Lillesand T.M. and Kiefer R.W., (2002) Remote Sensing and Image Interpretation, John Wiley and Sons, New Delhi.
- Lillesand, T. M., Ralph W. Kiefer and Jonathan W. Chapman., (2004) Remote Sensing and Image Interpretation, 5thed, Wiley.
- Mather Paul M., (2004) Computer Processing of Remotely Sensed Images- An Introduction, 3rd ed., John Wiley.
- Narayan L.R.A. (1999) Remote Sensing and its Applications., Universities Press.
- Ramasamy S.M., (2005) Remote Sensing in Geomorphology, New India Publishing Agency.

- Schowengerdt Robert A., (2006) Remote Sensing – Models and Methods for Image Processing, 2nd ed., Elsevier (Academic Press).

Online resources

- T. Sutton, O. Dassau, M. Sutton, A Gentle Introduction to GIS, Chief Directorate: Spatial Planning & Information, Department of Land Affairs, Eastern Cape, South Africa (ebook)

http://download.osgeo.org/qgis/doc/manual/qgis-1.0.0_a-gentle-gis-introduction_en.pdf

- QGIS Tutorials http://www.dst-iget.in./

SEMESTER VI

Course Title: **IGNEOUS PETROLOGY**
Course Code: **GEL-VI.C-8A**
Credits: **3 (45 Contact hours)**
Marks: **75**

Learning Objectives

The course will help the students to understand petrologic processes and common rock types. In practical's, students learn to identify, describe and classify rocks using hand specimens and rock thin sections.

Learning Outcomes

On completion of the course the students:

Will have gained an understanding of the processes involved in the formation of igneous rocks, their textures, structures, classifications and their importance.

Will have learned the composition, properties and genesis of different rock types.

Module I **(15 hours)**

Meteorites: Mineralogy and whole rock chemistry

Composition of the earth's interior = Primitive mantle Plate tectonics and igneous activity

Partial Melting and Generation of magma.

Magma Diversity:

- Partial Melting: Mafic
  Ultramafics, Basalts: Magma types, Basalt Tetrahedron.
  Anatexis: Felsic
  Granites/Pegmatites: Mingling, Mixing and Crustal contamination
- Igneous layering - crystal settling
  Gabbroic rocks, Anorthosite, Layered complexes Differentiation: Fractional Crystallization, liquid immiscibility, flowage differentiation

Module II **(15 hours)**

Ascent and emplacement of magma

Textures and microstructures of igneous rocks:

a. Primary: Nucleation, Growth, Diffusion
b. Secondary: Oswald ripening, twinning, zoning

Classification and Description of Igneous Rocks:

The International Union of Geological Sciences (IUGS) Classification System:

Gabbros, Granites (QAPF diagram).

Ternary diagram: Diopside-Albite-Anorthite (Di-Ab-An)

Module III **(15hours)**

Study of the following rock types (mineralogy, petrography and petrogenesis)

Ophiolites
Granitoids
Carbonatites
Kimberlites

Practical: 1 credit

Maximum Marks: 25

- Study of igneous rocks in hand specimen.
- Study of igneous rocks in thin sections
- CIPW Normative calculations

List of books recommended for reference

Mandatory reading

- Winter, J.D., (2009) Principles of Igneous and Metamorphic Petrology, Prentice Hall
- Gill, R., (2010)Igneous rocks and process – A Practical Guide, Wiley-Blackwell
- Frost B R and Frost C D., (2014) Essentials of Igneous and Metamorphic Petrology, Cambridge University Press.

Supplementary reading

- Best, M.G., (2002) Igneous and Metamorphic Petrology, 2nd edn., Blackwell, Oxford.
- Bose, M.K., (1997) Igneous Petrology, The World Press, Kolkata.
- MacKenzie, W. S., Donaldson, C H., and Guilford, C., (1982) Atlas of Igneous Rocks and Their Textures, Wiley
- Raymond, A. L., (1995) Petrology-The study of Igneous Sedimentary and Metamorphic rocks. Wm. C. Brown Communications, Inc.; USA.

Course Title: **STRATIGRAPHY OF INDIA- Part II**
Course Code: **GEL-VI.E-13A**
Credits: **3 (45 contact hours)**
Marks: **75**
Prerequisite:**GEL-V.E-9A**

Course Objectives

The course will help understanding the Indian stratigraphic units and to correlate International Geological Time Scale with Indian Stratigraphic Time Scale. Also to understand the geology, stratigraphy, fossil content, economic resources of the lithounits from the Phanerozoic Eon from the Indian context.

Learning Outcomes

The student will gain knowledge about the stratigraphy and geology of India with emphasis on the Stratigraphy of India wrt Paleozoic, Mesozoic and Cenozoic Era which will help in understanding the different episodes on the earth during the geologic past.

Module I **(15 hours)**

Precambrian-Cambrian boundary
Cambrian Tal
Muth Quartzites
Gondwana sedimentation: Peninsular, Extra-Peninsular
Permian-Triassic boundary

Module II **(15 hours)**

Jurassic of Kutch
Cretaceous of Trichinopoly
Deccan Flood Basalt (Age and Stratigraphy)
Cretaceous-Paleocene boundary

Module III **(15 hours)**

Tertiaries of Assam
Rise and evolution of Himalayas
Siwaliks
Pleistocene-Holocene Boundary
Plant and animal life in relation to glacial and interglacial cycles during Quaternary.
Recent: Laterite Formations of Goa

Practical Course**: 1 credit**
Maximum Marks**: 25**

1. Preparation of lithostratigraphic maps of India showing distribution of important geological formations.
2. Study of type hand specimens from their stratigraphic position and age.
3. Stratigraphic map of Goa

List of books recommended for reference

- Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley.
- Ramakrishnan, M and Vaidynadhan, R., (1994) Geology of India, Geological Society of India Publication, Bangalore. Vol. I and II.
- Nanda, H., (2014) Indian Stratigraphy, Anmol Publications Pvt. Ltd. New Delhi.
- Nichols, G., (2009) Sedimentology and Stratigraphy, Wiley-Blackwell and Sons Ltd.
- Sharma, R S., (2009) Cratons and Fold belts of India, Springer-Verlag Berlin Heidelberg.
- Valdiya, K. S., (2010). The Making of India, Macmillan India Pvt. Ltd.

Course Title: **ROCK STRUCTURES AND DEFORMATION MICROSTRUCTURES**
Course Code: **GEL-VI. E-14A**
Credits: **3 (45 Contact hours)**
Marks: **75**
Prerequisite:**GEL-V.E-11A**

Learning Objectives

The course will help to study deformational history of rocks. This study includes the understanding of the deformation and metamorphic processes the rock has undergone with the aim to reconstruct its structural and metamorphic history.

Learning Outcomes

On completion of the course the students:

Will understand the process of deformation and its resulting features.

It will enhance their application of skills in understanding deformation history and tectonics in field and in microsections..

Module I **(15 hours)**

Introduction to microstructures and terminology; Deformation mechanisms and processes– Brittle fracturing, Dissolution, Intracrystalline deformation; Twinning and kinking; Recovery; Recrystallization; Solid state diffusion, Grain Boundary Area Reduction (GBAR), Static recrystallization.

Module II **(15 hours)**

Foliation and its significance; Lineation and its significance; Mylonites, Shear sense indicators in mylonites; Strain shadows; Deformation of rock-forming minerals; Deformation of polymineralic rocks.

Module III **(15 hours)**

Microstructures of – igneous rocks (porphyritic rocks, mineral intergrowth, zoning); sedimentary rocks (sandstone); metamorphic rocks (isotropic fabrics, growth of porphyroblasts, twinning, sympectite intergrowth) and deformed rocks (deformation twinning, stylolites, GBM), fossils as strain markers

Practical Course:1 credit
Maximum Marks: 25

Study of rock slides exhibiting various microstructures:

- Cuspate and lobate sutured boundaries,
- GBAR (Grain Boundary Area Reduction),
- Bulging (BLG), Subgrain Rotation (SGR); Grain boundary migration (GBM)

- Deformation twins and Displaced twin lamellae
- Bending of cleavage planes, spaced and continuous cleavage
- Mineral (mica) fish,
- Porphyroclasts, asymmetric porphyroclasts depicting shear sense,
- Pressure shadows,
- Warping of foliation around porphyroclasts,
- S-C fabric.

List of books recommended for reference

Mandatory reading

- Vernon, R H., (2004) A Practical Guide to Rock Microstructures, Cambridge University Press.
- Winter, J D., (2014) Principles of Igneous and Metamorphic Petrology, Pearson Education Limited.
- Blenkinsop, T. (2002) Deformation microstructures and mechanisms in minerals and rocks, Kluwer Academic Publishers.
- Passchier, C. W and Trouw, R A., (2005) Microtectonics, Springer-Verlag Berlin Heidelberg
- Trouw, R A., Passchier, C W and Wiersma, D J., (2010) Atlas of Mylonites - and related microstructures, Springer-Verlag Berlin Heidelberg

Supplementary Reading

- Mukherjee, S., (2013) Deformation Microstructures in rocks. Springer-Verlag Berlin Heidelberg.

Course Title: **SURVEYING AND FIELD GEOLOGY**
Course Code: **GELVI.E-15**
Marks: **75**
Credits: **3 (45 Contact hours)**

Course Objectives

To Provide basic knowledge of surveying techniques

To upgrade and relate the theoretical knowledge of Geological aspects to field observations.

Learning Outcomes

Students will be expected to understand how preliminary surveys are carried out especially in mining areas.

They would be trained to work independently in the field of geology.

Module I **(15 hours)**

Surveying, Objectives of Survey;

Primary divisions of Surveying – Geodetic and Plane Surveys uses and Principles of Surveying.

Methods of locating a point

Plane Table Survey: Instruments, Procedures of Plane table surveys; Methods (Demonstrative): Radiation and Intersections, advantages and disadvantages of Plane Tabling.

Module II **(15 hours)**

Levelling, characteristics of land surveying instruments, Bench Marks, Change Points.

Levelling operations and steps in Levelling: Demonstration with exercises in the field.

Principles of Levelling: Simple and Differential,

Reduction of Levels: The Collimation, and Rise and Fall systems of Computation.

Theodolite survey: Principles and working,

Module III **(15 hours)**

SOI Toposheet Indexing scheme, Map symbol reading SOItoposheet map reading

Standard Symbols/colour for lithology and symbols related to structures

Munsell colour chart

Understanding map reliability

GPS surveys

Geological mapping

Basic field gear

Planning a field Project: Preparations for the field, Taking geologic notes in the field: Basic procedures at outcrops – noting characters of igneous, sedimentary and metamorphic rocks, Measuring strike and dip (attitude) of planar and linear features using a clinometer compass, a Brunton Compass.

Practical course: 1 credit
Maximum Marks: 25

- The evaluation is to be based on preparation of portfolio that should include plans drawn using Plane table, a Levelling Exercise.
- Assessment to be based on presentation of Field diary, Field report, and field based viva voce on the localities visited for field work.

List of books recommended for reference

Mandatory reading

- Compton, R R., (1985) Geology in the Field, John Wiley & Sons, Inc.
- Compton, R R., (1962) Manual of Field Geology, John Wiley & Sons, Inc.
- Gokhale, N W., (2001) A Guide to Field Geology, CBS Publishers & Distributors.
- Kanetkar, T P & Kulkarni, S V., (1988) Surveying & Levelling (Part I), Pune VidyarthiGrihaPrakashan.
- Lahee, F H. (1962) Field Geology, McGraw – Hill Book Company, Inc.
- Lambert, D A., (1998) Field Guide to Geology, Facts on File Inc.
- Lisle R., Brabham P and Barnes J., (2011) Basic Geological Mapping (Geological Field Guide), Wiley Blackwell.
- Basak, N N., (2014) Surveying and Levelling, McGraw Hill Education.

Supplementary reading

- Arora, K R., (2015) Surveying Vol-2 (13th edition). Standard Book House Unit of Rajsons Publication Pvt. Ltd.
- Barnes, J W and Lisle, R J., (2004) Basic Geological Mapping, John Wiley and Sons
- Coe, A, L., Argles, T W., Rothery, D A and Spicer, R A., (2010) Wiley-Blackwell, The Open University.
- McClay, K R., (2007) The Mapping of Geological Structures, John Wiley and Sons.
- Penning, W H. and Jukes-Browne., (2011) A Textbook of Field Geology, Nabu Press.
- Robinson W F and Tallack., (2016) Surveying and Levelling Instruments Theoretically and Practically Described for construction, Qualities, Selection, Preservation, Adjustments and Uses: With other apparatus and Appliances used by Civil Engineers and Surveyors in the Field, Wentworth Press.

Course Title: **PRINCIPLES OF GEOPHYSICAL EXPLORATION AND MINING**
Course Code: **GEL-VI.E-16A**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

Mining being a key source of revenue generation for the Central as well as State governments, and an important job provider for Geologists, this course is designed to equip the undergraduate student with basic knowledge of key concepts of mining processes right from exploration to exploitation, together with an acquaintance of government regulations that control the mining and mineral conservation processes. In Geophysical exploration the student will gain first-hand knowledge dealing with the principles and their significance.

Learning Outcomes

By the end of this course the student will have learnt about techniques of mineral exploration and exploitation, estimation of ore reserves, environmental impact of mining, and the importance of conservation of mineral resources, thereby partly equipping himself/herself on the way to becoming a mining geologist.

Module I **(15 hours)**

Mining Terminology
Classification of mining methods.
Factors influencing choice of mining method

- Open cast mining
- Underground mining
  - Coal mining methods
  - Alluvial mining

Ore Dressing or Beneficiation:

- Principles and methods
- Terminology of quantification of results

Environmental Impact of Mining
Brief outline of:

National Mineral Policy
Regulations and Acts
Regulating Agencies

Module II **(15 hours)**

Mineral Exploration: Sequence and phases

- Float ores and In situ ores
  - Pits, Trenches and Boreholes
    - Spacing
    - Drilling:

- Core and non-core drilling
- Equipment and accessories
- Core drill sampling
- core splitting
- logging
- Storage
- Sludge
- Combining Assay returns from sludge and core

Categories of reserves
Estimation of reserves

- Cross-sectional method
- Area of influence method
- Triangular method
- Weighted volume estimate method
- Estimation of stockpiles by prismoidal formula

Module III **(15 hours)**
Methods of Exploration: Geobotanical, Geochemical and Geophysical.
Geophysical Methods:

Self-potential method:, mechanism, equipment, interpretation of anomalies.

Gravity surveying:, , Gravity surveying, Interpretation

Magnetic surveying:, concepts, Rock magnetism, Geomagnetic field, Magnetic anomalies, Instruments used, Corrections, Interpretation, Application.

Practical Course**: 1 credit**
Maximum Marks: **25**

- Drawing cross - and longitudinal sections using bore-hole data
- Problems based on estimation of ore reserves
- Interpretation of bouguer gravity anomaly maps, and magnetic data.
- Core logging

List of books recommended for references

- Arogyaswamy, R. N. P., (1973) Courses in Mining Geology, Oxford & IBH Publishing Co.
- Babu S. K. & Sinha D. K., (1988) Practical Manual of Exploration and Prospecting, CBS Publishers and Distributors, New Delhi.
- Keller, E. A., (2011) Environmental Geology, Pearson Prentice Hall.
- McKinstry H. E., (1948) Mining Geology, Prentice-Hill Inc.
- Marjoribanks, R., (1997) Geological Methods in Mineral Exploration and Mining, Springer-Science+Business Media
- Peters, W C., (1987) Exploration and Mining Geology, Wiley
- Sharma J. P., (2009) Environmental Studies, Laxmi Publications (P) Ltd, New Delhi.

- Sinha, R. K & Sharma N. L., (1970) Mineral Economics, Oxford & IBH Publishing Co.
- Indian Bureau of Mines (IBM) Publications.
- Bhimasarikaram V.L.S., (1990) Exploration Geophysics - An Outline by Association of Exploration Geophysicists, Osmania University, Hyderabad.
- Dobrin, M B and Savit C H., (1988) Introduction to Geophysical Prospecting, McGraw Hill Inc.
- Lowrie, W., (2007) Fundamentals of Geophysics. Cambridge University Press.
- Ramachandra Rao and Prasaranga, M B, (1975) Outlines of Geophysical Prospecting - A Manual for Geologists by University of Mysore, Mysore.
- Telford, W. M., Geldart, L. P., and Sheriff, R. E., (1990) Applied geophysics (Vol. I) Cambridge University Press.

ANNEXURE I

Parvatibai Chowgule College of Arts and Science, Margao- Goa (Autonomous)

DEPARTMENT OF GEOLOGY

THREE YEAR B.Sc. DEGREE PROGRAMME IN GEOLOGY
(Revised & implemented June, 2019)

ANNEXURE II

COURSE STRUCTURE FOR SEMESTER I, III & V

Semester	CORE COMPULSORY		CORE ELECTIVES			
I	**GEL-I.C-1** Fundamentals of Mineralogy	**GEL-I.C-2A** Earth's Dynamics and Tectonics				
III	**GEL-III.C-5A** Advanced Mineralogy and Geochemistry		**GEL-III.E-1** Physical Geology	**GEL-III.E-2** Groundwater and Hydrogeology	**GEL-III.E-3A** Ore Genesis	**GEL-III.E-4** Marine Geology
V	**GEL-V.C-7** Sedimentary Petrology		***GEL-V.E-9B*** *Precambrian Stratigraphy of India*	**GEL-V.E-10** Petroleum Geology	**GEL-V.E-11A** Metamorphic Petrology	**GEL-V.E-12** Remote Sensing and Digital Image Processing

COURSE STRUCTURE FOR SEMESTER II, IV & VI

Semester	CORE COMPULSORY		CORE ELECTIVES			
II	**GEL-II.C-3A** Elementary Petrology	**GEL-II.C-4** Principles of Stratigraphy & Palaentology				
IV	**GEL-IV.C-6** Structural Geology		**GEL-IV.E-5A** Engineering Geology	**GEL-IV.E-6A** Optical Mineralogy	**GEL-IV.E-7** Natural Hazards and Management	**GEL-IV.E-8** Geotectonics
VI	**GEL-VI.C-8A** Igneous Petrology		***GEL-VI.E-13B*** *Phanerozoic Stratigraphy of India*	**GEL-VI.E-14A** Rock Structures and Deformation Microstructures	***GELVI.E-15A*** *Surveying, Mapping and Field Geology*	**GEL-VI.E-16A** Principles of Geophysical Exploration and Mining

Course Structure and List of Core and Elective Courses

COMPONENT A

SEMESTER	CORE COURSES		ELECTIVE COURSES			
I	**GEL-I.C-1** Fundamentals of Mineralogy	**GEL-I.C-2A** Earth's Dynamics and Tectonics	-----	-----	-----	-----
II	**GEL-II.C-3A** Elementary Petrology	**GEL-II.C-4** Principles of Stratigraphy and Paleontology	-----	-----	-----	-----
III	**GEL-III.C-5A** Advanced Mineralogy and Geochemistry		**GEL-III.E-1** Physical Geology	**GEL-III.E-2** Groundwater and Hydrogeology	**GEL-III.E-3A** Ore Genesis	**GEL-III.E-4** Marine Geology
IV	**GEL-IV.C-6** Structural Geology		**GEL-IV.E-5A** Engineering Geology	**GEL-IV.E-6A** Optical Mineralogy	**GEL-IV.E-7** Natural Hazards and Management	**GEL-IV.E-8** Geotectonics
V	**GEL-V.C-7** Sedimentary Petrology	**GEL-V.CP** Core Project	**GEL-V.E-9B** Precambrian Stratigraphy of India	**GEL-V.E-10** Petroleum Geology	**GEL-V.E-11A** Metamorphic Petrology	**GEL-V.E-12** Remote Sensing and Digital Image Processing
VI	**GEL-VI.C-8A** Igneous Petrology	**GEL-VI.CP** Core Project	**GEL-VI.E-13B** Phanerozoic Stratigraphy of India	**GEL-VI.E-14A** Rock Structures and Deformation Microstructures	**GELVI.E-15A** Surveying, Mapping and Field Geology	**GEL-VI.E-16A** Principles of Geophysical Exploration and Mining

Core Courses for students offering **Geology as the Minor**

SEMESTER I GEL-I.C-1: FUNDAMENTALS OF MINERALOGY
SEMESTER II GEL-II.C-3A: ELEMENTARY PETROLOGY
SEMESTER III GEL-III.C-5A: GEOCHEMISTRY AND SYSTEMATIC MINERALOGY
SEMESTER IV GEL-IV.C-6: STRUCTURAL GEOLOGY
SEMESTER V GEL-V.C-7A: SEDIMENTARY PETROLOGY
SEMESTER VI GEL-VI.C-8A: IGNEOUS PETROLOGY

ANNEXURE I

REVISED SYLLABUS OF THE UNDERGRADUATE DEGREE PROGRAMME IN GEOLOGY FOR SEMESTERS I, II, III, IV, V AND VI

(IMPLEMENTED FROM JUNE 2019 ONWARDS)

B.Sc. in Geology
PROGRAMME OUTCOMES

Programme Outcomes (PO)	**Short Title of the POs**	**Description of the Programme Outcomes** **Graduates will be able to :**
PO-1	Problem Analysis and Solutions	Think critically, identify, analyze problems/ situations and further attempt to design/ develop solutions that meet the specified goals.
PO-2	Use of Technology	Apply appropriate IT tools efficiently in their daily life- professional and personal.
PO-3	Environment and Sustainability	Be aware of environmental issues and commit towards sustainable development at local/ national and global context.
PO-4	Ethics	Recognize and understand professional ethics /human values and be responsible.
PO-5	Individual and Team work	Function effectively at various levels, capacities and situations.
PO-6	Communication	Communicate proficiently (oral and written) as a responsible member of society.
PO-7	Research Aptitude	Understand general research methods and be able to analyse, interpret and derive rational conclusions.
PO-8	Life Skills	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of domain specific change.

PROGRAMME SPECIFIC OUTCOMES (PSO)

After successful completion of a Bachelor's degree in Geology, the students will be able to :

PSO-1	Explain the theoretical concepts involved in courses like Mineralogy, Petrology and Structural Geology.
PSO-2	Apply theoretical concepts involved in mineral forming to confidently identify them in hand as well as in thin sections.
PSO-3	Analyse the theoretical concepts and apply them in interpreting the various petrographic features in rocks exhibited in hand specimens and in thin sections.
PSO-4	Create, analyse and interpret structural geological maps.
PSO-5	Make good field observations during field excursions and relate their understanding of various structural and petrological features learnt in classroom for correct interpretation.
PSO-6	Communicate confidently and write geological reports.
PSO-7	Demonstrate content knowledge appropriate to professional career goals

SEMESTER
I

Course Title: **FUNDAMENTALS OF MINERALOGY**
Course Code: **GEL-I. C-1**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives
As minerals are building blocks of earth's material, the course is designed to understand the basic concepts in mineralogy, their chemistry and identification of minerals in hand specimens. Further, the students will study crystallography in understanding the morphology, symmetry and the normal crystal classes.

Course Outcomes
Upon completion of the course, the student will be able to,

CO1 Understand what is a mineral and its formation.

CO2 Explain mineralogical properties like polymorphism, isomorphism, Pseudomorphism.

CO3 Describe the physical properties of minerals.

CO4 Relate crystal chemistry and chemical bonding to the formation of minerals like crystal structure, chemistry, chemical composition.

CO5 Compare and contrast the elemental and major oxide composition of the crust with the entire earth.

CO6 Link how the internal atomic structure of minerals affects the external development of a crystal in terms of crystal symmetry, crystal system and crystal forms.

CO7 Identify rock- forming minerals in hand specimen using their physical properties.

CO8 Classify minerals into crystal systems based on crystal symmetry.

Module I **(15 hours)**
Minerals: Rock-forming minerals and ore minerals.
Common physical properties of minerals including electrical and magnetic properties.
Isomorphism, Polymorphism, Pseudomorphism
silicate structures: (sorosilicate/ cyclosilicates/ nesosilicates/ inosilicate/ phyllosilicates/ tectosilicate)
Introduction to rock-forming mineral Olivine, Pyroxene, Amphibole, Mica, Feldspar, Quartz and its varieties
Important and abundant mineral groups: aluminosilicates, sulfides, sulfates, carbonates; oxides; halides; native metals (with three examples each)

Module II **(15 hours)**

Elemental and major oxide composition of the earth's crust -
Types of Atomic bonds (Ionic/Covalent/Metallic/ Van der Waal).
Radius Ratio, Ionic Radius,
Co-ordination Number. Types of co-ordination.
Atomic arrangement (HCP/CCP)

Module III **(15 hours)**

Space lattice. Unit cell. External morphology of a crystal. Crystal Forms with examples.
Crystallographic axes and Crystal systems.
Symmetry in crystals. (Axis, Plane, Center)
Interfacial angles and Contact Goniometer.
Parameters and Indices

Practical: 1 credit

Maximum Marks: 25

1. Identifying and determining the crystal symmetry, class, system and forms in the normal class of the six systems.
2. Identification and study of minerals w.r.t their physical properties, occurrence, chemical composition and use.

List of books recommended for reference

Mandatory Reading

- Perkins, D., (2015), Mineralogy, Pearson Education Limited.
- Dana, J.D & Ford, W. E., (2010). Dana's Manual of Mineralogy. J. Wiley & Sons.
- Klein, C. and Dutrow, B., (2007). The Manual of Mineral Science, John Wiley & Sons, Inc.
- Read, H. H., (1988). Rutley's elements of Mineralogy, CBS Publications.
- Battey, M H. (1971), Mineralogy for students, Oliver & Boyd

Supplementary Reading

- Deer, W. A., Howie, R. A & Zussman, J., (2013). An Introduction to the rock forming minerals, John Wiley and Sons.

Course Title: **EARTH'S DYNAMICS AND TECTONICS**
Course Code: **GEL-II. C-2A**
Credits: **3 (45 contact hours)**
Marks: **75**

Course Objectives

This is a core branch of earth science which deals with basic concepts of natural internal forces shaping the earth. Earth's Dynamics and Tectonics aims at acquainting the student with these forces as well as the geological structures resulting from the action of these forces on rocks. The course also aims at providing an understanding of the processes in action on the earth's surface and their impact on man and his institutions.

Course Outcomes

Upon completion of the course, the student will be able to:

CO1 Understand the origin and nature of the earth and its layered structure.

CO2 Gain insights into the spheres of the earth and their inter-relationship, the earth's Gravity, and magnetic field.

CO3 Relate the concept of Isostacy with plate tectonics.

CO4 Differentiate between the different types of forces acting in the lithosphere and link the different types of responses of brittle and ductile substances to stress.

CO5 Understand the exogenous and endogenous geological hazards.

CO6 Read and interpret geological maps and draw geological cross – sections.

CO7 Recognize different types of folds, faults and joints.

Module I **(15 hours)**

Origin of Solar System (Nebular Concept) and formation of a layered Earth.
Size and shape of the Earth.
Internal structure of the Earth: Geosphere asthenosphere, lithosphere, hydrosphere, biosphere, atmosphere (anoxic to oxic conditions) wrt to earth dynamic
Earth's Gravity : Acceleration due to gravity, change with latitude and altitude.
Earth's Magnetism: Earth as a magnet; lines of force, Source of Earth's Magnetic field, Declination and inclination, Geomagnetic axis and Geographic axis.

Module II **(15 hours)**

Introduction to Plate Tectonics:
Concept of isostacy
Lithostatic or confining pressure, Differential forces: tension, compression, couple.
Concept of stress and strain: stages of deformation: Elastic, Plastic and Rupture.

Brittle and ductile substances.
Introduction to geological hazards: exogenous (floods, drought and cyclones) and endogenous (volcanic hazards, earthquakes and tsunamis, mass wasting)

Module III **(15 hours)**
Map and Scales
Stratification, Strike and dip (true and apparent dip) strike and dip symbols.
Outcrop patterns of Horizontal, Inclined & vertical strata on various types of grounds (horizontal ground, valley and spur).
Folds: Terminology, causes, types of folds; symmetrical, asymmetrical, overturned, recumbent, isoclinal, fan, chevron, monocline, structural terrace, plunging and non-plunging; significance. Outcrop pattern of folds on horizontal ground, valley and spur.
Faults: Definition & terminology, geometric classification, significance; horst and graben.
Joints: Geometric classification, map symbols, columnar joints and sheet structure, significance.
Unconformities: Stages of development, types, significance; outliers and inliers; overlap and offlap.

Practical: 1 credit
Maximum Marks: 25

1. Drawing cross-section and description of structural maps involving single series (Horizontal and Inclined)
2. Graphical solution to structural problems.

List of books recommended for reference
Mandatory reading

- Travis, H., 2012. Living with Earth, Phi Learning Pvt. Ltd., New Delhi.
- Press, Siever, Grotzinger and Jordan., 2003. Understanding the Earth (4th edition).
- Charles C. Plummer and David McGeary., 2001. Physical Geology, (4th edition), Wm C. Brown Publishers.
- Monroe and Wicander., 2001. The Changing Earth: Exploring Geology and Evolution (3rd edition).
- Jain, A K .,Structural geology, , Geological Society of India.
- Holmes' Principles of Physical Geology edited by P.McL.D.Duff (ELBS).
- Hils, E. S., Elements of Structural Geology, Methuen.
- Mukerjee. P. K., A Textbook of Geology, World Press.

Supplementary Reading

- Zumberge J.H. & Nelson C.A., Elements of Geology (3rd edition), John Wiley & Sons, New York.

SEMESTER II

Course Title**: ELEMENTARY PETROLOGY**

Course Code: **GEL-I.C-3A**
Marks: **75**
Credits: **3** (**45 contact hours)**

Course Objectives

Petrology is the science of rocks. The course will help the students to exhibit an improved understanding of fundamental petrologic processes and common rock types. In practicals, students learn to identify, describe and classify rocks using hand specimens.

Course Outcomes

On completion of the course the students will be able to:

CO1 Understand the processes involved in the formation of rocks, their textures and structures.

CO2 **C**lassify rocks into their various types – Igneous, Sedimentary or Metamorphic.

CO3 Understand the importance of rocks.

CO4 Differentiate between the different rock types based on their textures, structures and mineralogy.

CO5 Identify the different textures and structures of rocks.

CO6 Describe the mineralogy and properties of, and identify common rock types.

Module I **(15hours)**

- Rocks and rock cycle
    - Magma: Definition, formation, composition,
        - Properties: temperature, density, viscosity
        - Bowen's Reaction Series
    - Mode of occurrences of Igneous rocks
    - Plutonic: Batholiths (stocks, bosses and roof - pendants), Multiple and Composite intrusions.
    - Hypabyssal: Dykes (Radiating, Arcuate, Ring dykes,), Sills, Laccoliths, Lopoliths
    - Extrusive forms: pyroclastics, lava flows and Volcanic necks,
    - Central and Fissure type of eruptions
    - Structures of Igneous rocks : layering, flow banding
    - Textures of Igneous rocks aphanitic (glassy), : phaneritic: porphyritic, poikilitic, ophitic, sub ophitic; holocrystalline
        - Classification: Based on chemical composition (TAS diagram)

Module II **(15 hours)**

Weathering (, types – Chemical and Physical, and products), Erosion, Transportation and Deposition
Diagenesis
Udden-Wentworth classification based on grain size
Sedimentary structures: Primary (stratification), chemogenic and biogenic
Textures: clastic and non clastic
Sedimentary environments: aeolian, fluvial, glacial and marine

Module III **(15 hours)**

Factors controlling metamorphism.
Types of metamorphism: burial, regional and contact,
Metamorphic grade
Metamorphic textures and structures: Foliated and non-foliated.
Index minerals and Isograds
Nomenclature of metamorphic rocks
Protolith: recognition and types (Mafic, Quartzofeldspathic, Pelitic, Calcareous,)
Metasomatism

Practical: 1 credit

Maximum Marks: 25

- Megascopic study of Igneous, Sedimentary and Metamorphic rocks.

List of books recommended for reference

Mandatory Reading

- Winter, J D., (2014). Principles of Igneous and Metamorphic Petrology, Pearson Education Limited.
- Gill, R., (2010) Igneous rocks and process – A Practical Guide, Wiley-Blackwell
- Boggs S., (2009) Petrology of Sedimentary rocks (2nd edition), Cambridge University Press.
- Prothero, D. R., and Schwab, F.; (2004) Sedimentary Geology. Macmillan.
- Best, M., (2003). Igneous and Metamorphic Petrology, Blackwell Publishing.
- Tucker E.M. (2001) Sedimentary Petrology (3rd Edition), Blackwell Science Ltd.
- Pettijohn F.J., (1984) Sedimentary Rocks (3rd Edition), CBS Publishers, New Delhi.

Supplementary Reading

- Ehlers, E.G. and H. Blatt., 1982. Petrology, Igneous, Sedimentary and Metamorphic, W.H Freeman, San Francisco.
- Mahapatra G B. A Textbook of Geology, CBS
- Parbin Singh. A Textbook of Engineering and General Geology (Seventh Ed),
- Mukerjee, P K. A Textbook of Geology, World Press.

Course Title: **PRINCIPLES OF STRATIGRAPHY AND PALEONTOLOGY**
Course Code: **GEL-II. C-4**
Marks: **75**
Credits: **3 (45 Contact hours)**

Course Objectives

Stratigraphy and Paleontology, the two branches of Geology work together to unearth the secrets of age from rocks of the earth's crust. Stratigraphers study the composition and arrangement of layered or stratified rocks. Paleontologists study the remains of plants and animals which have been preserved in the earth's crust by natural processes. With these objectives in mind it becomes pertinent to understand the basic concepts of Stratigraphy and Palaeontology.

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Understand principles of Stratigraphy and concept of Facies.

CO2 Differentiate between absolute and relative age of the earth.

CO3 Explain measurements of geologic time.

CO4 Describe how rocks are correlated.

CO5 Describe types of fossils, conditions and modes for fossilisation, how fossils can be used to locate economic deposits.

CO6 Describe and explain morphology of the hard parts of different phylum's and geological time range.

CO7 Understand map reading and handle clinometer compass.

CO8 Solve problems on bearings.

CO9 Describe and identify fossils/casts/shells w.r.t their morphology and geological age

CO10 Apply classroom teaching to field observations and preparing a geological report.

Module I **(15 hours)**

Principles of stratigraphy: Uniformitarianism, Original horizontality, Order of superposition, Faunal succession, Cross-cutting relationship, Inclusions.
Principles of stratigraphic analysis, Facies concept in stratigraphy
Walther's Law of Facies.
Age of the earth:, radiometric dating; Principles.
Measurement of geologic time:

Time Units: Eon-Era-Period-Epoch-Age

Lithostratigraphic/ Rock Units: Group-Formation-Member-Bed
Chrono-/ Time stratigraphic units: Erathem-System-Series-Stage
Standard Stratigraphic Scale.

Correlation and methods of Correlation:
Paleontological Criteria : Index/ Zone fossils
Lithological Similarity: Marker/ Key bed
Structural relations: Tectonic criteria

Brief account of the Geological Formations of Goa.

Module II **(15 hours)**

Fossils: Mega- Micro-Ichnofossils
Conditions for fossilization; Favourable environments for fossilization.
Modes of fossilization: Petrification, Carbonization, Natural moulds and casts
Frozen and mummified fossils.
Uses of fossils in locating coal and petroleum deposits.

Module III **(15 hours)**

Binomial Nomenclature of Organisms and Taxonomy
Morphology of the hard parts and geological time range of the following:
Phyllum: Arthropoda- Class: Trilobita
Phyllum: Mollusca- Class : Pelecypoda
:Gastropoda
:Cephalopoda- Nautiloidea
Ammonoidea
Belemnoidea
Phyllum: Brachiopoda
Phyllum: Echinodermata- Class: Echinoidea

Practical: 1 credit
Maximum Marks: 25

- Map reading
- Use of clinometer compass and exercises on Bearings
- Study of fossils/casts/shells w.r.t their morphology and geological age.

List of books recommended for reference

Mandatory Reading

- Dana, J.D., (2010), Manual of Geology, Anmol Publications.
- Monroe, J and Wicander, R., (1994). The Changing Earth: Exploring Geology and Evolution, Brooks/Cole
- Black. R M., (1989). The Elements of Palaeontology, Cambridge University Press.

- Spencer, E, W, Basic concepts of Historical Geology, Oxford & IBH Publishing Co.
- Koregave, M A., Fundamentals of Invertebrate Palaeontology, Book World Enterprises.

Supplementary Reading

- A Textbook of Geology, P.K Mukherjee (World Press).

SEMESTER III

Course Title**: ADVANCED MINERALOGY AND GEOCHEMISTRY**
Course Code: **GEL-III.C-5A**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

- The course provides geoscientific study of mineralogy in understanding the structure, chemistry, optical & physical properties, stability relations and genesis of minerals. With respect to geochemistry the student will understand the distribution of various elements and their abundances in the earth's crust.

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Understand the concept of Gibbs Phase Rule.

CO2 Correlate structure, chemical composition with physical and optical properties of minerals of major silicate group of minerals.

CO3 Interpret stability relations of minerals using Phase diagrams.

CO4 Understand how minerals originate and associate with each other in a rock

CO5 Understand the geochemical composition of the earth.

CO6 Describe how compatible elements are involved in the various geochemical processes.

CO7 Explain how incompatible elements are involved in the various geochemical processes.

CO8 Evaluate and interpret how geochemistry can be used to interpret tectonic setting.

CO9 Solve applied quantitative problems.

CO10 Plot major oxides in tectonic discriminant diagrams

Module I **(15 hours)**

Introduction to mineral chemistry, Gibbs Phase Rule, Phase diagram.

Structure, mineral chemistry, paragenesis, and Phase diagrams of the following silicate group of minerals:

Olivine group (Forsterite-Fayalite System)
Pyroxene group (Diopside-Anorthite System)
Feldspar group (Albite-Anorthite System; Orthoclase-Albite System)

MODULE II **(15 hours)**

Structure, mineral chemistry, paragenesis, and stability relations of the following silicate group of minerals:

- Feldspathoid group (Leucite-Silica System)
- Silica
- Amphibole
- Mica

MODULE III **(15 hours)**

- Whole rock analysis (major, trace REE)
- Concept of compatible and incompatible elements,
- Use of geochemistry in deducing tectonics.
- Primitive mantle normalized diagram and their significance in petrogenesis.

Practical: 1 credit
Maximum Marks: 25

1. Calculation of end-members for olivine, pyroxene and feldspar group of minerals.
2. Plotting of major oxides in tectonic discriminant diagrams

List of books recommended for reference

- Deer, W. A, Howie, R. A and Zussman. J., (2013). An Introduction to Rock-Forming Minerals, Mineralogical Society.
- Ford, W. E., (2006). Dana's Textbook of Mineralogy (with extended treatise Crystallography and Physical Mineralogy). CBS Publishers, New Delhi.
- Griffen, D. T, Phillips, W. R and William, R. Phillips., (2004). Optical Mineralogy: The Nonopaque Minerals. CBS Publishers, New Delhi.
- Mason and Berry, (2004). Mineralogy, CBS Publishers, New Delhi.
- Faure, G (1998) Principles and Applications of Geochemistry. Prentice Hall
- White, W M (1997) Geochemistry, Wiley-Blackwell
- Krauskopf, K B and Bird, D K (1995) Introduction to Geochemistry. McGraw-Hill
- Mason, B and Moore, C., (1982). Principles of Geochemistry, John Wiley & Sons.

Course Title: **PHYSICAL GEOLOGY**
Course Code: **GEL-III.E-1**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives: The natural agencies like wind, rivers, glaciers have been moulding and remoulding the surface of the earth over millions of years. This course aims at the understanding of the processes and the physical forces responsible in developing the surficial features and highlighting the role of these natural agencies in grading and degrading the land surface.

Course Outcomes:
Upon completion of the course, the student will be able to,

CO1 Identify the dominant medium of erosion, transportation and deposition in a given area and explain the mechanisms for those processes.

CO2 Identify various dessert landforms and explain the processes involved in their formation.

CO3 Identify various fluvial landforms and explain the processes involved in their formation.

CO4 Identify various Karst topography and features and explain the processes involved in their formation.

CO5 Identify various glacial and coastal landforms and explain the processes involved in their formation.

CO6 Assign stream order as per Strahler’s Method, Analyze various attributes of basin morphometry and drainage.

CO7 Prepare and analyze long and cross sections of river profiles from SOI Toposheet.

CO8 Deduct the processes involved in shaping the geomorphology of a local area by an integrated approach of applying theoretical knowledge and field based observations.

Module I **(15 Hours)**
Weathering and erosion

Earth Systems Affecting Weathering

Mechanical Weathering – Pressure Release, Frost Action, Thermal Expansion and Contraction, Salt Growth, Impact of Organism

Chemical Weathering – Organisms Role, Oxidation, Acid Action, Dissolution/Leaching, Hydrolysis, Spheroidal Weathering

Factors Affecting rate of Weathering.
Rate of Weathering versus Stability of Minerals

Weathering versus Erosion

Transportation and deposition

Laminar and Turbulent Flow
Agents of Transportation – Wind, Water, Glaciers, Gravity
Modes of transportation – Bed Load (sliding, rolling, saltation), Suspension, dissolved load
Factors Affecting Depositions

Action of Wind

Generation of Winds,
Characteristics of Desert.
Problems Associated with Desertification.
Sediment Transport – Lifting Mechanism, Bed Load and Suspended Load

Desert Landforms:

Depositional: sand dunes, Sand Seas/Ergs, Playa, sabkha

Erosional: Grooves, Ventifacts & Yardangs mushroom rock, Inselbergs, Mesas and Buttes, Deflation Basin, Desert Pavement and Lag Gravel

Module II **(15 Hours)**

Drainage Basin and River System –, Drainage Patterns –
Dynamics of Stream Flow – Discharge, Gradient, Velocity, Sediment Load, Base Level
Concept of Graded Stream
River System and Plate Tectonics

Geological Action of Rivers

Erosion by River

Process of Stream Erosion – Removal of Regolith, Downcutting, Headward Erosion.
Bradshaw Model
Erosional Feature in Upper Course - Steep Valleys, Gorges, Interlocking Spurs, Potholes, Waterfall and Rapid
Erosional Features in Middle and Lower Course – Meander, Ox Bow Lake, Hogbacks, Cuestas

Depositional Landforms by River

Floodplains – Meanders, Point Bars, Natural Levees, Backswamps, Braided Stream
Alluvial Valleys – Step Terraces
Deltas – Formation and Types
Alluvial Fans

Erosion by Groundwater

Karst Topography – Caves, Sinkholes, Solution Valleys, Disappearing Streams, Tower Karst

Deposition by Groundwater

Speleothems – Stalactites, Stalagmites

Module III **(15 Hours)**

Types of glaciers and Glacial Budget

Glacier Flow – Surging Glacier, Crevasses

Ablation – Melting, Evaporation, Calving

Geological Work of Glaciers

Erosional Features of Glaciers

Erosion Process– and erosional landforms related to valley and continental glaciation.

Depositional Features of Glaciers

Glacial Drift – Till and Stratified Drift

Action of Sea Waves

Erosional and depositional features of the coast.

PRACTICAL MODULE: 1 Credit

- Basin Morphometry Perimeter Calculation using rotameter
- Area Calculation – Square Grid/Planimeter/Area using triangles
- Stream Ordering (Strahler's Method)
- Drainage Network Morphology – Bifurcation and Length ratio
- Basin Geometry – Basin Circularity, Intensity of Dissection – Drainage Density, Stream Frequency, Hypsometric Curve
- Draw Inference for the Basin based on the result
- Long Profile and Cross Profile of River – Upper Course, Middle Course, Lower Course of river from SOI Toposheet. Field visit to nearby area to understand and describe the various physical geology features.

REFERENCE BOOKS:

- Monroe, S. J and R. Wicander., 2014. The Changing Earth: Exploring Geology and Evolution. Brooks Cole Publishers.
- Mathur, S. M., 2012. Physical Geology of India. National Book Trust
- Carlson, D.H., Plummer, C.C., McGeary, D., 2008. Physical Geology: Earth revealed. Higher Education.
- McConnell, D., Steer, D., Knight, C., Owens, K., Park, L., 2008. The Good Earth – Introduction to Earth Science. Higher Education.
- Monroe, J.S., Wicander, R., Hazlett, R., 2007. Physical geology – Exploring the Earth (6^{th} Ed.) Thomson Brooks/Cole.
- King, C.A.M., 2006: Techniques in Geomorphology, Edward Arnold, London

Course Title: **GROUNDWATER AND HYDROGEOLOGY**
Course Code: **GEL-III.E-2**
Credits: **3(45 contact hours)**
Marks: **75**

Course Objectives

To impart knowledge about groundwater, its movement, methods of its exploration, the criteria of its quality, methods of its conservation, recharge of groundwater, monitoring of groundwater quality and quantity.

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Understand the concept of Groundwater, its sub- surface distribution and sources.

CO2 Explain the rock properties of porosity and permeability affecting the movement of groundwater.

CO3 Differentiate between the various types of aquifers.

CO4 Carry out groundwater exploration by resistivity method.

CO5 Draw flow-nets from groundwater levels.

CO6 Determine water quality based on various parameters.

CO7 Understand the effects of over withdrawal of groundwater and waterlogging, and suggest mitigation measures.

Module I **(15 hours)**

Hydrologic cycle and its components
Factors controlling all the components: Evaporation, precipitation, runoff, Infiltration Hydrologic budget
Vertical distribution of ground water
Types of Groundwater: soil water, vaddose, capillary water, Meteoric water
Rock properties affecting movement of ground water:
1) Porosity(primary and secondary), effective porosity, specific retention, controlling factors of porosity
2) Permeability: Darcy’s law, laboratory methods of measurement of permeability (constant head, falling head), specific yield, Relation between grain size, porosity, specific yield and specific retention.
Definition of an aquifer, aquiclude, aquitard, aquifuge, and types of aquifers: Unconfined, Confined (Artesian), Perched aquifer.

Module II **(15 hours)**

Groundwater Exploration: Resistivity methods

Groundwater levels and Flow nets

Aquifer parameters: 1) Transmissivity, 2) Storativity,3) Hydraulic conductivity: methods of determination (pumping test and tracer test)

Drawdown and cone of depression

Groundwater quality:

- Parameters :physical ,chemical and biological
- Major, minor and trace constituents.
- I.S.I standards for drinking water

Module III **(15 hours)**

Effects of withdrawal, effects of waterlogging

Artificial recharge

Saline water intrusion in aquifer

Ghyben-Hertzberg relation

Pollution of ground water: Arsenic and Fluoride

Practical: 1 credit

Maximum Marks: 25

- Drawing flow nets
- Determination of depth to water table from bore hole data.
- Numerical problems on determination of porosity, bulk density, saturation percentage and void ratio of sample
- Problems based on Ghyben –Hertzberg formulae
- Graphical presentation of chemical data of water
- Resistivity survey (demonstration)

List of books recommended for reference

Mandatory Reading

- Todd , D.K and Mays, L.W., 3rd edition , 2012. Groundwater Hydrology, Wiley India Pvt. Ltd.
- Keller, E.A., 4th edition, 2011. Environmental Geology, CBS Publishers, New Delhi.
- Hiscock, K and Bense, V F. Hydrogeology: Principles and Practice.
- Valdiya K.S., 1987, Environmental Geology: Indian Context, Tata-McGraw Hill
- Ragunath H.M., 1983, Groundwater, Wiley Eastern Ltd, New Delhi.

Course Title**: ORE GENESIS**
Course Code**: GEL-III.E-3A**
Credits**: 3 (45 contact hours)**
Marks: **75**

Course Objectives: The course aims at understanding the various types of mineral deposits, classification, their mode of occurrence, geologic & geographical distribution and genesis. It primarily focuses on the processes of formation of ore deposits. Furthermore, it also aims at identification of economic minerals in hand specimens.

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Differentiate between rock-forming minerals and ore minerals.

CO2 Understand the basis of classifying ore minerals.

CO3 Understand the origin and stages of ore formation.

CO4 Classify the various ore minerals under categories such as magmatic, hydrothermal, volcanogenic etc.

CO5 Explain the processes involved in the formation of ore deposits.

CO6 Understand the genesis and occurrence of various ore deposits in India.

CO7 Evaluate ore minerals in hand specimen using their physical properties.

Module I **(15 hours)**

Goldsmith geochemical Classification

Tenor, Prospects, Resource & Reserves of ore minerals

Classification of Ore Deposits:

- Modified Lindgren's Scheme; Bateman Scheme; Based on Tectonic Setting

Processes Forming Mineral Deposits

- Requirements for Ore deposit formation
- Syngenetic & Epigenetic deposits

Magmatic Ore Forming Processes

- Orthomagmatic ore formation (Bushveld; Sudbury)
- Ore deposits at mid-ocean ridges (Black & White Smokers) and in ophiolites (podiform chromites)
- Ore formation related to alkaline magmatic rocks, carbonatites and kimberlites
- Ore deposits in pegmatites

Module II **(15 hours)**

Magmatic-Hydrothermal Ore Forming Systems

Hydrothermal ore formation (Source of Hydrothermal Solutions; Textures & Structures; Host rock alteration)

Volcanogenic ore deposits (VMS; Terrestrial epithermal gold, silver and base metal)

Porphyry copper (Mo-Au-Sn-W) deposits

Hydrothermal-metasomatic ore deposits

Skarn, Greisen

Supergene Ore Formation Systems

Residual (eluvial) ore deposits

Supergene enrichment by descending (vadose) solutions

Sedimentary Ore Formation Systems

Black shales in metallogenesis (European Copper Shale)

Autochthonous iron and manganese Deposits

Sediment-hosted & submarine-exhalative (sedex) base metal deposits

Mississippi Valley type (MVT) Lead-Zinc deposits

Placer deposits

Metamorphic Ore Forming System

Orogenic Cu-Zn-Au deposits

Ore Deposits in Space and time

Metallogenic Epochs

Plate Tectonic Setting of Ore Deposits

Module III **(15 hours)**

Indian occurrences of

Metallic Deposits:

Iron

Manganese

Chromium

Copper-Lead-Zinc

Gold

Non metallic Deposits:

Diamond, Baryte, Bauxite,

Nuclear Minerals

Industrial Minerals (Refractory, Abrasives, Cement, Fertilizer, Electrical and Electronics).

PRACTICAL MODULE = 1 Credit

- Descriptive evaluation of ore minerals in hand sample
- Introduction to reflected light microscopy of ore minerals (demonstration) Site visits to local mineralized geology

REFERENCE BOOKS

For Ore Forming Process: (E-books Available of All)

1. Pohl, L.W., 2011. Economic Geology – Principles and Practice. Wiley-Blackwell
2. Robb, L., 2005. Introduction to Ore-Forming Processes. Blackwell Publishing
3. Evans, A.M., 1993. Ore Geology and Industrial Minerals – An Introduction (3rd Ed.) Blackwell Publishing
4. Edwards, R. & Atkinson, K., 1986. Ore Deposit Geology and its influence on Mineral Exploration. Chapman and Hall Ltd.
5. Hutchison, C., Economic Deposits and their Tectonic Setting.

For Ore Deposits in Indian Context:

1. Prasad, U., 2014. Economic Geology: Economic Mineral Deposits (2nd Ed.), CBS Publishers, New Delhi
2. Srivastav, J.P., 2012. Introduction to Ore Microscopy. Prentice Hall India Learning Private Limited
3. Tiwari, A.K., 2010. Ore Geology, Economic Minerals and Mineral Economics. Atlantic
4. Gokhale, G.V.G.K., 1983. Ore Deposits of India. CBS Publishers, New Delhi

Mandatory Reading

Principle Reference books used for course preparation will be Economic Geology by Walter Pohl and Economic Geology by Umeshwar Prasad.

Course Title: **MARINE GEOLOGY**
Course Code: **GEL-III.E-4**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives:
To provide knowledge on essential concepts of oceanography.
To study the tectonics, geology, economic resources w.r.t. the oceans.

Course Outcomes:
Upon completion of the course, the student will be able to,

CO1 Understand ocean bathymetry and learn to identify features of the ocean floor such as mid ocean ridges, seamounts, guyots, hydrothermal vents, pillow basalts, trenches.

CO2 Relate the ocean features to its tectonic origin.

CO3 Understand the various processes which generate ocean currents.

CO4 Classify marine sediments into four broad categories based on their origin i.e lithogenous , hydrogeneous, biogenous, cosmogenous.

CO5 Identify the characteristics of important marine resources for the future such as polymetallic nodules and gas hydrates.

CO6 Recognise how near shore geological processes shape coastlines over time

Module I **(15 hours)**
Ocean basins: Shape, size of the Pacific, Atlantic and Indian Oceans
Coriolis Effect
Ocean circulation
Ocean salinity
Techniques used to study ocean bathymetry
Concept of Plate Tectonics and ocean floor spreading,
Magneto stratigraphy

Module II **(15 hours)**
Marine Provinces
Morphological features of the ocean floor;
- Mid Oceanic Ridges and its features;
- Abyssal plains and its features
- Ocean trench and its features

Continental slope and shelf and their features
Ocean islands: Hot spot, Atolls

Module III **(15 hours)**

Clastic Sedimentation in different marine environments:
Biogenic sedimentation
Chemogenic sedimentation
Near coastal geological processes
Coastal Zone Regulations (CRZ), Exclusive Economic Zone (EEZ); Minerals in the EEZ of India.
Mineral deposits

Practicals = 1 credit

- Preparation of salinity and ocean current map.
- Drawing and labeling of ocean profile.
- Preparation of ocean resource distribution maps
- Visits to National Laboratories engaged in Ocean Research such as NIO and NCAOR.

List of books recommended for references:

- Trujillo, A. P and Thurman H., 2013. Essentials of Oceanography, Eastern Economy Edition, PHI Learning Pvt. Ltd, New Delhi.
- Pinet, R. P., 2009. Invitation to Oceanography,(5TH Edition), Jones and Bartlett Publishers, London.
- Thurman, H V. and Trujillo A., 2003, Introductory Oceanography, Prentice Hall.
- Qasim, S.Z., 1996, India's Exclusive Economic Zone, Omega Scientific Roonwal, G.S. Publishers.
- Kennett J P., 1981. Marine Geology, Prentice Hall.

Online resources

- https://oceanexplorer.noaa.gov/edu/learning/welcome.html , Date: 15/3/19
- http://www.nio.org/index/option/com_nomenu/task/show/id/134 , Date: 15/3/19

https://pubs.usgs.gov/gip/dynamic/dynamic.html ,

SEMESTER IV

Course Title: **STRUCTURAL GEOLOGY**
Course Code: **GEL-IV.C-6**
Marks: 75
Credits: 3 (45 Contact hours)

Course Objectives

The course is designed for the students to understand the geometry and mechanics of the various geological structures that result through the deformative processes operative within the earth.

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Gather knowledge about the geometry of various structures acquired by rocks at primary and secondary stages.

CO2 Understand the concepts of stress and strain.

CO3 Understand the application of stress and strain in rock deformation.

CO4 Identify rock structures and deformities like joints, folds and faults.

CO5 Understand a structural separation in geological context based on unconformities.

CO6 Identify secondary structures developing in rocks.

CO7 Interpret geological maps

CO8 Solve structural problems based on provided data.

Module I **15 hours**

Primary and secondary structures.
Concept of rock deformation.
Stress and Strain in rocks, 2-D stress and strain analysis;
Strain ellipses of different types and their geological significance.

Module II **15 hours**

Unconformities.
Joints: Joints and fracture mechanics, classification of joints.
Faults: Terminology, classification, criteria for faulting.
Diapirs (salt domes)

Module III **15 hours**

Cleavage and foliation: types, origin and relation to major structures.
Lineations- Description and origin of lineation.
Folds- morphology; Geometric and genetic classification; Mechanics and causes of folding
Lineation and relationship with folds

Practicals : Credit 1
Maximum Marks: 25

Solving Geological Maps

Completion of Outcrops

Stereographic Projection of Structural Data

Graphical Solution for Structural Problems

List of recommended reference books:
Mandatory Reading

- Hobbs, B and Alison, O. R. D., 2014. Structural Geology: The Mechanics of Deforming Metamorphic Rocks, Elsevier Science Publishing Co. Inc
- Fossen, H., 2010. Structural Geology, Cambridge University Press.
- Twiss, R. J and Moores, E. M., (2006). Structural Geology, W H Freeman and Company.
- Pollard, D. D and Fletcher, R. C., (2005). Fundamentals of Structural Geology, Cambridge University Press.
- Davis, G. H., (1996). Structural Geology of Rocks and Regions, Wiley
- Hatcher, R., (1995). Structural Geology: Principles, Concepts and Problems. Pearson.

Course Title: **ENGINEERING GEOLOGY**
Course Code: **GEL-IV.E-5A**
Marks: **75**
Credits: **3 (45 contact hours)**

Course Objective

To impart sufficient knowledge of engineering geology so as to be able to anticipate the technical problems related to geology of various engineering sites and suggest possible remedial measures.

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Understand issues related to geological basement and structure of a region.

CO2 Identify the characteristics of basement rock formations and problems associated with them.

CO3 Describe and interpret geological structures in geological maps and drawing cross sections.

CO4 Assess the area appropriately suggested for a geotechnical project and apply the geological knowledge for a safe and secure construction and operation of a geotechnical project.

CO5 Suggest remedial measures to encounter the problems detected.

CO6 Interpret core logs and suggest suitable remedial measures.

CO7 Collect data interpret and analyse it to solve problems associated with the engineering project as well as the environment.

CO8 Explore and suggest novel ideas using geological background for the geotechnical project.

CO9 Suggest Site feasibility based on geological maps.

CO10 Carry out physical and mineralogical descriptions of cores.

CO11 Draw relationship of core log to RQD values

CO12 Compute reservoir area, catchment area, reservoir capacity.

CO13 Solve numerical problems on ultimate strength of rocks

Module I **(15 hours)**

Aim of engineering geology
Porosity and permeability of rocks
Principles of mechanical behaviour of rock materials
Engineering properties of rocks; specific gravity, compressive strength, hardness, toughness.

Soil profile and Engineering properties of soil;
Role of structures (joints, fractures, folds, faults) and water/fluids in engineering geology
Use of rocks / aggregates in construction

Module II **(15 hours)**
Role of engineering geologists in planning, design and construction of major man-made civil structural features.
Methods of site investigation
Introduction to core logging
Geological investigations/geotechnical problems related to groundwater occurrence,

Module III **(15 hours)**
Geological investigations for landslides, bridges and tunnels -design and construction.
Geological investigations in dams and reservoirs.
Case studies of dam failures
Site improvement methods

Practical: 1 credit
Maximum Marks: 25

- Site feasibility based on geological map.
- Physical and mineralogical descriptions of cores,
- Relationship of core log to RQD values
- Computation of reservoir area, catchment area, reservoir capacity
- Numerical problems on ultimate strength of rocks

List of recommended reference books.

- Parthsarthy, A, Panchapakesan, V., Nagarajan, R., (2013) Engineering Geology, Wiley.
- Price, D.G., (2009), Engineering Geology Principles and Practice, Springer.
- Bell, .F.G, (2007). Engineering Geology, Butterworth-Heineman
- Narayanswami S.B.S. (2000), Engineering Geology, Dhanpat Rai & Co, India.
- Sathya, N S., (1992). Engineering Geology, B.S, Dhanpat Rai and Co. Pvt Ltd.
- Gupte R.B. (1992). A Textbook of Engineering Geology., Pune Vidyarthi Griha Prakashan.

Course Title: **OPTICAL MINERALOGY**
Course Code: **GEL-IV.E-6A**
Marks: **75**
Credits: **3 (45 Contact hours)**

Course Objectives

- The objective of the course is to provide the basics of geoscientific studies in Optical Mineralogy involving optical properties of minerals in plane polarized light, in between crossed polars and convergent light. Further, it will strengthen their knowledge in understanding of optical indicatrices and determination of optic sign of minerals. The knowledge of optics is applied in understanding and identification of minerals.

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Understand basic concepts in optical mineralogy wrt relief, pleochroism, character between crossed polars, extinction and their types, interference colours, zoning and twinning.

CO2 Correlate elementary principles of optics to crystal optics.

CO3 Distinguish Uniaxial and Biaxial Indicatrix

CO4 Understand the concept of formation of Interference colours and determine their orders as per Newton's Scale.

CO5 Handle Petrological Microscopes.

CO6 Identify major rock-forming minerals in microsections.

CO7 Detect Optic Sign for Uniaxial and Biaxial Minerals using Interference Figures.

CO8 Determine Anorthite content of Plagioclase.

CO9 Calculate Optic Axial Angle.

Module I **(15 hours)**

Introduction: Nature of light, Polarized light, Refractive Index, Critical angle and Total Internal reflection, Wave Surface, Double Refraction.

Parts and working of a Polarizing / Petrological microscope

Properties of minerals in Plane Polarised Light (PPL): Colour, Form, Cleavage/Cracks; Relief, Twinkling; Pleochroism,

Pleochroic halos.

Module II **(15 hours)**

Optical characters of minerals: Isotropism and Anisotropism

Properties of minerals Between Crossed Polars (BXP): Interference colours: Formation, Newton's Scale, Anomalous interference colours;

Extinction and Extinction types.

Twinning and Zoning

Alteration, Inclusions.

Module III **(15 hours)**

Optical accessories

Uniaxial indicatrix

Biaxial indicatrix

Convergent Light: Principle

- Uniaxial Interference Figure
- Biaxial Interference Figure
- Optic sign of Uniaxial and Biaxial Minerals
- 2V and 2E

Practical: 1 credit

Maximum Marks: 25

- Identification of common rock forming minerals based on optical properties
- Interference figures (Demonstration)
- Determination of optic sign (demonstration)
- Determination of An-content using extinction angles (demonstration)

List of books recommended for reference

Mandatory Reading

- Perkins, D., (2015). Mineralogy. Pearson New International Edition
- Nesse, D. W., (2012), Introduction to Optical Mineralogy, Oxford University Press.
- Kerr, P., (1977), Optical Mineralogy, McGraw Hill Publishers.
- MacKenzie, W. S and Guilford, C., Atlas of Rock forming minerals in thin section_

Supplementary reading

- Cornelis, K and Cornelis, H. (1993). Manual of Mineralogy, John Wiley and Sons Ltd.

Course Title: **NATURAL HAZARDS AND MANAGEMENT**
Course **Code: GEL-IV.E-7**
Marks**: 75**
Credits: **3 (45 Contact hours)**
Prerequisites**: GEL-III.E-1**

Course Objectives
The course is designed with an aim to give the student an understanding about: various natural hazards; stages in management aimed at avoiding and /or reducing loss to life and property; and Agencies involved in mitigation and management of damage due to hazards.

Course Outcomes
Upon completion of the course, the student will be able to,

CO1 Understand the causes, effects and mitigation measures for natural hazards such as droughts, floods, cyclones, volcanic eruptions, tsunami, landslides & subsidence, salinity hazards, coastal erosion.

CO2 Appreciate the CRZ act and its impact on disaster mitigation.

CO3 Understand the framework and roles of various bodies under the National disaster management plan of India.

CO4 Prepare a simple disaster management plan for a building/unit.

Module I **(15 hours)**
Classification of hazards: Natural and man-made disasters

Droughts: types, causes, mitigation
Floods: causes and effects, prediction, Cloud burst/Flashfloods, remedial measures
Cyclones: Structures, origin, effects, prediction, path tracking and early warning systems.

Module II **(15 hours)**

Volcanic eruption: Types, localization, volcanic hazards and mitigation
Earthquakes: Causes, Magnitude and intensity, Recording, effects and preparedness, Earthquake Zonation Map.
Tsunamis: relation of Tsunamis to tectonics; Damage due to tsunamis, Co-ordinated approach to early warning of tsunamis.
Landslides and Avalanches: Classification of mass wasting, mechanics, causes of landslides and stabilizing methods of slopes; civil engineering measures.
Subsidence: Causes, slow and brisk types

Module III **(15 hours)**

Salinity hazards: Inland and coastal

Coastal erosion and mitigatory measures

CRZ act and its impact on disaster mitigation

National Disaster Management: national and international support

Planning strategy: co-operative plan, identifying resources, setting priorities.

Hazard coping operations and rehabilitation

Proposed operational processes for individual Natural Disasters mentioned above.
Case study of Parvatibai Chowgule College Disaster Plan

Practical: 1 credit
Maximum Marks: 25

- Hazard zonation map of India: ,earthquakes, floods droughts, landslides and Cyclone
- Discussing disaster management plan for Parvatibai Chowgule College
- Land-use land cover mapping

List of books recommended for reference
Mandatory reading

- Paul, K, B., 2011, Environmental Hazards and Disasters: Context, Perspectives and Management, Wiley-Blackwell, West Sussex.
- Keller, E. A., 2011, Environmental Geology, Santa Barbara Prentice Hall.
- Hess, D., 2012, Mc Knight's Physical Geography, PHI learning, Pvt Ltd, New Delhi.
- Sethi, V. K., 2009, Disaster Management, Essential Books PW, New Delhi.
- Joshi M.V., 2004, Environmental Disaster, Causes, Impacts and Remedies, Adhyayan Publishers.
- Krynine, D. and Judd W., 1998, Principles of Engineering Geology and Geotectonics, McGraw Hill.
- Holmes, A., edited by Duff P.M.D.,1993, 4th edition, Physical Geology, E.L.B.S Publications.
- Valdiya K.S., 1987, Environmental Geology: Indian Context, Tata-McGraw Hill

Online resources

- https://ndma.gov.in/en/national-policy.html Date:19/3/19

- The Gazette of India : extraordinary [part ii—sec. 3(i)] ministry of environment, forest and climate change notification New Delhi, the 18th January, 2019 G.S.R. 37(e).— [18/01/2019]- coastal regulation zone notification.

http://www.moef.nic.in/sites/default/files/GSR%2037(E)%20DATED%2018.01.2019.pdf,

Course Title**: GEOTECTONICS**
Course Code: **GEL-IV.E-8**
Marks: **75**
Credits: **3 (45 Contact hours)**

Course Objectives

Ever since the creation of the earth, there have been marked changes in the distribution of land and sea. The dynamics of these changes are stupendous. The subject of Geotectonics aims at understanding the mechanism of such changes and explaining the structure of the earth and the processes responsible for the movement and redistribution of continents and seas.

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Gain an insight into the study of the earth's interior using seismic data.

CO2 Understand the various layers of the earth's interior and the mechanism of plate tectonics.

CO3 Explain the origin and nature of the earth's magnetic field and palaeomagnetism.

CO4 Understand the theory of Continental Drift along with supporting evidences.

CO5 Explain mountain building (orogenesis) and its relation with plate tectonics.

CO6 Identify and plot various tectonic features on the earth's surface.

Module I **(15 hours)**

Interior of the earth:

Clues from the study of earthquake and density;
The earth's layers; the crust-continental crust and oceanic crust;
Crust-mantle boundary
Structure of the mantle
Low Velocity Zone (LVZ)
Core-mantle boundary; P wave shadow zone,
Nature of the core; S wave shadow zone.

Earth's Magnetic field:

Origin and nature
Dynamo hypothesis and Herndon's Georeactor Theory.
Geocentric axial dipole,
Paleomagnetism,
Marine magnetic anomalies,
Magnetic reversals and magnetic stripes

Module II **(15 hours)**

Continental drift:

Wegener's hypothesis.

- Evidences: Continental fit; similarity of rock sequences and mountain ranges; glacial evidence, fossil evidence;

Paleomagnetism and Polar wandering.

Plate tectonics:

Plate margins, plate boundaries and associated activities,

Triple junctions;

Divergent, Oceanic Ridges, Sea floor spreading, transform faults; hotspots.

Convergent: oceanic–oceanic, oceanic-continental, continental-continental; oceanic trenches, subduction zones

Transform boundaries;

Wilson Cycle (Rift valleys, the Red sea and the Gulf of Aden)

Geometrical aspects and mechanism of plate motion.

Module III **(15 hours)**

Mountain building: Orogenesis

Plate boundaries and orogenesis: Orogenesis at oceanic-oceanic plate boundaries, oceanic-continental plate boundaries and continental-continental plate boundaries.

Case study: Tracking the rise of Himalayas.

Case study: Frequency of Earthquakes in North India

Case Study: Occurrence of Tsunami in SE Asia

Practical: 1 credit

Maximum Marks: 25

- Plotting of oceanic ridges, trenches, subduction zones, sea mounts, plate boundaries
- Exercises in plate tectonics.

List of books recommended for reference

Mandatory reading

- Monroe, S. J and R. Wicander., 2014. The Changing Earth: Exploring Geology and Evolution, Brooks Cole Publishers.
- Marshak, S., 2011. Earth: Portrait of a Planet, W. W. Norton & Company.
- Prasad, C. V. R. K., 2005. Elementary Exercises in Geology, Universities Press.
- Skinner, J. B and S, C. Porter., 2003. The Dynamic Earth: An Introduction to Physical Geology, John Wiley and Sons.
- Condie, K. C., 1997. Plate Tectonics and Crustal Evolution, Butterworth-Heinemann.
- *Duff, D and Holmes, A., 1993, Holmes Principles of Physical Geology, Springer.*

SEMESTER V

Course Title: **SEDIMENTARY PETROLOGY**
Course Code: **GEL-V. C-7A**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

To provide an understanding of the origin of sedimentary rocks, the relationship of sedimentary processes to plate tectonics, and the use of sedimentary rocks in the study of the geological past.

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Understand the processes leading to the formation of sedimentary rocks.

CO2 Identify and explain the various textures and structures of sedimentary rocks.

CO3 Relate different sedimentary facies with the environment of deposition.

CO4 Describe and identify the textures, structures and mineral composition and origin of various clastic and non-clastic sedimentary rocks.

Module I **(15 hours)**

The Origin of Sedimentary Rocks**:**

Erosion, transportation and deposition of sediments.
Hjulstrom's diagram

Provenance
Components of clastic sediments: Heavy, Clay, Quartz, Feldspars, other minerals
Environment of deposition and sedimentary facies
Basins - Plate tectonics and sedimentation
Sedimentary Textures

Grain Size, Udden-Wentworth Size Scale, Phi Scale, Roundness and Sphericity.
Maturity: Textural, Mineralogical and Chemical

Classification of Sedimentary rocks (Folk's and Dunham's, Okhadas)

Module II **(15 hours)**

Primary sedimentary structures

Depositional, Erosional

Secondary sedimentary structures

Chemical, biogenic

Soft sediment deformations

Module III **(15 hours)**

Clastic Sedimentary Rocks

Sandstones, Breccias and Conglomerates**:**

Textures, Structures, Mineral composition, Textural maturity,

Mudrocks:

Structures, Colour, Mineral composition;

Non-clastic Sedimentary Rocks

Limestones and Dolomites:

Textures; Mineralogy; Structures; Diagenesis, Reefs and Palaeoclimate; Dolomites: Dolomitization.

Residual: (Laterite and Bauxite)

Origin and Climate.

Carbonaceous sediments:

Nature and form of organic residues; The Coal series

Practical Course: 1credit
Maximum Marks: 25

- Study and identification of sedimentary rocks w.r.t textures, structures, their classification.
- Study of sedimentary rocks in thin sections
- Exercises in grain size and shape analysis.

List of books recommended for reference

- Boggs S., (2009) Petrology of Sedimentary rocks (2nd edition), Cambridge University Press.
- Blatt H; Tracy R. J and Owens B. E., (2006) Petrology- Igneous Sedimentary and Metamorphic 3rd edition W H Freeman and Company New York.
- Boggs, Jr., (2005) Principles of Sedimentology and Stratigraphy (4 edition), Prentice Hall.
- Prothero, D. R., and Schwab, F.; (2004) Sedimentary Geology. Macmillan.
- Tucker E.M. (2001) Sedimentary Petrology (3rd Edition), Blackwell Science Ltd.
- Raymond A L (1995) Petrology-The study of Igneous Sedimentary and Metamorphic rocks. Wm. C. Brown Communications, Inc.; USA.
- Greensmith, J. (1989) Petrology of the Sedimentary rocks (7th Edition), CBS Publishers, New Delhi.
- Ehlers G.E. and Blatt H., (1987) Petrology – Igneous, Sedimentary and Metamorphic, CBS Publishers, New Delhi.
- Pettijohn F.J., (1984) Sedimentary Rocks (3rd Edition), CBS Publishers, New Delhi.
- Colinson, J D & Thompson, (1982) Sedimentary Structures, Allen & Unwin.

Course Title: **PRECAMBRIAN STRATIGRAPHY OF INDIA**
Course Code: **GEL-V.E-9B**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

The Peninsular India is a shield comprising of composite crustal blocks of Archean antiquity and therefore it preserves record of the various tectonic events that this land has witnessed. This course aims at providing a basic understanding of the various stratigraphic units and the correlation of International Geological Time Scale with Indian Stratigraphic Time Scale. It aims to provide understanding of the Precambrian geology, stratigraphy, fossil content and the economic resources of the lithounits from the Peninsular India.

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Understand evolution and stabilisation of the Archean cratons in India with special emphasis on Dharwar craton.

CO2 Understand the tectonics behind Mobile Belts of India

CO3 Differentiate between western Dharwar Craton and Eastern Dharwar Craton.

CO4 Interpret geological and geochemical differences of the basement rocks for Sargur (Gorur Gneiss) and Dharwarian (Peninsular Gneissic Complex)

CO5 Relate the lithostratigraphy of Sargur and Dharwar Schist Belt and correlate it with the Goa Group of rocks.

CO6 Understand the Purana basins in India with emphasis on Cuddapah Vindhyans and Kaladgis.

CO7 Identify specimens representing rock Formations in Goa

CO8 Assigning stratigraphy Formations based on fossils.

CO9 Solve problems in stratigraphic correlation

Module I **(15 hours)**

Physiographic subdivisions of India and their distinctive characters.

Geology of India

Cratonic provinces of Peninsular India shield: (Dharwar craton/ Singhbhum craton,/Bundelkhand craton/, Aravalli craton,/ Bastar craton) and their economic importance, with emphasis on the Dharwar craton.

Mobile Belts of Peninsular India: Eastern Ghat Mobile Belt, Satpura Mobile Belt, Pandayan Mobile Belt

Module II **(15 hours)**

Gorur Gneiss

Sargur Supracrustals

Dharwar craton: Eastern Dharwar Craton (Deccan Batholith) and Western Dharwar Craton (Peninsular Gneiss)

Greenschist/Greenstone Belts of Peninsular India:

Dharwar type Greenstone Belt: Dharwar Supergroup: Bababudan Group, Chitradurga Group

Goa Group of rocks

Kolar type greenstone Belt: Kolar

Module III **(15 hours)**

Proterozoic Basins of Peninsular India:

Vindhyan Supergroup;

Cuddapah Supergroup;

Kaladgi Supergroup.

Outline of Bhīma Supergroup, Delhi Supergroup, Kurnool Supergroup

Practical: 1 credit

Maximum Marks: 25

- Study of specimens representing rock formations of Goa.
- Assigning stratigraphy Formations based on fossils.
- Maps related to Indian Geology/ Problems in stratigraphic correlation.

List of books recommended for reference

Mandatory Reading

- Dessai, A G (2018). Geology and Mineral resources of Goa. New Delhi Publishers
- Mascarenhas, A and Kalavampara, G., (2015). Natural Resources of Goa: A Geological Perspective. Geological Society of Goa.
- Ramakrishnan, M and Vaidynadhan, R., (1994), Geology of India, Geological Society of India Publication, Bangalore. Vol. I and II.

Supplementary Reading

- Valdiya, K. S., (2015). The making of India: Geodynamic evolution, Springer
- Nanda, H., (2014), Indian Stratigraphy, Anmol Publications Pvt. Ltd. New Delhi.
- Sharma, R. S., (2009). Cratons and fold belts of India, Springer

Course Title: **PETROLEUM GEOLOGY**
Course Code: **GEL-V.E-10**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

The course aims to provide the students an understanding of essential and basic concepts of Petroleum Geology, the process and the operations involved in Petroleum exploration & extraction and to provide knowledge on the petroliferous basins of India.

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Describe the Physical & chemical properties of Hydrocarbons.

CO2 Compare various exploration techniques involved in hydrocarbon detection.

CO3 Understand the process of drilling & completion of a Petroleum well.

CO4 Prepare isopach maps.

CO5 Delineate and describe the petroliferous domains in India.

CO6 Analyse well logs.

Module I **(15 hours)**

Introduction and Aspects of Petroleum Geology, Characteristics of Hydrocarbons (Physical and Chemical properties), Petroleum System, Composition, Origin (Types of Kerogen), Occurrence, Migration and Accumulation of Petroleum; Petroleum traps (Stratigraphic and Structural); Reservoir rocks, conditions & mechanisms.

Functions of Petroleum Geologist

Understanding oil and gas: Exploration, Drilling and Completion, Production, Services

Module II **(15 hours)**

Surface indications and direct detection of Hydrocarbons

Surface and Subsurface exploration techniques: Concept

Geophysical methods of exploration: Gravity and Seismic methods

Types of rigs and its selection

Rotary drilling system and equipment's

Drilling sequence: Coring; Casing and Cementation and Drilling fluids;

Module III **(15 hours)**

GeoLogging and Well logs (Electric, Radioactive and Acoustic);

Formation evaluation and Testing

Well Completion and Stimulation
An outline of the oil belts of the world; Global geographic and stratigraphic distributions of oil and gas;
Important Onshore and Offshore Petroliferous basins of India.
Recent trends in Petroleum Geology.

Practical Course**: 1 credit**
Maximum Marks**: 25**

- Plotting of Petroliferous basins on maps (World and India)
- Problems based on Well log interpretation
- Creation of carbonate isopachous maps
- Problems on mud circulation
- Observations of well cuttings and cores samples
- Demonstration/Determination of porosity

List of books recommended for reference

- Hyne, N J., (2001) Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production, PennWell Corporation.
- Selley, R.C., (1998) Elements of Petroleum Geology, W.H. Freeman & Company, New York.
- North, F.K., 1(986) Petroleum Geology, Allen & UnWin, 607p
- Morris, J., (1985) Practical Petroleum Geology, The University of Texas at Austin - Petroleum Extension Service.
- Levorsen, A.I., (1967) Geology of Petroleum, W.H. Freeman and Company.

Course Title: **METAMORPHIC PETROLOGY**
Course Code: **GEL-V. E-11A**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

To provide essential concepts of metamorphism and metamorphic rocks.
To study metamorphic rocks w.r.t fabrics and types.
To understand the concept of facies.
Also to understand how metamorphism is related to plate tectonics

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Understand metamorphism and their upper and lower limits and study metamorphic concepts like factors, types of metamorphism and facies.

CO2 Apply fundamental principles of metamorphism to development of textures.

CO3 Classify metamorphic rocks based on mineral assemblage and fabric.

CO4 Relate the types of metamorphism with the product.

CO5 Represent metamorphic rocks graphically using Phase Diagrams.

CO6 Correlate deformation with grade of metamorphism.

CO7 Evaluate how the different factors like temperature, pressure, protolith, chemically active fluids and time control metamorphism.

CO8 Interpret tectonic setting of Metamorphic Belts based on field characters and kinematic stress indicators.

CO9 Interpret the metamorphic processes combining the evidences derived from hand specimens, microsections and protolith.

CO10 Differentiate between Barrovian and Buchan Zones

CO11 Apply the facies concept to progressive contact and regional including burial metamorphism.

CO12 Identify textures of metamorphic rocks in hand specimens.

CO13 Identify textures, structures, mineralogy of metamorphic rocks in thin sections

Module I **(15 hours)**

Definition and explanation of metamorphism (upper and lower limits) and metamorphic rocks.

Factors controlling metamorphism:

Heat (T): Geothermal gradient (in different crustal regions), Radioactivity, magmatic intrusions, tectonics;

Pressure (P): Deviatoric, Lithostatic, Hydrostatic, Fluid pressure

Chemically active fluids (X_f): H_2O and CO_2

Composition of the parent rocks (X): pelites, mafites, ultramafites, quartzofeldspathic, carbonate rocks, sandstones and greywackes.

Time (δt): Role of time in metamorphism.

Phase Rule and Phase diagrams Graphical representation of metamorphic rocks.

Protoliths.

Types of metamorphism: Regional metamorphism its characteristics and products, burial metamorphism its characteristics and products, contact metamorphism its characteristics and products.

Relationship of brittle and ductile deformation with grade of metamorphism metasomatism, cataclastic metamorphism and their products, impact/shock metamorphism.

Metamorphism in relation to plate tectonics:

Divergent(constructive) boundary

Convergent (Destructive) boundary: subduction zone (sensu lato)

Continent-Continent Collision zones

Intra-plate environments

Module II **(15 hours)**

Metamorphic textures: Inherited/Relict fabric lepidoblastic, nematoblastic, granoblastic, equigranular mosaic, Porphyroblastic; cataclastic and mylonitic textures.

Kinematic stress indicators and their role in interpreting tectonic history

Nomenclature and classification based on mineralogy and fabric

Field characters of metamorphic rocks:

Variations in mineralogy and fabric. Prograde and Retrograde metamorphism

metamorphic zones and index/critical minerals, their significance in mapping and understanding tectonic history.

Module III **(15 hours)**

Facies: Concept after Goldschmidt and Eskola; Zonation in mineralogy – Buchanan (Low pressure) Barrovian (high pressure).

Facies of progressive contact metamorphism: characteristic mineral assemblages in pelites and carbonates (pure and impure) protolith

Facies of progressive regional metamorphism – characteristic mineral assemblages wrt facies (Zeolite, Prehnite-Pumpellyite, Greenschist, Amphibolite, Granulite,) in pelitic, mafic protolith.
Facies of burial metamorphism: Blueschist, Eclogite
Paired Metamorphic Belts

Practical Course: **1 credit**
Maximum Marks: 25

- Megascopic study and identification of metamorphic rocks w.r.t mineralogy, texture, type of metamorphism, facies, protolith.
- Microscopic study and identification of metamorphic rocks wrt to mineralogy, texture type of metamorphism, facies and protolith.
- Plotting ACF diagrams and commenting on the protolith.

List of books recommended for reference
Mandatory Reading

- Winter J D., (2011) Principles of Igneous and Metamorphic Petrology. PHI Learning Pvt. Ltd.
- Philpotts, A & Ague, J (2010) Principles of Igneous and Metamorphic Petrology. Cambridge University Press, New York
- Vernon, R H. and Clarke, G.L., (2008) Principles of Metamorphic Petrology, Cambridge University Press
- Best, M., (2003). Igneous and Metamorphic Petrology, Blackwell Publishing.
- Raymond, A. L., (1995) Petrology-The study of Igneous Sedimentary and Metamorphic rocks. Wm. C. Brown Communications, Inc.; USA.
- Yardley, B W. D., (1989) An introduction to Metamorphic Petrology, Longman Group Publishers Pvt. Ltd.
- Winkler, G. F., (1987) Petrogenesis of Metamorphic rocks 5th edition Narosa Publishing House, New Delhi.
- Turner, F., (1980) Metamorphic Petrology: Mineralogical, Field and Tectonic Aspects, CRC Press.

Supplementary Reading

- Frost B R and Frost C D., (2014) Essentials of Igneous and Metamorphic Petrology, Cambridge University Press.
- Bucher, K and Grapes, R., (2010) Petrogenesis of Metamorphic rocks, Springer-Heidelberg Dordrecht, London NY.

- Ernst, W G and Rumble D., (2008) Metamorphic Conditions along Convergent Plate Junctions: Mineralogy, Petrology, Geochemistry and Tectonics, Geological Society of Amer.
- Blatt, H; Tracy R. J and Owens B. E., (2006) Petrology- Igneous Sedimentary and metamorphic 3rd edition W H Freeman and Company New York.
- Miyashiro, A., (1994) Metamorphic Petrology, CRC Press.
- Roger, M., (1990). Petrology of the Metamorphic Rocks.Unwin Hyman Ltd, UK
- Miyashiro, A, (1978) Metamorphism and Metamorphic belts, The Greshman Press Old Woking, Surrey

Course Title: **REMOTE SENSING AND DIGITAL IMAGE PROCESSING**
Course Code: **GEL-V.E-12**
Credits: **3 (45 Contact hours)**
Marks: **75**
Mandatory requirement: **Individual Laptop with MS Windows OS**

Learning Objectives

This course is designed as an introduction to the use of remote imaging in geologic applications. The basic concepts of image production, processing and interpretations are covered.

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Explain remote sensing principles, purposes, advantages and limitations.

CO2 Define and describe electromagnetic spectrum and interactions with various types of media.

CO3 Describe characteristics of remote sensing imagery.

CO4 Describe sensors and image acquisition methods.

CO5 Search and download satellite imagery from online portals such as Bhuvan, USGS Earth explorer.

CO6 Understand the application of digital imagery for interpretation of lithology, Structure and geomorphology

CO7 Prepare various maps using Quantum GIS and Google Earth.

Module I **(15 hours)**

Energy Sources and Radiation Principles.
Electromagnetic Spectrum
Energy interactions in the Atmosphere: Scattering, Absorption.
Atmospheric windows
Energy interactions with earth surface features: Spectral Reflectance of rock, Soil water, and vegetation.
Photo recognition elements
The concept of resolution: Spatial, Spectral, Temporal and Radiometric.
Space Borne Imaging Systems- The Landsat, IRS, SPOT and High resolution Land Satellites (the characteristics of these satellites- orbits, sensors, and their resolutions)
Multispectral remote sensing and hyper spectral remote sensing

Module II **(15 hours)**
Concept of Digital numbers
Georeferencing
Image Rectification and Restoration.
Image Enhancement.: Low and high pass filter, directional filters
Contrast Manipulation.
Spatial Feature Manipulation.
Multi-Image Manipulation.

Module III **(15 hours)**
Image Classification: Unsupervised and Supervised Classification.
Supervised Classification:
    The Training Stage.
    The Classification Stage: Minimum-Distance to Means Classifier, Gaussian Maximum Likelihood Classifier.
Classification Accuracy Assessment and ground truth verification

Practical Course: 1 credit
Maximum Marks: 25
- Interpretation of Satellite Imagery for – landforms, geological structures, rock and soil types, man-made structures.
- Data Products and Meta data
- Digital Image Processing (using number matrix): enhancement, manipulation and classification.
- Digital image processing on Computer (demonstration)

List of books recommended for reference

- Heywood I, Sarah, Cornelius, Steve, Carver., (2011) An Introduction to Geographical Information Systems, Pearson Education Pvt. Ltd., New Delhi.
- Schowengerdt Robert A., (2006) Remote Sensing – Models and Methods for Image Processing, 2nd ed., Elsevier (Academic Press).
- George Joseph., (2005) Fundamentals of Remote Sensing, University press Private Ltd, Hyderabad.
- Lillesand, T. M., Ralph W. Kiefer and Jonathan W. Chapman., (2004) Remote Sensing and Image Interpretation, 5thed, Wiley.
- Mather Paul M., (2004) Computer Processing of Remotely Sensed Images- An Introduction, 3rd ed., John Wiley.
- Gupta, R P., (2003) Remote Sensing Geology. Springer-Verlag
- Lillesand T.M. and Kiefer R.W., (2002) Remote Sensing and Image Interpretation, John Wiley and Sons, New Delhi.

- Jensen John R., (2000) Remote Sensing of the Environment – An Earth Resource perspective, Pearson Education Series, Low Price Edition.
- Drury, S.A., (1993) Image Interpretation in Geology, 2nd ed., Chapman and Hall, London.
- Harold, R W., (1969) Aerial Stereo Photographs, Hubbard Press, USA.

Online resources

- Fundemental of remote sensing, Canada Centre for Mapping and Earth Observation , Natural Resources Canada. https://www.nrcan.gc.ca/node/9309
- DST-IGET, Remote Sensing Tutorials http://dst-iget.in/index.php/tutorialdetails/2/2

SEMESTER VI

Course Title: **IGNEOUS PETROLOGY**
Course Code: **GEL-VI.C-8A**
Credits: **3 (45 Contact hours)**
Marks: **75**

Learning Objectives

The course will help the students to understand petrologic processes and common rock types. In practical's, students learn to identify, describe and classify rocks using hand specimens and rock thin sections.

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Understand conceptual techniques wrt nucleation and growth of minerals thereby understanding the formation of a rock.

CO2 Identify igneous rocks in hand specimen.

CO3 Identify igneous rocks in thin sections

CO4 Classify igneous rocks

CO5 Evaluate a rock wrt its environment of formation (PT) conditions thereby assign a name.

CO6 Identify key textural and microstructures and their application related to geological processes.

CO7 Interpret ternary phase diagrams.

CO8 Classify rocks based on their chemical analysis.

Module I **(15 hours)**

Meteorites: Mineralogy and whole rock chemistry
Composition of the earth's interior = Primitive mantle Plate tectonics and igneous activity
Partial Melting and Generation of magma.
Magma Diversity:
- Partial Melting: Mafic, Ultramafics
  - Basalts: Magma types, Basalt Tetrahedron.
- Anatexis in Felsic rocks
  - Granites/Pegmatites: Mingling, Mixing and Crustal contamination
- Igneous layering - crystal settling
  - Gabbroic rocks, Anorthosite

Layered complexes Differentiation: Fractional Crystallization, liquid immiscibility, flowage differentiation

Module II **(15 hours)**

Ascent and emplacement of magma

Textures and microstructures of igneous rocks:

a. Primary: Nucleation, Growth, Diffusion
b. Secondary: Oswald ripening, twinning, zoning

Classification and Description of Igneous Rocks:

The International Union of Geological Sciences (IUGS) Classification System: Gabbros, Granites (QAPF diagram).

Ternary System: Diopside-Albite-Anorthite (Di-Ab-An)

Module III **(15hours)**

Study of the following rock types (mineralogy, petrography and petrogenesis)

Ophiolites
Granitoids
Carbonatites
Kimberlites

Practical: 1 credit

Maximum Marks: 25

- Study of igneous rocks in hand specimen.
- Study of igneous rocks in thin sections
- CIPW Normative calculations

List of books recommended for reference

Mandatory reading

- Frost B R and Frost C D., (2014) Essentials of Igneous and Metamorphic Petrology, Cambridge University Press.
- Gill, R., (2010). Igneous rocks and process – A Practical Guide, Wiley-Blackwell
- Winter, J.D., (2009) Principles of Igneous and Metamorphic Petrology, Prentice Hall

Supplementary reading

- Best, M.G., (2002). Igneous and Metamorphic Petrology, 2nd edn., Blackwell, Oxford.
- Bose, M.K., (1997). Igneous Petrology, The World Press, Kolkata.
- Raymond, A. L., (1995). Petrology-The study of Igneous Sedimentary and Metamorphic rocks. Wm. C. Brown Communications, Inc.; USA.
- MacKenzie, W. S., Donaldson, C H., and Guilford, C., (1982). Atlas of Igneous Rocks and Their Textures, Wiley

Course Title: **PHANEROZOIC STRATIGRAPHY OF INDIA**
Course Code: **GEL-VI.E-13B**
Credits: **3 (45 contact hours)**
Marks: **75**
Prerequisite: **GEL-V.E-9A**

Course Objectives

The course will help understanding the Indian stratigraphic units and to correlate International Geological Time Scale with Indian Stratigraphic Time Scale. Also to understand the geology, stratigraphy, fossil content, economic resources of the lithounits from the Phanerozoic Eon from the Indian context.

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Understand the Gondwana sedimentation and its economic significance.

CO2 Understand the geology and geotectonics of Triassic of Spiti.

CO3 Understand the geology and geotectonics of Jurassic of Kutch.

CO4 Understand the geology and geotectonics of Cretaceous of Trichinopoly.

CO5 Understand Deccan Flood Volcanism.

CO6 Analyse and interpret the Gondwana breakup.

CO7 Understand the geology and geotectonics of Tertiaries of Assam and its economic significance.

CO8 Understand the upheaval and evolution of Himalayas.

CO9 Relate boundary problems associated with Precambrian-Cambrian, Permian-Triassic, Cretaceous-Tertiary and Pleistocene-Holocene boundaries in India and their relation to mass extinctions.

CO10 Prepare lithostratigraphic maps.

Module I **(15 hours)**

Precambrian-Cambrian boundary
Cambrian Tal
Muth Quartzites
Gondwana sedimentation: Peninsular, Extra-Peninsular
Permian-Triassic boundary

Module II **(15 hours)**
Jurassic of Kutch
Cretaceous of Trichinopoly
Deccan Flood Basalt (Age and Stratigraphy)
Cretaceous-Paleocene boundary

Module III **(15 hours)**
Tertiaries of Assam
Rise and evolution of Himalayas
Siwaliks
Pleistocene-Holocene Boundary
Plant and animal life in relation to glacial and interglacial cycles during Quaternary.
Recent: Laterite Formations of Goa

Practical Course**: 1 credit**
Maximum Marks**: 25**

1. Preparation of lithostratigraphic maps of India showing distribution of important geological formations.
2. Study of type hand specimens from their stratigraphic position and age.
3. Stratigraphic map of Goa

List of books recommended for reference

- Nanda, H., (2014) Indian Stratigraphy, Anmol Publications Pvt. Ltd. New Delhi.
- Valdiya, K. S., (2010). The Making of India, Macmillan India Pvt. Ltd.
- Nichols, G., (2009) Sedimentology and Stratigraphy, Wiley-Blackwell and Sons Ltd.
- Sharma, R S., (2009) Cratons and Fold belts of India, Springer-Verlag Berlin Heidelberg.
- Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley.
- Ramakrishnan, M and Vaidynadhan, R., (1994) Geology of India, Geological Society of India Publication, Bangalore. Vol. I and II.

Course Title: **ROCK STRUCTURES AND DEFORMATION MICROSTRUCTURES**
Course Code: **GEL-VI. E-14A**
Credits: **3 (45 Contact hours)**
Marks: **75**
Prerequisite: **GEL-V.E-11A**

Learning Objectives

The course will help to study deformational history of rocks. This study includes the understanding of the deformation and metamorphic processes the rock has undergone with the aim to reconstruct its structural and metamorphic history.

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Understand the process and mechanisms of rock structures and rock deformation microstructures.

CO2 Interpret the significance of microstructures in Igneous, Sedimentary and Metamorphic rocks.

CO3 Apply the significance of features like foliation and lineation in field as well as in microsections in understanding microstructures and rock deformation.

CO4 Interpret Shear Sense Indicators in Mylonites.

CO5 Enhance application skills in relating deformation history to tectonism.

CO6 Interpret deformation features in field and in microsections.

CO7 Identify and Interpret the significance of rock structures in thin sections.

CO8 Identify and Interpret the significance of rock deformation microstructures in thin sections.

Module I **(15 hours)**

Introduction to microstructures and terminology; Deformation mechanisms and processes– Brittle fracturing, Dissolution, Intracrystalline deformation; Twinning and kinking; Recovery; Recrystallization; Solid state diffusion, Grain Boundary Area Reduction (GBAR), Static recrystallization.

Module II **(15 hours)**

Foliation and its significance; Lineation and its significance; Mylonites, Shear sense indicators in mylonites; Strain shadows; Deformation of rock-forming minerals; Deformation of polymineralic rocks.

Module III **(15 hours)**

Microstructures of – igneous rocks (porphyritic rocks, mineral intergrowth, zoning); sedimentary rocks (sandstone); metamorphic rocks (isotropic fabrics, growth of porphyroblasts, twinning, sympectite intergrowth) and deformed rocks (deformation twinning, stylolites, GBM), fossils as strain markers

Practical Course:1 credit
Maximum Marks: 25

Study of rock slides exhibiting various microstructures:

- Cuspate and lobate sutured boundaries,
- GBAR (Grain Boundary Area Reduction),
- Bulging (BLG), Subgrain Rotation (SGR); Grain boundary migration (GBM)
- Deformation twins and Displaced twin lamellae
- Bending of cleavage planes, spaced and continuous cleavage
- Mineral (mica) fish,
- Porphyroclasts, asymmetric porphyroclasts depicting shear sense,
- Pressure shadows,
- Warping of foliation around porphyroclasts,
- S-C fabric.

List of books recommended for reference

Mandatory reading

- Winter, J D., (2014) Principles of Igneous and Metamorphic Petrology, Pearson Education Limited.
- Trouw, R A., Passchier, C W and Wiersma, D J., (2010) Atlas of Mylonites - and related microstructures, Springer-Verlag Berlin Heidelberg
- Passchier, C. W and Trouw, R A., (2005) Microtectonics, Springer-Verlag Berlin Heidelberg
- Vernon, R H., (2004) A Practical Guide to Rock Microstructures, Cambridge University Press.
- Blenkinsop, T. (2002) Deformation microstructures and mechanisms in minerals and rocks, Kluwer Academic Publishers.

Supplementary Reading

- Mukherjee, S., (2013) Deformation Microstructures in rocks. Springer-Verlag Berlin Heidelberg.

Course Title: **SURVEYING, MAPPING AND FIELD GEOLOGY**
Course Code: **GELVI.E-15A**
Marks: **75**
Credits: **3 (45 Contact hours)**
Mandatory requirement: **Individual Laptop with MS Windows OS**

Course Objectives

To Provide basic knowledge of surveying techniques
To upgrade and relate the theoretical knowledge of Geological aspects to field observations.
This course also introduces the basic principles and techniques of Geographic information Systems (GIS)

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Carry out dumpy level survey.

CO2 Carry out plane table survey.

CO3 Understand SOI Toposheet catalogue.

CO4 Learn to plan for a geology field trip.

CO5 Record detailed field observations systematically in their field diary and subsequently prepare a geologic field report of the same.

Module I **(15 hours)**

Surveying, Objectives of Survey;
Primary divisions of Surveying – Geodetic and Plane Surveys uses and Principles of Surveying.
Methods of locating a point
Plane Table Survey: Instruments, Procedures of Plane table surveys; Methods (Demonstrative): Radiation and Intersections, advantages and disadvantages of Plane Tabling.
Levelling, characteristics of land surveying instruments, Bench Marks, Change Points.
Levelling operations and steps in Levelling: Demonstration with exercises in the field.
Principles of Levelling: Simple and Differential,
Reduction of Levels: The Collimation, and Rise and Fall systems of Computation.
Theodolite survey: Principles and working,

Module II **(15 hours)**

SOI Toposheet Indexing scheme, Map symbol reading SOI toposheet map reading
Standard Symbols/colour for lithology and symbols related to structures
Munsell colour chart

Understanding map reliability
GPS surveys
Geological mapping
Basic field gear
Planning a field Project: Preparations for the field, Taking geologic notes in the field: Basic procedures at outcrops – noting characters of igneous, sedimentary and metamorphic rocks, Measuring strike and dip (attitude) of planar and linear features using a clinometer compass, a Brunton Compass.

Module III **(15 hours)**
Introduction to GIS
Components of GIS
Georeferencing
Digitizing: Point, line, polygon
Attribute data
Map layout and cartographic output

Practical course: 1 credit
Maximum Marks: 25

- The evaluation is to be based on preparation of portfolio that should include plans drawn using Plane table, a Levelling Exercise.
- Assessment to be based on presentation of Field diary, Field report, and field based viva voce on the localities visited for field work.
- Hands-on exercises in QGIS and Google Earth.

List of books recommended for reference
Mandatory reading

- Basak, N N., (2014) Surveying and Levelling, McGraw Hill Education.
- Lisle R., Brabham P and Barnes J., (2011) Basic Geological Mapping (Geological Field Guide), Wiley Blackwell.
- C.P.Lo and Albert K. W. Yeung., (2002) Concepts and Techniques of Geographic Information System, Prentice –Hall, India.
- Kang – Tsung – Chang., (2002) Introduction to Geographical Information System, , McGraw Hill.
- Gokhale, N W., (2001) A Guide to Field Geology, CBS Publishers & Distributors.
- Lambert, D A., (1998) Field Guide to Geology, Facts on File Inc.
- Burrough, P. A. and McDonnell, R. A., (2000) Principles of Geographical Information System, Oxford University Press.

- Kanetkar, T P & Kulkarni, S V., (1988) Surveying & Levelling (Part I), Pune VidyarthiGrihaPrakashan.
- Compton, R R., (1985) Geology in the Field, John Wiley & Sons, Inc.
- Compton, R R., (1962) Manual of Field Geology, John Wiley & Sons, Inc.
- Lahee, F H. (1962) Field Geology, McGraw – Hill Book Company, Inc.

Supplementary reading

- Robinson W F and Tallack., (2016) Surveying and Levelling Instruments Theoretically and Practically Described for construction, Qualities, Selection, Preservation, Adjustments and Uses: With other apparatus and Appliances used by Civil Engineers and Surveyors in the Field, Wentworth Press.
- Arora, K R., (2015) Surveying Vol-2 (13^{th} edition). Standard Book House Unit of Rajsons Publication Pvt. Ltd.
- Penning, W H. and Jukes-Browne., (2011) A Textbook of Field Geology, Nabu Press.
- Coe, A, L., Argles, T W., Rothery, D A and Spicer, R A., (2010) Wiley-Blackwell, The Open University.
- McClay, K R., (2007) The Mapping of Geological Structures, John Wiley and Sons.
- Barnes, J W and Lisle, R J., (2004) Basic Geological Mapping, John Wiley and Sons

Online resources

- T. Sutton, O. Dassau, M. Sutton, A Gentle Introduction to GIS, Chief Directorate: Spatial Planning & Information, Department of Land Affairs, Eastern Cape, South Africa (ebook), http://download.osgeo.org/qgis/doc/manual/qgis-1.0.0_a-gentle-gis-introduction_en.pdf
- DST-IGET, QGIS Tutorials http://dst-iget.in/index.php/tutorialdetails/1/1

Course Title: **PRINCIPLES OF GEOPHYSICAL EXPLORATION AND MINING**
Course Code: **GEL-VI.E-16A**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

Mining being a key source of revenue generation for the Central as well as State governments, and an important job provider for Geologists, this course is designed to equip the undergraduate student with basic knowledge of key concepts of mining processes right from exploration to exploitation, together with an acquaintance of government regulations that control the mining and mineral conservation processes. In Geophysical exploration the student will gain first-hand knowledge dealing with the principles and their significance.

Course Outcomes

Upon completion of the course, the student will be able to,

CO1 Gain knowledge of key concepts of mining processes right from exploration to exploitation

CO2 Understand the difference between the nature of, and factors leading to the choice between, Open-cast and Underground mining methods.

CO3 Explain the different techniques of ore beneficiation.

CO4 Get acquainted with government agencies and regulations that control the mining and mineral conservation processes.

CO5 Explain the principles behind, and methods of Geophysical, Geochemical and Geobotanical exploration.

CO6 Draw cross - and longitudinal sections using bore-hole Data.

CO7 Estimate ore reserves using different methods.

CO8 Get a first-hand experience in core-logging

Module I **(15 hours)**

Mining Terminology
Classification of mining methods.
Factors influencing choice of mining method

- Open cast mining
- Underground mining
  - Coal mining methods
  - Alluvial mining

Ore Dressing or Beneficiation:

- Principles and methods
- Terminology of quantification of results

Environmental Impact of Mining

Brief outline of:

National Mineral Policy

Regulations and Acts

Regulating Agencies

Module II **(15 hours)**

Mineral Exploration: Sequence and phases

- Float ores and In situ ores
  - Pits, Trenches and Boreholes
    - Spacing
    - Drilling:
      - Core and non-core drilling
      - Equipment and accessories
      - Core drill sampling
      - core splitting
      - logging
      - Storage
      - Sludge
      - Combining Assay returns from sludge and core

Categories of reserves

Estimation of reserves

- Cross-sectional method
- Area of influence method
- Triangular method
- Weighted volume estimate method
- Estimation of stockpiles by prismoidal formula

Module III **(15 hours)**

Methods of Exploration: Geobotanical, Geochemical and Geophysical.

Geophysical Methods:

Self-potential method:, mechanism, equipment, interpretation of anomalies.

Gravity surveying:, , Gravity surveying, Interpretation

Magnetic surveying:, concepts, Rock magnetism, Geomagnetic field, Magnetic anomalies, Instruments used, Corrections, Interpretation, Application.

Practical Course**: 1 credit**
Maximum Marks: **25**

1. Drawing cross - and longitudinal sections using bore-hole data
2. Problems based on estimation of ore reserves
3. Interpretation of bouguer gravity anomaly maps, and magnetic data.
4. Core logging

List of books recommended for references

- Keller, E. A., (2011) Environmental Geology, Pearson Prentice Hall.
- Sharma J. P., (2009) Environmental Studies, Laxmi Publications (P) Ltd, New Delhi.
- Lowrie, W., (2007) Fundamentals of Geophysics. Cambridge University Press.
- Marjoribanks, R., (1997) Geological Methods in Mineral Exploration and Mining, Springer-Science+Business Media
- Telford, W. M., Geldart, L. P., and Sheriff, R. E., (1990) Applied geophysics (Vol. I) Cambridge University Press.
- Bhimasarikaram V.L.S., (1990) Exploration Geophysics - An Outline by Association of Exploration Geophysicists, Osmania University, Hyderabad.
- Dobrin, M B and Savit C H., (1988) Introduction to Geophysical Prospecting, McGraw Hill Inc.
- Babu S. K. & Sinha D. K., (1988) Practical Manual of Exploration and Prospecting, CBS Publishers and Distributors, New Delhi.
- Peters, W C., (1987) Exploration and Mining Geology, Wiley
- Ramachandra Rao and Prasaranga, M B, (1975) Outlines of Geophysical Prospecting - A Manual for Geologists by University of Mysore, Mysore.
- Arogyaswamy, R. N. P., (1973) Courses in Mining Geology, Oxford & IBH Publishing Co.
- Sinha, R. K & Sharma N. L., (1970) Mineral Economics, Oxford & IBH Publishing Co.
- McKinstry H. E., (1948) Mining Geology, Prentice-Hill Inc.
- Indian Bureau of Mines (IBM) Publications.

ANNEXURE A

Department of Geology

(Summary of changes incorporated in the syllabus)

Semester	Course Title	Existing (Indicate only the unit where the change is proposed)	Changes Proposed	Specify the reason for the change
V	GEL-V.E-9B Precambrian Stratigraphy of India	GEL-V.E-9A Stratigraphy of India – Part I	Change in the title of the course; geologic time specified	as the prescribed syllabus pertains to a specific geologic time
VI	GEL-VI.E-15A Surveying, Mapping and Field Geology	GEL-VI.E-15 Surveying and Field Geology Change is proposed in Module II and III	Existing Module I on Surveying and Module II on Levelling are merged as Module I. Existing Module III on Field Geology is adjusted as Module II and a new module on GIS is added as Module III	The said module on GIS was existing only as a practical component and no theory on its application was conducted
	GEL-VI.E-13B Phanerozoic Stratigraphy of India	GEL-VI.E-13A Stratigraphy of India – Part II	Change in the title of the course; geologic time specified.	as the prescribed syllabus pertains to a specific geologic time

Parvatibai Chowgule College of Arts and Science, Margao- Goa (Autonomous)

DEPARTMENT OF GEOLOGY

THREE YEAR B.Sc. DEGREE PROGRAMME IN GEOLOGY

(3^{rd} Revision- Implemented June, 2020)

COURSE STRUCTURE FOR SEMESTER I, III & V

Semester	CORE COMPULSORY		CORE ELECTIVES				SKILL ENHANCEMENT COURSES (SEC)
I	**GEL-I.C-1** Fundamentals of Mineralogy	**GEL-I.C-2A** Earth's Dynamics and Tectonics					
III	**GEL-III.C-5A** Advanced Mineralogy and Geochemistry		**GEL-III.E-1** Physical Geology	**GEL-III.E-2** Groundwater and Hydrogeology	**GEL-III.E-3A** Ore Genesis	**GEL-III.E-4** Marine Geology	***GEL-III.SEC-1:*** *Operational Geology and Gemmology*
V	**GEL-V.C-7** Sedimentary Petrology		**GEL-V.E-9B** Precambrian Stratigraphy of India	**GEL-V.E-10** Petroleum Geology	**GEL-V.E-11A** Metamorphic Petrology	**GEL-V.E-12** Remote Sensing and Digital Image Processing	

COURSE STRUCTURE FOR SEMESTER II, IV & VI

Semester	CORE COMPULSORY		CORE ELECTIVES				SKILL ENHANCEMENT COURSES (SEC)
II	**GEL-I.C-1** Fundamentals of Mineralogy	**GEL-I.C-2A** Earth's Dynamics and Tectonics					
IV	**GEL-IV.C-6** Structural Geology		**GEL-IV.E-5A** Engineering Geology	**GEL-IV.E-6A** Optical Mineralogy	**GEL-IV.E-7** Natural Hazards and Management	**GEL-IV.E-8** Geotectonics	***GEL-IV.SEC-2:*** *GIS for Beginners*
VI	**GEL-VI.C-8A** Igneous Petrology		**GEL-VI.E-13B** Phanerozoic Stratigraphy of India	***GEL-VI.E-14B*** *Rock Structures and Deformation Microstructures*	**GELVI.E-15A** Surveying, Mapping and Field Geology	**GEL-VI.E-16A** Principles of Geophysical Exploration and Mining	

Revised Course Structure and List of Core, Elective and Skill Enhancement Courses

COMPONENT A

SEMESTER	CORE COURSES		ELECTIVE COURSES				SEC
I	**GEL-I.C-1** Fundamentals of Mineralogy	**GEL-I.C-2A** Earth's Dynamics and Tectonics	-----	-----	-----	-----	
II	**GEL-II.C-3A** Elementary Petrology	**GEL-II.C-4** Principles of Stratigraphy and Paleontology	-----	-----	-----	-----	
III	**GEL-III.C-5A** Advanced Mineralogy and Geochemistry		**GEL-III.E-1** Physical Geology	**GEL-III.E-2** Groundwater and Hydrogeology	**GEL-III.E-3A** Ore Genesis	**GEL-III.E-4** Marine Geology	**GEL-III.SEC-1:** Operational Geology and Gemmology
IV	**GEL-IV.C-6** Structural Geology		**GEL-IV.E-5A** Engineering Geology	**GEL-IV.E-6A** Optical Mineralogy	**GEL-IV.E-7** Natural Hazards and Management	**GEL-IV.E-8** Geotectonics	**GEL-IV.SEC-2:** GIS for Beginners
V	**GEL-V.C-7** Sedimentary Petrology	**GEL-V.CP** Core Project	**GEL-V.E-9B** Precambrian Stratigraphy of India	**GEL-V.E-10** Petroleum Geology	**GEL-V.E-11A** Metamorphic Petrology	**GEL-V.E-12** Remote Sensing and Digital Image Processing	
VI	**GEL-VI.C-8A** Igneous Petrology	**GEL-VI.CP** Core Project	**GEL-VI.E-13B** Phanerozoic Stratigraphy of India	**GEL-VI.E-14B** Rock Structures and Deformation Microstructures	**GELVI.E-15A** Surveying, Mapping and Field Geology	**GEL-VI.E-16A** Principles of Geophysical Exploration and Mining	

Core Courses for students offering **Geology as the Minor**

SEMESTER I GEL-I.C-1: FUNDAMENTALS OF MINERALOGY
SEMESTER II GEL-II.C-3A: ELEMENTARY PETROLOGY
SEMESTER III GEL-III.C-5A: GEOCHEMISTRY AND SYSTEMATIC MINERALOGY
SEMESTER IV GEL-IV.C-6: STRUCTURAL GEOLOGY
SEMESTER V GEL-V.C-7A: SEDIMENTARY PETROLOGY
SEMESTER VI GEL-VI.C-8A: IGNEOUS PETROLOGY

SEMESTER

I

Course Title: **FUNDAMENTALS OF MINERALOGY**
Course Code: **GEL-I. C-1**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives
As minerals are building blocks of earth's material the course is designed to understand the basic concepts in mineralogy, their chemistry and identification of minerals in hand specimens. Further, the students will study crystallography in understanding the morphology, symmetry and the normal crystal classes.

Course Outcomes
Upon completion of the course, the student will be able to :

- **CO1** Explain what is a mineral and its formation.
- **CO2** Explain mineralogical properties like polymorphism, isomorphism, Pseudomorphism.
- **CO3** Describe the physical properties of minerals.
- **CO4** Relate crystal chemistry and chemical bonding to the formation of minerals like crystal structure, chemistry, chemical composition.
- **CO5** Compare and contrast the elemental and major oxide composition of the crust with the entire earth.
- **CO6** Link how the internal atomic structure of minerals affects the external development of a crystal in terms of crystal symmetry, crystal system and crystal forms.
- **CO7** Identify rock- forming minerals in hand specimen using their physical properties.
- **CO8** Classify minerals into crystal systems based on crystal symmetry.

Module I **(15 hours)**
Minerals: Rock-forming minerals and ore minerals.
Common physical properties of minerals including electrical and magnetic properties.
Isomorphism, Polymorphism, Pseudomorphism
silicate structures: (sorosilicate/ cyclosilicates/ nesosilicates/ inosilicate/ phyllosilicates/tectosilicate)
Introduction to rock-forming mineral Olivine, Pyroxene, Amphibole, Mica, Feldspar, Quartz and its varieties
Important and abundant mineral groups: aluminosilicates, sulfides, sulfates, carbonates; oxides; halides; native metals (with three examples each)

Module II **(15 hours)**
Elemental and major oxide composition of the earth's crust -
Types of Atomic bonds (Ionic/Covalent/Metallic/ Van der Waal).
Radius Ratio, Ionic Radius,
Co-ordination Number.Types of co-ordination.
Atomic arrangement (HCP/CCP)

Module III **(15 hours)**
Space lattice.Unit cell.External morphology of a crystal. Crystal Forms with examples.
Crystallographic axes and Crystal systems.
Symmetry in crystals. (Axis, Plane, Center)
Interfacial angles and Contact Goniometer.
Parameters and Indices

Practical: 1 credit
Maximum Marks: 25

1. Identifying and determining the crystal symmetry, class, system and forms in the normal class of the six systems.
2. Identification and study of minerals w.r.t their physical properties, occurrence, chemical composition and use.

List of books recommended for reference
Mandatory Reading

- Perkins, D., (2015), Mineralogy, Pearson Education Limited.
- Dana, J.D & Ford, W. E., (2010). Dana's Manual of Mineralogy. J. Wiley & Sons.
- Klein, C. and Dutrow, B., (2007). The Manual of Mineral Science, John Wiley & Sons, Inc.
- Read, H. H., (1988). Rutley's elements of Mineralogy, CBS Publications.
- Battey, M H. (1971), Mineralogy for students, Oliver & Boyd

Supplementary Reading

- Deer, W. A., Howie, R. A & Zussman, J., (2013). An Introduction to the rock forming minerals, John Wiley and Sons.

Course Title: **EARTH'S DYNAMICS AND TECTONICS**
Course Code: **GEL-II. C-2A**
Credits: **3 (45 contact hours)**
Marks: **75**

Course Objectives
This is a core branch of earth science which deals with basic concepts of natural internal forces shaping the earth. Earth's Dynamics and Tectonics aims at acquainting the student with these forces as well as the geological structures resulting from the action of these forces on rocks. The course also aims at providing an understanding of the processes in action on the earth's surface and their impact on man and his institutions.

Course Outcomes
Upon completion of the course, the student will be able to :

- **CO1** Explain the origin and nature of the earth and its layered structure.
- **CO2** Gain insights into the spheres of the earth and their inter-relationship, the earth's Gravity, and magnetic field.
- **CO3** Relate the concept of Isostacy with plate tectonics.
- **CO4** Differentiate between the different types of forces acting in the lithosphere and link the different types of responses of brittle and ductile substances to stress.
- **CO5** Explain the exogenous and endogenous geological hazards.
- **CO6** Read and interpret geological maps and draw geological cross – sections.
- **CO7** Recognize different types of folds, faults and joints.

Module I (15 hours)
Origin of Solar System (Nebular Concept) and formation of a layered Earth.
Size and shape of the Earth.
Internal structure of the Earth: Geosphere asthenosphere, lithosphere, hydrosphere, biosphere, atmosphere (anoxic to oxic conditions) wrt to earth dynamic
Earth's Gravity : Acceleration due to gravity, change with latitude and altitude.
Earth's Magnetism: Earth as a magnet; lines of force, Source of Earth's Magnetic field, Declination and inclination, Geomagnetic axis and Geographic axis.

Module II (15 hours)
Introduction to Plate Tectonics:
Concept of isostacy
Lithostatic or confining pressure, Differential forces: tension, compression, couple.
Concept of stress and strain: stages of deformation: Elastic, Plastic and Rupture.
Brittle and ductile substances.
Introduction to geological hazards: exogenous (floods, drought and cyclones) and endogenous (volcanic hazards, earthquakes and tsunamis, mass wasting)

Module III **(15 hours)**

Map and Scales

Stratification, Strike and dip (true and apparent dip) strike and dip symbols.

Outcrop patterns of Horizontal, Inclined & vertical strata on various types of grounds (horizontal ground, valley and spur).

Folds: Terminology, causes, types of folds; symmetrical, asymmetrical, overturned, recumbent, isoclinal, fan, chevron, monocline, structural terrace, plunging and non-plunging; significance. Outcrop pattern of folds on horizontal ground, valley and spur.

Faults: Definition & terminology, geometric classification, significance; horst and graben.

Joints: Geometric classification, map symbols, columnar joints and sheet structure, significance.

Unconformities: Stages of development, types, significance; outliers and inliers; overlap and offlap.

Practical: 1 credit

Maximum Marks: 25

1. Drawing cross-section and description of structural maps involving single series (Horizontal and Inclined)
2. Graphical solution to structural problems.

List of books recommended for reference

Mandatory reading

- Travis, H., 2012. Living with Earth, Phi Learning Pvt. Ltd., New Delhi.
- Press, Siever, Grotzinger and Jordan., 2003. Understanding the Earth (4th edition).
- Charles C. Plummer and David McGeary., 2001. Physical Geology, (4th edition), Wm C. Brown Publishers.
- Monroe and Wicander., 2001. The Changing Earth: Exploring Geology and Evolution (3rd edition).
- Jain, A K .,Structural geology, , Geological Society of India.
- Holmes' Principles of Physical Geology edited by P.McL.D.Duff (ELBS).
- Hils, E. S., Elements of Structural Geology, Methuen.
- Mukerjee. P. K., A Textbook of Geology, World Press.

Supplementary Reading

- Zumberge J.H. & Nelson C.A., Elements of Geology (3rd edition), John Wiley & Sons, New York.

SEMESTER II

Course Title: **ELEMENTARY PETROLOGY**
Course Code: **GEL-I.C-3A**
Marks: **75**
Credits: **3** (**45 contact hours)**

Course Objectives
Petrology is the science of rocks. The course will help the students to exhibit an improved understanding of fundamental petrologic processes and common rock types. In practicals, students learn to identify, describe and classify rocks using hand specimens.

Course Outcomes
On completion of the course the students will be able to :

- **CO1** Explain the processes involved in the formation of rocks, their textures and structures.
- **CO2** Classify rocks into their various types – Igneous, Sedimentary or Metamorphic.
- **CO3** Explain the importance of rocks.
- **CO4** Differentiate between the different rock types based on their textures, structures and mineralogy.
- **CO5** Identify the different textures and structures of rocks.
- **CO6** Describe the mineralogy and properties of, and identify common rock types.

Module I **(15hours)**

- Rocks and rock cycle
  - Magma: Definition, formation, composition,
    - Properties: temperature, density, viscosity
    - Bowen's Reaction Series
  - Mode of occurrences of Igneous rocks
  - Plutonic: Batholiths (stocks, bosses and roof - pendants), Multiple and Composite intrusions.
  - Hypabyssal: Dykes (Radiating, Arcuate, Ring dykes,), Sills, Laccoliths, Lopoliths
  - Extrusive forms: pyroclastics, lava flows and Volcanic necks,
  - Central and Fissure type of eruptions
  - Structures of Igneous rocks : layering, flow banding
  - Textures of Igneous rocks aphanitic (glassy), : phaneritic: porphyritic, poikilitic, ophitic, sub ophitic; holocrystalline
    - Classification: Based on chemical composition (TAS diagram)

Module II **(15 hours)**
Weathering (, types – Chemical and Physical, and products), Erosion, Transportation and Deposition
Diagenesis
Udden-Wentworth classification based on grain size
Sedimentary structures: Primary (stratification), chemogenic and biogenic
Textures: clastic and non clastic

Sedimentary environments: aeolian, fluvial, glacial and marine

Module III **(15 hours)**
Factors controlling metamorphism.
Types of metamorphism: burial, regional and contact,
Metamorphic grade
Metamorphic textures and structures: Foliated and non-foliated.
Index minerals and Isograds
Nomenclature of metamorphic rocks
Protolith: recognition and types (Mafic, Quartzofeldspathic, Pelitic, Calcareous,)
Metasomatism

Practical: 1 credit
Maximum Marks: 25
- Megascopic study of Igneous, Sedimentary and Metamorphic rocks.

List of books recommended for reference
Mandatory Reading

- Winter, J D., (2014). Principles of Igneous and Metamorphic Petrology, Pearson Education Limited.
- Gill, R., (2010) Igneous rocks and process – A Practical Guide, Wiley-Blackwell
- Boggs S., (2009) Petrology of Sedimentary rocks (2nd edition), Cambridge University Press.
- Prothero, D. R., and Schwab, F.; (2004) Sedimentary Geology. Macmillan.
- Best, M., (2003). Igneous and Metamorphic Petrology, Blackwell Publishing.
- Tucker E.M. (2001) Sedimentary Petrology (3rd Edition), Blackwell Science Ltd.
- Pettijohn F.J., (1984) Sedimentary Rocks (3rd Edition), CBS Publishers, New Delhi.

Supplementary Reading

- Ehlers, E.G. and H. Blatt., 1982. Petrology, Igneous, Sedimentary and Metamorphic, W.H Freeman, San Francisco.
- Mahapatra G B. A Textbook of Geology, CBS
- Parbin Singh. A Textbook of Engineering and General Geology (Seventh Ed),
- Mukerjee, P K. A Textbook of Geology, World Press.

Course Title: **PRINCIPLES OF STRATIGRAPHY AND PALEONTOLOGY**
Course Code: **GEL-II. C-4**
Marks: **75**
Credits: **3 (45 Contact hours)**

Course Objectives

Stratigraphy and Paleontology, the two branches of Geology work together to unearth the secrets of age from rocks of the earth's crust. Stratigraphers study the composition and arrangement of layered or stratified rocks. Paleontologists study the remains of plants and animals which have been preserved in the earth's crust by natural processes. With these objectives in mind it becomes pertinent to understand the basic concepts of Stratigraphy and Palaeontology.

Course Outcomes

Upon completion of the course, the student will be able to :

- **CO1** Explain principles of Stratigraphy and concept of Facies.
- **CO2** Differentiate between absolute and relative age of the earth.
- **CO3** Explain measurements of geologic time.
- **CO4** Describe how rocks are correlated.
- **CO5** Describe types of fossils, conditions and modes for fossilisation, how fossils can be used to locate economic deposits.
- **CO6** Describe and explain morphology of the hard parts of different phylum's and geological time range.
- **CO7** Explain map reading and handle clinometer compass.
- **CO8** Solve problems on bearings.
- **CO9** Describe and identify fossils/casts/shells w.r.t their morphology and geological age
- **CO10** Apply classroom teaching to field observations and preparing a geological report.

Module I **(15 hours)**

Principles of stratigraphy: Uniformitarianism, Original horizontality, Order of superposition, Faunal succession, Cross-cutting relationship, Inclusions.
Principles of stratigraphic analysis, Facies concept in stratigraphy
Walther's Law of Facies.
Age of the earth:, radiometric dating; Principles.
Measurement of geologic time:

Time Units: Eon-Era-Period-Epoch-Age
Lithostratigraphic/ Rock Units: Group-Formation-Member-Bed
Chrono-/ Time stratigraphic units: Erathem-System-Series-Stage
Standard Stratigraphic Scale.

Correlation and methods of Correlation:

Paleontological Criteria : Index/ Zone fossils
Lithological Similarity: Marker/ Key bed
Structural relations: Tectonic criteria

Brief account of the Geological Formations of Goa.

Module II **(15 hours)**
Fossils: Mega- Micro-Ichnofossils
Conditions for fossilization; Favourable environments for fossilization.
Modes of fossilization: Petrification, Carbonization, Natural moulds and casts
Frozen and mummified fossils.
Uses of fossils in locating coal and petroleum deposits.

Module III **(15 hours)**
Binomial Nomenclature of Organisms and Taxonomy
Morphology of the hard parts and geological time range of the following:
Phyllum: Arthropoda- Class: Trilobita
Phyllum: Mollusca- Class :Pelecypoda
:Gastropoda
:Cephalopoda- Nautiloidea
Ammonoidea
Belemnoidea
Phyllum: Brachiopoda
Phyllum:Echinodermata- Class: Echinoidea

Practical: 1 credit
Maximum Marks: 25

- Map reading
- Use of clinometer compass and exercises on Bearings
- Study of fossils/casts/shells w.r.t their morphology and geological age.

List of books recommended for reference
Mandatory Reading

- Dana, J.D., (2010), Manual of Geology, Anmol Publications.
- Monroe, J and Wicander, R., (1994). The Changing Earth: Exploring Geology and Evolution, Brooks/Cole
- Black. R M., (1989). The Elements of Palaeontology, Cambridge University Press.
- Spencer, E, W, Basic concepts of Historical Geology, Oxford & IBH Publishing Co.
- Koregave, M A., Fundamentals of Invertebrate Palaeontology, Book World Enterprises.

Supplementary Reading

- A Textbook of Geology, P.K Mukherjee (World Press).

SEMESTER III

Course Title**: ADVANCED MINERALOGY AND GEOCHEMISTRY**
Course Code: **GEL-III.C-5A**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

- The course provides geoscientific study of mineralogy in understanding the structure, chemistry, optical & physical properties, stability relations and genesis of minerals. With respect to geochemistry the student will understand the distribution of various elements and their abundances in the earth's crust.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Explain the concept of Gibbs Phase Rule.
CO2 Correlate structure, chemical composition with physical and optical properties of minerals of major silicate group of minerals.
CO3 Interpret stability relations of minerals using Phase diagrams.
CO4 Explain how minerals originate and associate with each other in a rock
CO5 Explain the geochemical composition of the earth.
CO6 Describe how compatible elements are involved in the various geochemical processes.
CO7 Explain how incompatible elements are involved in the various geochemical processes.
CO8 Evaluate and interpret how geochemistry can be used to interpret tectonic setting.
CO9 Solve applied quantitative problems.
CO10 Plot major oxides in tectonic discriminant diagrams

Module I **(15 hours)**

Introduction to mineral chemistry, Gibbs Phase Rule, Phase diagram.

Structure, mineral chemistry, paragenesis, and Phase diagrams of the following silicate group of minerals:

Olivine group (Forsterite-Fayalite System)
Pyroxene group (Diopside-Anorthite System)
Feldspar group (Albite-Anorthite System; Orthoclase-Albite System)

MODULE II **(15 hours)**

Structure, mineral chemistry, paragenesis, and stability relations of the following silicate group of minerals:

- Feldspathoid group (Leucite-Silica System)
- Silica
- Amphibole
- Mica

MODULE III **(15 hours)**

- Whole rock analysis (major, trace REE)
- Concept of compatible and incompatible elements,
- Use of geochemistry in deducing tectonics.
- Primitive mantle normalized diagram and their significance in petrogenesis.

Practical: 1 credit
Maximum Marks: 25

1. Calculation of end-members for olivine, pyroxene and feldspar group of minerals.
2. Plotting of major oxides in tectonic discriminant diagrams

List of books recommended for reference

- Deer, W. A, Howie, R. A and Zussman. J., (2013). An Introduction to Rock-Forming Minerals, Mineralogical Society.
- Ford, W. E., (2006). Dana's Textbook of Mineralogy (with extended treatise Crystallography and Physical Mineralogy). CBS Publishers, New Delhi.
- Griffen, D. T, Phillips, W. R and William, R. Phillips., (2004). Optical Mineralogy: The Nonopaque Minerals. CBS Publishers, New Delhi.
- Mason and Berry, (2004). Mineralogy, CBS Publishers, New Delhi.
- Faure, G (1998) Principles and Applications of Geochemistry. Prentice Hall
- White, W M (1997) Geochemistry, Wiley-Blackwell
- Krauskopf, K B and Bird, D K (1995) Introduction to Geochemistry. McGraw-Hill
- Mason, B and Moore, C., (1982). Principles of Geochemistry, John Wiley & Sons.

CourseTitle: **PHYSICAL GEOLOGY**
Course Code: **GEL-III.E-1**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives: The natural agencies like wind, rivers, glaciers have been moulding and remoulding the surface of the earth over millions of years. This paper aims at the understanding of the processes and the physical forces responsible in developing the surficial features and highlighting the role of these natural agencies in grading and degrading the land surface.

Course Outcomes:
Upon completion of the course, the student will be able to :

- **CO1** Identify the dominant medium of erosion, transportation and deposition in a given area and explain the mechanisms for those processes.
- **CO2** Identify various dessert landforms and explain the processes involved in their formation.
- **CO3** Identify various fluvial landforms and explain the processes involved in their formation.
- **CO4** Identify various Karst topography and features and explain the processes involved in their formation.
- **CO5** Identify various glacial and coastal landforms and explain the processes involved in their formation.
- **CO6** Assign stream order as per Strahler's Method, Analyze various attributesof basin morphometry and drainage.
- **CO7** Prepare and analyze long and cross sections of river profiles from SOI Toposheet.
- **CO8** Deduct the processes involved in shaping the geomorphology of a local area by an integrated approach of applying theoretical knowledge and field based observations.

Module I **(15 Hours)**

Weathering and erosion

Earth Systems Affecting Weathering

Mechanical Weathering – Pressure Release, Frost Action, Thermal Expansion and Contraction, Salt Growth, Impact of Organism

Chemical Weathering – Organisms Role, Oxidation, Acid Action, Dissolution/Leaching, Hydrolysis, Spheroidal Weathering

Factors Affecting rate of Weathering.

Rate of Weathering versus Stability of Minerals

Weathering versus Erosion

Transportation and deposition

Laminar and Turbulent Flow

Agents of Transportation – Wind, Water, Glaciers, Gravity

Modes of transportation – Bed Load (sliding, rolling, saltation), Suspension, dissolved load

Factors Affecting Depositions

Action of Wind

Generation of Winds,

Characteristics of Desert.

Problems Associated with Desertification.

Sediment Transport – Lifting Mechanism, Bed Load and Suspended Load

Desert Landforms:

Depositional: sand dunes, Sand Seas/Ergs, Playa, sabkha

Erosional: Grooves, Ventifacts & Yardangs mushroom rock, Inselbergs, Mesas and Buttes,

Deflation Basin, Desert Pavement and Lag Gravel

Module II **(15 Hours)**

Drainage Basin and River System –, Drainage Patterns –

Dynamics of Stream Flow – Discharge, Gradient, Velocity, Sediment Load, Base Level

Concept of Graded Stream

River System and Plate Tectonics

Geological Action of Rivers

Erosion by River

Process of Stream Erosion – Removal of Regolith, Downcutting, Headward Erosion.

Bradshaw Model

Erosional Feature in Upper Course - Steep Valleys, Gorges, Interlocking Spurs, Potholes, Waterfall and Rapid

Erosional Features in Middle and Lower Course – Meander, Ox Bow Lake, Hogbacks, Cuestas

Depositional Landforms by River

Floodplains – Meanders, Point Bars, Natural Levees, Backswamps, Braided Stream

Alluvial Valleys – Step Terraces

Deltas – Formation and Types

Alluvial Fans

Erosion by Groundwater

Karst Topography – Caves, Sinkholes, Solution Valleys, Disappearing Streams, Tower Karst

Deposition by Groundwater

Speleothems – Stalactites, Stalagmites

Module III **(15 Hours)**

Types of glaciers and Glacial Budget
Glacier Flow – Surging Glacier, Crevasses
Ablation – Melting, Evaporation, Calving

Geological Work of Glaciers

Erosional Features of Glaciers

Erosion Process– and erosional landforms related to valley and continental glaciation.

Depositional Features of Glaciers

Glacial Drift – Till and Stratified Drift

Action of Sea Waves

Erosional and depositional features of the coast.

PRACTICAL MODULE: 1 Credit

- Basin Morphometry Perimeter Calculation using rotameter
- Area Calculation – Square Grid/Planimeter/Area using triangles
- Stream Ordering (Strahler's Method)
- Drainage Network Morphology – Bifurcation and Length ratio
- Basin Geometry – Basin Circularity, Intensity of Dissection – Drainage Density, Stream Frequency, Hypsometric Curve
- Draw Inference for the Basin based on the result
- Long Profile and Cross Profile of River – Upper Course, Middle Course, Lower Course of river from SOI Toposheet. Field visit to nearby area to understand and describe the various physical geology features.

REFERENCE BOOKS:

- Monroe, S. J and R. Wicander., 2014. The Changing Earth: Exploring Geology and Evolution. Brooks Cole Publishers.
- Mathur, S. M., 2012. Physical Geology of India. National Book Trust
- Carlson, D.H., Plummer, C.C., McGeary, D., 2008. Physical Geology: Earth revealed. Higher Education.
- McConnell, D., Steer, D., Knight, C., Owens, K., Park, L., 2008. The Good Earth – Introduction to Earth Science. Higher Education.
- Monroe, J.S., Wicander, R., Hazlett, R., 2007. Physical geology – Exploring the Earth (6^{th} Ed.) Thomson Brooks/Cole.
- King, C.A.M., 2006: Techniques in Geomorphology, Edward Arnold, London

Course Title: **GROUNDWATER AND HYDROGEOLOGY**
Course Code: **GEL-III.E-2**
Credits: **3(45 contact hours)**
Marks: **75**

Course Objectives

To impart knowledge about groundwater, its movement, methods of its exploration, the criteria of its quality, methods of its conservation, recharge of groundwater, monitoring of groundwater quality and quantity.

Course Outcomes

Upon completion of the course, the student will be able to :

- **CO1** Explain the concept of Groundwater, its sub- surface distribution and sources.
- **CO2** Explain the rock properties of porosity and permeability affecting the movement of groundwater.
- **CO3** Differentiate between the various types of aquifers.
- **CO4** Carry out groundwater exploration by resistivity method.
- **CO5** Draw flow-nets from groundwater levels.
- **CO6** Determine water quality based on various parameters.
- **CO7** Explain the effects of over withdrawal of groundwater and waterlogging, and suggest mitigation measures.

Module I **(15 hours)**

Hydrologic cycle and its components

Factors controlling all the components: Evaporation, precipitation, runoff, Infiltration

Hydrologic budget

Vertical distribution of ground water

Types of Groundwater: soil water, vaddose, capillary water, Meteoric water

Rock properties affecting movement of ground water:

1) Porosity(primary and secondary), effective porosity, specific retention, controlling factors of porosity

2) Permeability: Darcy's law, laboratory methods of measurement of permeability (constant head, falling head), specific yield, Relation between grain size, porosity, specific yield and specific retention.

Definition of an aquifer, aquiclude, aquitard, aquifuge, and types of aquifers: Unconfined, Confined (Artesian), Perched aquifer.

Module II **(15 hours)**

Groundwater Exploration: Resistivity methods

Groundwater levels and Flow nets

Aquifer parameters: 1) Transmissivity, 2) Storativity,3) Hydraulic conductivity: methods of determination (pumping test and tracer test)

Drawdown and cone of depression

Groundwater quality:

- Parameters :physical ,chemical and biological
- Major, minor and trace constituents.
- I.S.I standards for drinking water
-

Module III **(15 hours)**

Effects of withdrawal, effects of waterlogging

Artificial recharge

Saline water intrusion in aquifer

Ghyben-Hertzberg relation

Pollution of ground water: Arsenic and Fluoride

Practical: 1 credit

Maximum Marks: 25

- Drawing flow nets
- Determination of depth to water table from bore hole data.
- Numerical problems on determination of porosity, bulk density, saturation percentage and void ratio of sample
- Problems based on Ghyben –Hertzberg formulae
- Graphical presentation of chemical data of water
- Resistivity survey (demonstration)

List of books recommended for reference

Mandatory Reading

- Todd , D.K and Mays, L.W., 3rd edition , 2012. Groundwater Hydrology, Wiley India Pvt. Ltd.
- Keller, E.A., 4th edition, 2011. Environmental Geology, CBS Publishers, New Delhi.
- Hiscock, K and Bense, V F. Hydrogeology: Principles and Practice.
- Valdiya K.S., 1987, Environmental Geology: Indian Context, Tata-McGraw Hill
- Ragunath H.M., 1983, Groundwater, Wiley Eastern Ltd, New Delhi.

Course Title**: ORE GENESIS**
Course Code**: GEL-III.E-3A**
Credits**: 3 (45 contact hours)**
Marks: **75**

Course Objectives: The course aims at understanding the various types of mineral deposits, classification, their mode of occurrence, geologic & geographical distribution and genesis. It primarily focuses on the processes of formation of ore deposits. Furthermore, it also aims at identification of economic minerals in hand specimens.

Course Outcomes

Upon completion of the course, the student will be able to :

- **CO1** Differentiate between rock-forming minerals and ore minerals.
- **CO2** Explain the basis of classifying ore minerals.
- **CO3** Explain the origin and stages of ore formation.
- **CO4** Classify the various ore minerals under categories such as magmatic, hydrothermal, volcanogenic etc.
- **CO5** Explain the processes involved in the formation of ore deposits.
- **CO6** Explain the genesis and occurrence of various ore deposits in India.
- **CO7** Evaluate ore minerals in hand specimen using their physical properties.

Module I **(15 hours)**

Goldsmith geochemical Classification

Tenor, Prospects, Resource & Reserves of ore minerals

Classification of Ore Deposits:

- Modified Lindgren's Scheme; Bateman Scheme; Based on Tectonic Setting

Processes Forming Mineral Deposits

- Requirements for Ore deposit formation
- Syngenetic & Epigenetic deposits

Magmatic Ore Forming Processes

- Orthomagmatic ore formation (Bushveld; Sudbury)
- Ore deposits at mid-ocean ridges (Black & White Smokers) and in ophiolites (podiform chromites)
- Ore formation related to alkaline magmatic rocks, carbonatites and kimberlites
- Ore deposits in pegmatites

Module II **(15 hours)**

Magmatic-Hydrothermal Ore Forming Systems

- Hydrothermal ore formation (Source of Hydrothermal Solutions; Textures & Structures; Host rock alteration)
- Volcanogenic ore deposits (VMS; Terrestrial epithermal gold, silver and base metal)
- Porphyry copper (Mo-Au-Sn-W) deposits
- Hydrothermal-metasomatic ore deposits
- Skarn, Greisen

Supergene Ore Formation Systems
- Residual (eluvial) ore deposits
- Supergene enrichment by descending (vadose) solutions

Sedimentary Ore Formation Systems
- Black shales in metallogenesis (European Copper Shale)
- Autochthonous iron and manganese Deposits
- Sediment-hosted & submarine-exhalative (sedex) base metal deposits
- Mississippi Valley type (MVT) Lead-Zinc deposits
- Placer deposits

Metamorphic Ore Forming System
- Orogenic Cu-Zn-Au deposits

Ore Deposits in Space and time
- Metallogenic Epochs
- Plate Tectonic Setting of Ore Deposits

Module III **(15 hours)**

Indian occurrences of
- Metallic Deposits:
  - Iron
  - Manganese
  - Chromium
  - Copper-Lead-Zinc
  - Gold
- Non metallic Deposits:
  - Diamond, Baryte, Bauxite,
- Nuclear Minerals
- Industrial Minerals (Refractory, Abrasives, Cement, Fertilizer, Electrical and Electronics).

PRACTICAL MODULE = 1 Credit
- Descriptive evaluation of ore minerals in hand sample
- Introduction to reflected light microscopy of ore minerals (demonstration) Site visits to local mineralized geology

REFERENCE BOOKS

For Ore Forming Process: (E-books Available of All)

1. Pohl, L.W., 2011. Economic Geology – Principles and Practice. Wiley-Blackwell
2. Robb, L., 2005. Introduction to Ore-Forming Processes. Blackwell Publishing
3. Evans, A.M., 1993. Ore Geology and Industrial Minerals – An Introduction (3rd Ed.) Blackwell Publishing
4. Edwards, R. & Atkinson, K., 1986. Ore Deposit Geology and its influence on Mineral Exploration. Chapman and Hall Ltd.
5. Hutchison, C., Economic Deposits and their Tectonic Setting.

For Ore Deposits in Indian Context:

1. Prasad, U., 2014. Economic Geology: Economic Mineral Deposits (2nd Ed.), CBS Publishers, New Delhi
2. Srivastav, J.P., 2012. Introduction to Ore Microscopy. Prentice Hall India Learning Private Limited
3. Tiwari, A.K., 2010. Ore Geology, Economic Minerals and Mineral Economics. Atlantic
4. Gokhale, G.V.G.K., 1983. Ore Deposits of India. CBS Publishers, New Delhi

Mandatory Reading

Principle Reference books used for course preparation will be Economic Geology by Walter Pohl and Economic Geology by Umeshwar Prasad.

Course Title: **MARINE GEOLOGY**
Course Code: **GEL-III.E-4**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives:
To provide knowledge on essential concepts of oceanography.
To study the tectonics, geology, economic resources w.r.t. the oceans.

Course Outcomes:
Upon completion of the course, the student will be able to :

- **CO1** Explain ocean bathymetry and learn to identify features of the ocean floor such as mid ocean ridges, seamounts, guyots, hydrothermal vents, pillow basalts, trenches.
- **CO2** Relate the ocean features to its tectonic origin.
- **CO3** Explain the various processes which generate ocean currents.
- **CO4** Classify marine sediments into four broad categories based on their origin i.e lithogenous ,hydrogeneous, biogenous, cosmogenous.
- **CO5** Identify the characteristics of important marine resources for the future such as polymetallic nodules and gas hydrates.
- **CO6** Recognise how near shore geological processes shape coastlines over time

Module I **(15 hours)**

Ocean basins: Shape, size of the Pacific, Atlantic and Indian Oceans
Coriolis Effect
Ocean circulation
Ocean salinity
Techniques used to study ocean bathymetry
Concept of Plate Tectonics and ocean floor spreading,
Magneto stratigraphy

Module II **(15 hours)**

Marine Provinces
Morphological features of the ocean floor;

- Mid Oceanic Ridges and its features;
- Abyssal plains and its features
- Ocean trench and its features
- Continental slope and shelf and their features
- Ocean islands: Hot spot, Atolls

Module III **(15 hours)**

Clastic Sedimentation in different marine environments:

- Biogenic sedimentation
- Chemogenic sedimentation

Near coastal geological processes
Coastal Zone Regulations (CRZ), Exclusive Economic Zone (EEZ); Minerals in the EEZ of India.
Mineral deposits

Practicals = 1 credit

- Preparation of salinity and ocean current map.
- Drawing and labeling of ocean profile.
- Preparation of ocean resource distribution maps
- Visits to National Laboratories engaged in Ocean Research such as NIO and NCAOR.

List of books recommended for references:

- Trujillo, A. P and Thurman H., 2013. Essentials of Oceanography, Eastern Economy Edition, PHI Learning Pvt. Ltd, New Delhi.
- Pinet, R. P., 2009. Invitation to Oceanography,(5TH Edition), Jones and Bartlett Publishers, London.
- Thurman, H V. and Trujillo A., 2003, Introductory Oceanography, Prentice Hall.
- Qasim, S.Z., 1996, India's Exclusive Economic Zone, Omega Scientific Roonwal, G.S. Publishers.
- Kennett J P., 1981. Marine Geology, Prentice Hall.

Online resources

- https://oceanexplorer.noaa.gov/edu/learning/welcome.html , Date: 15/3/19
- http://www.nio.org/index/option/com_nomenu/task/show/id/134 , Date: 15/3/19

https://pubs.usgs.gov/gip/dynamic/dynamic.html ,

SKILL ENHANCEMENT COURSE (SEC)

Course Title : **OPERATIONAL GEOLOGY AND GEMMOLOGY**
Course Code :**GEL-III.SEC-1**
Credits :**4 (60 Contact hours)**
Marks :**100**

Prerequisites**:** Students should have their own laptops
XII level knowledge of Physics

Course Objectives

- The objective of the course is to provide skills to equip students with the basic skills of data management and analysis in MS Excel.
- The course deals with introduction to simple Excel functions and tools that are commonly used in day-to-day data management.
- Further the course deals with using Excel for Drill hole database management.
- To introduce students to the study of gemstones.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Manage any data in a more systematic manner in excel spreadsheets.
CO2 Perform basic data analysis on a given set of data using Excel tools
CO3 Explain the phases and processes involved in a drilling project.
CO4 Explain the various types of data that is generated in a drilling project
CO5 To create a drill hole database in Excel.
CO6 Decide the factors deciding cost of a gemstone.
CO7 Explain the causes of colours in gemstones
CO8 Explain how gemstones are synthesized.
CO9 Explain how gemstones are enhanced from low-grade to saleable quality.
CO10 Explain the styles of cuts preferred for different gemstones

Module I (15 hours)

Introduction to Excel

Overview of the User Interface, Overview of Workbooks, Editing and Formatting Worksheets

Excel Tables: creation, editing, sorting and filtering of data, conditional formatting, Text to column, Merging and splitting of data.

Formulas and Functions

Statistical functions: mean, mode, variance, standard deviation, Kurtosis

Introduction to charts and Graphs

Setting page layout for printing

Module II (15 hours)

Drill hole data management in Excel

Overview of drilling project: Surveying, geological mapping, Borehole logging, sampling process.

Survey data collection
Sampling data- Quality assurance and Quality control (QAQC): data collection and data analysis, scatter plots and control charts.
Management of drill hole data in excel: types of files (mandatory and optional files)
Data collection, entry and modification and validation.

Module III **(15 hours)**

Introduction to Gemmology
Association of Gemstones with rocks
Factors deciding the cost of a gemstone
Causes of colour in gemstones
International grading of diamonds
Composites

Module IV **(15 hours)**

Enhancement and Treatments of gemstones
Synthesis of gemstones
Need for Faceting
Styles of cut
Visual observation of gemstones

List of books recommended for reference

For Operational Geology

- Berk N. and Carey M.,(2004) Data Analysis with Microsoft® Excel Updated for Office 2007®
- Marjoribanks, R., (1997) Geological Methods in Mineral Exploration and Mining, Springer-Science+Business Media

For Gemmology

- Fernandes S. and Choudhary G., (2010) Understanding Rough Gemstones, Indian Institute of Jewellery.
- Karanth, R V; (2000) Gem and Gem deposits of India, Geological Society of India.
- Read, P. G., (1991). Gemmology, Butterworth-Heinemann Ltd.
- Sinkankas, J., (1969) Mineralogy: A First Course, Van Nostrand Reinhold Company.
- Webster, R., edited by Anderson, B, W., (1983) Gems: Their Sources, Descriptions and Identification, Butterworth-Heinemann Ltd.

SEMESTER IV

Course Title: **STRUCTURAL GEOLOGY**
Course Code: **GEL-IV.C-6**
Marks: 75
Credits: 3 (45 Contact hours)

Course Objectives

The course is designed for the students to understand the geometry and mechanics of the various geological structures that result through the deformative processes operative within the earth.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Gather knowledge about the geometry of various structures acquired by rocks at primary and secondary stages.
CO2 Explain the concepts of stress and strain.
CO3 Explain the application of stress and strain in rock deformation.
CO4 Identify rock structures and deformities like joints, folds and faults.
CO5 Explain a structural separation in geological context based on unconformities.
CO6 Identify secondary structures developing in rocks.
CO7 Interpret geological maps
CO8 Solve structural problems based on provided data.

Module I **15 hours**

Primary and secondary structures.
Concept of rock deformation.
Stress and Strain in rocks, 2-D stress and strain analysis;
Strain ellipses of different types and their geological significance.

Module II **15 hours**

Unconformities.
Joints: Joints and fracture mechanics, classification of joints.
Faults: Terminology, classification, criteria for faulting.
Diapirs (salt domes)

Module III **15 hours**

Cleavage and foliation: types, origin and relation to major structures.
Lineations- Description and origin of lineation.
Folds- morphology; Geometric and genetic classification; Mechanics and causes of folding
Lineation and relationship with folds

Practicals : Credit 1
Maximum Marks: 25

Solving Geological Maps
Completion of Outcrops

Stereographic Projection of Structural Data

Graphical Solution for Structural Problems

List of recommended reference books:

Mandatory Reading

- Hobbs, B and Alison, O. R. D., 2014. Structural Geology: The Mechanics of Deforming Metamorphic Rocks, Elsevier Science Publishing Co. Inc
- Fossen, H., 2010. Structural Geology, Cambridge University Press.
- Twiss, R. J and Moores, E. M., (2006). Structural Geology, W H Freeman and Company.
- Pollard, D. D and Fletcher, R. C., (2005). Fundamentals of Structural Geology, Cambridge University Press.
- Davis, G. H., (1996). Structural Geology of Rocks and Regions, Wiley
- Hatcher, R., (1995). Structural Geology: Principles, Concepts and Problems. Pearson.

Course Title: **ENGINEERING GEOLOGY**
Course Code: **GEL-IV.E-5A**
Marks: **75**
Credits: **3 (45 contact hours)**

Course Objective

To impart sufficient knowledge of engineering geology so as to be able to anticipate the technical problems related to geology of various engineering sites and suggest possible remedial measures.

Course Outcomes

Upon completion of the course, the student will be able to :

- **CO1** Explain issues related to geological basement and structure of a region.
- **CO2** Identify the characteristics of basement rock formations and problems associated with them.
- **CO3** Describe and interpret geological structures in geological maps and drawing cross sections.
- **CO4** Assess the area appropriately suggested for a geotechnical project and apply the geological knowledge for a safe and secure construction and operation of a geotechnical project.
- **CO5** Suggest remedial measures to encounter the problems detected.
- **CO6** Interpret core logs and suggest suitable remedial measures.
- **CO7** Collect data interpret and analyse it to solve problems associated with the engineering project as well as the environment.
- **CO8** Explore and suggest novel ideas using geological background for the geotechnical project.
- **CO9** Suggest Site feasibility based on geological maps.
- **CO10** Carry out physical and mineralogical descriptions of cores.
- **CO11** Draw relationship of core log to RQD values
- **CO12** Compute reservoir area, catchment area, reservoir capacity.
- **CO13** Solve numerical problems on ultimate strength of rocks

Module I **(15 hours)**

Aim of engineering geology

Porosity and permeability of rocks

Principles of mechanical behaviour of rock materials

Engineering properties of rocks; specific gravity, compressive strength, hardness, toughness.

Soil profile and Engineering properties of soil;

Role of structures (joints, fractures, folds, faults) and water/fluids in engineering geology

Use of rocks / aggregates in construction

Module II **(15 hours)**

Role of engineering geologists in planning, design and construction of major man-made civil structural features.

Methods of site investigation

Introduction to core logging

Geological investigations/geotechnical problems related to groundwater occurrence,

Module III **(15 hours)**

Geological investigations for landslides, bridges and tunnels -design and construction.

Geological investigations in dams and reservoirs.

Case studies of dam failures

Site improvement methods

Practical: 1 credit
Maximum Marks: 25

- Site feasibility based on geological map.
- Physical and mineralogical descriptions of cores,
- Relationship of core log to RQD values
- Computation of reservoir area, catchment area, reservoir capacity
- Numerical problems on ultimate strength of rocks

List of recommended reference books.

- Parthsarthy, A, Panchapakesan, V., Nagarajan, R., (2013) Engineering Geology, Wiley.
- Price, D.G.,(2009), Engineering Geology Principles and Practice, Springer.
- Bell, .F.G, (2007). Engineering Geology, Butterworth-Heineman
- Narayanswami S.B.S. (2000), Engineering Geology, Dhanpat Rai & Co, India.
- Sathya, N S., (1992). Engineering Geology, B.S, Dhanpat Rai and Co. Pvt Ltd.
- Gupte R.B. (1992). A Textbook of Engineering Geology., Pune VidyarthiGrihaPrakashan.

Course Title: **OPTICAL MINERALOGY**
Course Code: **GEL-IV.E-6A**
Marks: **75**
Credits: **3 (45 Contact hours)**

Course Objectives

- The objective of the course is to provide the basics of geoscientific studies in Optical Mineralogy involving optical properties of minerals in plane polarized light, in between crossed polars and convergent light. Further, it will strengthen their knowledge in understanding of optical indicatrices and determination of optic sign of minerals. The knowledge of optics is applied in understanding and identification of minerals.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Explain basic concepts in optical mineralogy wrt relief, pleochroism, character between crossed polars, extinction and their types, interference colours, zoning and twinning.
CO2 Correlate elementary principles of optics to crystal optics.
CO3 Distinguish Uniaxial and Biaxial Indicatrix
CO4 Explain the concept of formation of Interference colours and determine their orders as per Newton's Scale.
CO5 Handle Petrological Microscopes.
CO6 Identify major rock-forming minerals in microsections.
CO7 Detect Optic Sign for Uniaxial and Biaxial Minerals using Interference Figures.
CO8 Determine Anorthite content of Plagioclase.
CO9 Calculate Optic Axial Angle.

Module I **(15 hours)**

Introduction: Nature of light, Polarized light, Refractive Index, Critical angle and Total Internal reflection, Wave Surface, Double Refraction.

Parts and working of a Polarizing / Petrological microscope

Properties of minerals in Plane Polarised Light (PPL): Colour, Form, Cleavage/Cracks; Relief, Twinkling; Pleochroism,

Pleochroic halos.

Module II **(15 hours)**

Optical characters of minerals: Isotropism and Anisotropism

Properties of minerals Between Crossed Polars (BXP): Interference colours: Formation, Newton's Scale, Anomalous interference colours;

Extinction and Extinction types.

Twinning and Zoning

Alteration, Inclusions.

Module III **(15 hours)**

Optical accessories
Uniaxial indicatrix
Biaxial indicatrix
Convergent Light: Principle
 Uniaxial Interference Figure
 Biaxial Interference Figure
 Optic sign of Uniaxial and Biaxial Minerals
 2V and 2E

Practical: 1 credit
Maximum Marks: 25

- Identification of common rock forming minerals based on optical properties
- Interference figures (Demonstration)
- Determination of optic sign (demonstration)
- Determination of An-content using extinction angles (demonstration)

List of books recommended for reference

Mandatory Reading

- Perkins, D., (2015). Mineralogy. Pearson New International Edition
- Nesse, D. W., (2012), Introduction to Optical Mineralogy, Oxford University Press.
- Kerr, P., (1977), Optical Mineralogy, McGraw Hill Publishers.
- MacKenzie, W. S and Guilford, C., Atlas of Rock forming minerals in thin section_

Supplementary reading

- Cornelis, K and Cornelis, H. (1993). Manual of Mineralogy, John Wiley and Sons Ltd.

Course **Title: NATURAL HAZARDS AND MANAGEMENT**
Course **Code: GEL-IV.E-7**
Marks: 75
Credits: 3 (45 Contact hours)
Prerequisites: GEL-III.E-1

Course Objectives
The course is designed with an aim to give the student an understanding about: various natural hazards; stages in management aimed at avoiding and /or reducing loss to life and property; and Agencies involved in mitigation and management of damage due to hazards.

Course Outcomes
Upon completion of the course, the student will be able to :

- **CO1** Understand the causes, effects and mitigation measures for natural hazards such as droughts, floods, cyclones, volcanic eruptions, tsunami, landslides & subsidence, salinity hazards, coastal erosion.
- **CO2** Appreciate the CRZ act and its impact on disaster mitigation.
- **CO3** Explain the framework and roles of various bodies under the National disaster management plan of India.
- **CO4** Prepare a simple disaster management plan for a building/unit.

Module I **(15 hours)**
Classification of hazards: Natural and man-made disasters

Droughts: types, causes, mitigation
Floods: causes and effects, prediction, Cloud burst/Flashfloods, remedial measures
Cyclones: Structures, origin, effects, prediction, path tracking and early warning systems.

Module II **(15 hours)**

Volcanic eruption: Types, localization, volcanic hazards and mitigation
Earthquakes: Causes, Magnitude and intensity, Recording, effects and preparedness, Earthquake Zonation Map.
Tsunamis: relation of Tsunamis to tectonics; Damage due to tsunamis, Co-ordinated approach to early warning of tsunamis.
Landslides and Avalanches: Classification of mass wasting, mechanics, causes of landslides and stabilizing methods of slopes; civil engineering measures.
Subsidence: Causes, slow and brisk types

Module III **(15 hours)**

Salinity hazards: Inland and coastal

Coastal erosion and mitigatory measures

CRZ act and its impact on disaster mitigation

National Disaster Management: national and international support

Planning strategy: co-operative plan, identifying resources, setting priorities.

Hazard coping operations and rehabilitation

Proposed operational processes for individual Natural Disasters mentioned above.

Case study of Parvatibai Chowgule College Disaster Plan

Practical: 1 credit
Maximum Marks: 25

- Hazard zonation map of India: ,earthquakes, floods droughts, landslides and Cyclone
- Discussing disaster management plan for Parvatibai Chowgule College
- Land-use land cover mapping

List of books recommended for reference
Mandatory reading

- Paul, K, B., 2011, Environmental Hazards and Disasters: Context, Perspectives and Management, Wiley-Blackwell, West Sussex.
- Keller, E. A., 2011, Environmental Geology, Santa Barbara Prentice Hall.
- Hess, D., 2012, Mc Knight's Physical Geography, PHI learning, Pvt Ltd, New Delhi.
- Sethi, V. K., 2009, Disaster Management, Essential Books PW, New Delhi.
- Joshi M.V., 2004, Environmental Disaster, Causes, Impacts and Remedies, Adhyayan Publishers.
- Krynine, D. and Judd W., 1998, Principles of Engineering Geology and Geotectonics, McGraw Hill.
- Holmes, A., edited by Duff P.M.D.,1993, 4th edition, Physical Geology, E.L.B.S Publications.
- Valdiya K.S., 1987, Environmental Geology: Indian Context, Tata-McGraw Hill

Online resources

- https://ndma.gov.in/en/national-policy.html Date:19/3/19

- The Gazette of India : extraordinary [part ii—sec. 3(i)] ministry of environment, forest and climate change notification New Delhi, the 18th January, 2019 G.S.R. 37(e).— [18/01/2019]- coastal regulation zone notification.

http://www.moef.nic.in/sites/default/files/GSR%2037(E)%20DATED%2018.01.2019.pdf,

Course Title**: GEOTECTONICS**
Course Code: **GEL-IV.E-8**
Marks: **75**
Credits: **3 (45 Contact hours)**

Course Objectives

Ever since the creation of the earth, there have been marked changes in the distribution of land and sea. The dynamics of these changes are stupendous. The subject of Geotectonics aims at understanding the mechanism of such changes and explaining the structure of the earth and the processes responsible for the movement and redistribution of continents and seas.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Gain an insight into the study of the earth's interior using seismic data.
CO2 Explain the various layers of the earth's interior and the mechanism of plate tectonics.
CO3 Explain the origin and nature of the earth's magnetic field and palaeomagnetism.
CO4 Explain the theory of Continental Drift along with supporting evidences.
CO5 Explain mountain building (orogenesis) and its relation with plate tectonics.
CO6 Identify and plot various tectonic features on the earth's surface.

Module I **(15 hours)**

Interior of the earth:

Clues from the study of earthquake and density;
The earth's layers; the crust-continental crust and oceanic crust;
Crust-mantle boundary
Structure of the mantle
Low Velocity Zone (LVZ)
Core-mantle boundary; P wave shadow zone,
Nature of the core; S wave shadow zone.

Earth's Magnetic field:

Origin and nature
Dynamo hypothesis and Herndon's Georeactor Theory.
Geocentric axial dipole,
Paleomagnetism,
Marine magnetic anomalies,
Magnetic reversals and magnetic stripes

Module II **(15 hours)**

Continental drift:

Wegener's hypothesis.

- Evidences: Continental fit; similarity of rock sequences and mountain ranges; glacial evidence, fossil evidence;

Paleomagnetism and Polar wandering.

Plate tectonics:

Plate margins, plate boundaries and associated activities,
Triple junctions;
Divergent, Oceanic Ridges, Sea floor spreading, transform faults; hotspots.
Convergent: oceanic–oceanic, oceanic-continental, continental-continental; oceanic trenches, subduction zones
Transform boundaries;
Wilson Cycle (Rift valleys, the Red sea and the Gulf of Aden)

Geometrical aspects and mechanism of plate motion.

Module III **(15 hours)**

Mountain building: Orogenesis

Plate boundaries and orogenesis: Orogenesis at oceanic-oceanic plate boundaries, oceanic-continental plate boundaries and continental-continental plate boundaries.

Case study: Tracking the rise of Himalayas.

Case study: Frequency of Earthquakes in North India

Case Study: Occurrence of Tsunami in SE Asia

Practical: 1 credit
Maximum Marks: 25

- Plotting of oceanic ridges, trenches, subduction zones, sea mounts, plate boundaries
- Exercises in plate tectonics.

List of books recommended for reference

Mandatory reading

- Monroe, S. J and R. Wicander., 2014. The Changing Earth: Exploring Geology and Evolution, Brooks Cole Publishers.
- Marshak, S., 2011. Earth: Portrait of a Planet, W. W. Norton & Company.
- Prasad, C. V. R. K., 2005. Elementary Exercises in Geology, Universities Press.
- Skinner, J. B and S, C. Porter., 2003. The Dynamic Earth: An Introduction to Physical Geology, John Wiley and Sons.
- Condie, K. C., 1997. Plate Tectonics and Crustal Evolution, Butterworth-Heinemann.
- Duff, D and Holmes, A., 1993, Holmes Principles of Physical Geology, Springer.

SKILL ENHANCEMENT COURSE (SEC)

Course Title : **GIS FOR BEGINNERS**
Course Code :**GEL-IV.SEC-2**
Credits :**4 (60 Contact hours)**
Marks :**100**

Requisites

Students should have their own laptops compatible with the latest long term release of QGIS, Google Earth.

Basic knowledge of computers.

Strong desire to learn new technologies and innovative thinking.

Course Objectives

To impart GIS training in Spatial data visualization techniques, Creating Geospatial datasets, Working with mobile Global Positioning System (GPS) data, tabular data, and raster data, Accessing open source data, Visual image interpretation, Terrain analysis.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Become proficient in the use of leading open source GIS platforms QGIS.
CO2 Use open source GIS platforms Google Earth Pro.
CO3 Use mobile GPS to collect field data and convert it into Suitable GIS data formats.
CO4 Extract geospatial data from both hardcopy maps and open source GIS portals.
CO5 Visually identify various features such as landforms, geologic structures, manmade structures etc on satellite imagery.
CO6 Apply GIS techniques such as those used for analyzing and presenting water quality data.
CO7 Apply GIS techniques such as those used for analyzing and presenting terrain data.
CO8 Produce aesthetically pleasing and informative maps.
CO9 Create Webmaps using Google My Maps.
CO10 Prepare and execute a simple GIS project in their domain of study.

Tools exposed:

We will use open source GIS – QGIS software, Google Earth Pro®, GPS Essentials (for Android phones) throughout the programme.

Module I – Basics of GIS **(15 hours)**

What is GIS? - Installing QGIS, QGIS interface

Spatial Data Model Concepts: Raster and Vector data - Loading spatial data and visualization in QGIS

Coordinate Reference Systems Concept - Projecting and re-projecting data in QGIS.

Concept of Georeferencing - Georeferencing a Toposheet: Using GCP's, Image to Image Registration.

Data creation: Digitization - Data handling and storage in GIS, Creating Data Layers: Point, Line and Polygon, Editing Tools and Functionalities, Symbology/Styling

Working with Mobile GPS - GPS essentials app, collecting Geotagged photographs and data.

From excel to GIS - CSV TO Point layer, Attribute joins from table.

Module II – Visual Image Interpretation and Open source data **(15 hours)**

Overview of Google Earth pro - Installing Google Earth Pro, Interface and working in Google earth pro.

Elements of Visual Image Interpretation: Tone, Texture, Pattern, Shape, Size, Association - Image interpretation using Google Earth Satellite Imagery: Manmade features.

Elements of Visual Image Interpretation: Tone, Texture, Pattern, Shape, Size, Association - Image interpretation using Google Earth Satellite Imagery: Coastal features.

Elements of Visual Image Interpretation: Tone, Texture, Pattern, Shape, Size, Association - Image interpretation using Google Earth Satellite Imagery: Geological Features and landforms.

QGIS plugins - Open Street Maps, Open Layers, MapLibrary

Open Source Data - Overview of Bhuvan portal

Module: III –GIS Analysis and Cartography [Map making] **(15 hours)**

Working with Tabular Data - Field Calculator:Calculating area under a polygon, generate Simple statistics of a vector field, selecting features by expressions.

Working with vector data - Convex Hull, Clipping, Buffer, Dissolve, Merge Shapefiles

Working with Raster Data using DEM - Raster merge and clip using DEM, Reprojecting DEM

Terrain Analysis – Hillshade, Slope, Aspect, Creating layer mask, Profile tool, 3D modelling

Working with groundwater data - Interpolation and Contouring from point data.

Advance cartography and styling - Blending modes, styling by attribute size,symbols, Labels, colour schemes,transparency, textured polygons.

Map Creation - Map Composer- TODALS

Web maps - Google MyMaps

Module IV – GIS applications Case studies and Project **(15 hours)**

Students are expected to execute a meaningful GIS project with their own data or data from open source databases preferable in their subject domain.

References

Online resources

- T. Sutton, O. Dassau, M. Sutton, A Gentle Introduction to GIS, Chief Directorate: Spatial Planning & Information, Department of Land Affairs, Eastern Cape, South Africa (ebook)

http://download.osgeo.org/qgis/doc/manual/qgis-1.0.0_a-gentle-gis-introduction_en.pdf

- QGIS Tutorials

http://www.dst-iget.in./
https://www.qgistutorials.com/en/index.html

Books

- Burrough, P. A. and McDonnell, R. A., (2000) Principles of Geographical Information System, Oxford University Press.
- C.P.Lo and Albert K. W. Yeung., (2002) Concepts and Techniques of Geographic Information System, Prentice –Hall, India.
- Heywood I, Sarah, Cornelius, Steve, Carver.,(2011) An Introduction to Geographical Information Systems, Pearson Education Pvt. Ltd., New Delhi.

SEMESTER V

Course Title: **SEDIMENTARY PETROLOGY**
Course Code: **GEL-V. C-7A**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

To provide an understanding of the origin of sedimentary rocks, the relationship of sedimentary processes to plate tectonics, and the use of sedimentary rocks in the study of the geological past.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Explain the processes leading to the formation of sedimentary rocks.
CO2 Identify and explain the various textures and structures of sedimentary rocks.
CO3 Relate different sedimentary facies with the environment of deposition.
CO4 Describe and identify the textures, structures and mineral composition and origin of various clastic and non-clastic sedimentary rocks.

Module I **(15 hours)**

The Origin of Sedimentary Rocks**:**
Erosion, transportation and deposition of sediments.
Hjulstrom's diagram
Provenance
Components of clastic sediments: Heavy, Clay, Quartz, Feldspars, other minerals
Environment of deposition and sedimentary facies
Basins - Plate tectonics and sedimentation
Sedimentary Textures
Grain Size, Udden-Wentworth Size Scale, Phi Scale, Roundness and Sphericity.
Maturity: Textural, Mineralogical and Chemical
Classification of Sedimentary rocks (Folk's and Dunham's, Okhadas)

Module II **(15 hours)**

Primary sedimentary structures
Depositional, Erosional
Secondary sedimentary structures
Chemical, biogenic
Soft sediment deformations

Module III **(15 hours)**

Clastic Sedimentary Rocks

Sandstones, Breccias and Conglomerates**:**

Textures, Structures, Mineral composition, Textural maturity,

Mudrocks:

Structures, Colour, Mineral composition;

Non-clastic Sedimentary Rocks

Limestones and Dolomites:

Textures; Mineralogy; Structures; Diagenesis, Reefs and Palaeoclimate; Dolomites: Dolomitization.

Residual: (Laterite and Bauxite)

Origin and Climate.

Carbonaceous sediments:

Nature and form of organic residues; The Coal series

Practical Course: 1credit
Maximum Marks: 25

- Study and identification of sedimentary rocks w.r.t textures, structures, their classification.
- Study of sedimentary rocks in thin sections
- Exercises in grain size and shape analysis.

List of books recommended for reference

- Boggs S., (2009) Petrology of Sedimentary rocks (2nd edition), Cambridge University Press.
- Blatt H; Tracy R. J and Owens B. E., (2006) Petrology- Igneous Sedimentary and Metamorphic 3rd edition W H Freeman and Company New York.
- Boggs, Jr., (2005) Principles of Sedimentology and Stratigraphy (4 edition), Prentice Hall.
- Prothero, D. R., and Schwab, F.; (2004) Sedimentary Geology. Macmillan.
- Tucker E.M. (2001) Sedimentary Petrology (3rd Edition), Blackwell Science Ltd.
- Raymond A L (1995) Petrology-The study of Igneous Sedimentary and Metamorphic rocks. Wm. C. Brown Communications, Inc.; USA.
- Greensmith, J. (1989) Petrology of the Sedimentary rocks (7th Edition), CBS Publishers, New Delhi.
- Ehlers G.E. and Blatt H., (1987) Petrology – Igneous, Sedimentary and Metamorphic, CBS Publishers, New Delhi.
- Pettijohn F.J., (1984) Sedimentary Rocks (3rd Edition), CBS Publishers, New Delhi.
- Colinson, J D & Thompson, (1982) Sedimentary Structures, Allen &Unwin.

CourseTitle: **PRECAMBRIAN STRATIGRAPHY OF INDIA**
Course Code: **GEL-V.E-9B**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

The Peninsular India is a shield comprising of composite crustal blocks of Archean antiquity and therefore it preserves record of the various tectonic events that this land has witnessed. This course aims at providing a basic understanding of the various stratigraphic units and the correlation of International Geological Time Scale with Indian Stratigraphic Time Scale. It aims to provide understanding of the Precambrian geology, stratigraphy, fossil content and the economic resources of the lithounits from the Peninsular India.

Course Outcomes

Upon completion of the course, the student will be able to :

- **CO1** Explain evolution and stabilisation of the Archean cratons in India with special emphasis on Dharwar craton.
- **CO2** Explain the tectonics behind Mobile Belts of India
- **CO3** Differentiate between western Dharwar Craton and Eastern Dharwar Craton.
- **CO4** Interpret geological and geochemical differences of the basement rocks for Sargur (Gorur Gneiss) and Dharwarian (Peninsular Gneissic Complex)
- **CO5** Relate the lithostratigraphy of Sargur and Dharwar Schist Belt and correlate it with the Goa Group of rocks.
- **CO6** Explain the Purana basins in India with emphasis on Cuddapah Vindhyans and Kaladgis.
- **CO7** Identify specimens representing rock Formations in Goa
- **CO8** Assigning stratigraphy Formations based on fossils.
- **CO9** Solve problems in stratigraphic correlation

Module I **(15 hours)**

Physiographic subdivisions of India and their distinctive characters.

Geology of India

Cratonic provinces of Peninsular India shield: (Dharwar craton/ Singhbhum craton,/Bundelkhand craton/, Aravalli craton,/ Bastar craton) and their economic importance, with emphasis on the Dharwar craton.

Mobile Belts of Peninsular India: Eastern Ghat Mobile Belt, Satpura Mobile Belt, Pandayan Mobile Belt

Module II **(15 hours)**

Gorur Gneiss

Sargur Supracrustals

Dharwar craton: Eastern Dharwar Craton (Deccan Batholith) and Western Dharwar Craton (Peninsular Gneiss)
Greenschist/Greenstone Belts of Peninsular India:
Dharwar type Greenstone Belt: Dharwar Supergroup: Bababudan Group, Chitradurga Group
Goa Group of rocks
Kolar type greenstone Belt: Kolar

Module III **(15 hours)**
Proterozoic Basins of Peninsular India:
Vindhyan Supergroup;
Cuddapah Supergroup;
Kaladgi Supergroup.
Outline of Bhīma Supergroup, Delhi Supergroup, Kurnool Supergroup

Practical: 1 credit
Maximum Marks: 25
- Study of specimens representing rock formations of Goa.
- Assigning stratigraphy Formations based on fossils.
- Maps related to Indian Geology/ Problems in stratigraphic correlation.

List of books recommended for reference
Mandatory Reading
- Dessai, A G (2018). Geology and Mineral resources of Goa. New Delhi Publishers
- Mascarenhas, A and Kalavampara, G., (2015). Natural Resources of Goa: A Geological Perspective. Geological Society of Goa.
- Ramakrishnan, M and Vaidynadhan, R., (1994), Geology of India, Geological Society of India Publication, Bangalore. Vol. I and II.

Supplementary Reading
- Valdiya, K. S., (2015). The making of India: Geodynamic evolution, Springer
- Nanda, H., (2014), Indian Stratigraphy, Anmol Publications Pvt. Ltd. New Delhi.
- Sharma, R. S., (2009). Cratons and fold belts of India, Springer

Course Title: **PETROLEUM GEOLOGY**
Course Code: **GEL-V.E-10**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

The course aims to provide the students an understanding of essential and basic concepts of Petroleum Geology, the process and the operations involved in Petroleum exploration & extraction and to provide knowledge on the petroliferous basins of India.

Course Outcomes

Upon completion of the course, the student will be able to :

- **CO1** Describe the Physical & chemical properties of Hydrocarbons.
- **CO2** Compare various exploration techniques involved in hydrocarbon detection.
- **CO3** Explain the process of drilling & completion of a Petroleum well.
- **CO4** Prepare isopach maps.
- **CO5** Delineate and describe the petroliferous domains in India.
- **CO6** Analyse well logs.

Module I **(15 hours)**

Introduction and Aspects of Petroleum Geology, Characteristics of Hydrocarbons (Physical and Chemical properties), Petroleum System, Composition, Origin (Types of Kerogen), Occurrence, Migration and Accumulation of Petroleum; Petroleum traps (Stratigraphic and Structural); Reservoir rocks, conditions & mechanisms.

Functions of Petroleum Geologist

Understanding oil and gas: Exploration, Drilling and Completion, Production, Services

Module II **(15 hours)**

Surface indications and direct detection of Hydrocarbons

Surface and Subsurface exploration techniques: Concept

Geophysical methods of exploration: Gravity and Seismic methods

Types of rigs and its selection

Rotary drilling system and equipment's

Drilling sequence: Coring; Casing and Cementation and Drilling fluids;

Module III **(15 hours)**

GeoLogging and Well logs (Electric, Radioactive and Acoustic);

Formation evaluation and Testing

Well Completion and Stimulation

An outline of the oil belts of the world; Global geographic and stratigraphic distributions of oil and gas;

Important Onshore and Offshore Petroliferous basins of India.

Recent trends in Petroleum Geology.

Practical Course**: 1 credit**
Maximum Marks**: 25**

- Plotting of Petroliferous basins on maps (World and India)
- Problems based on Well log interpretation
- Creation of carbonate isopachous maps
- Problems on mud circulation
- Observations of well cuttings and cores samples
- Demonstration/Determination of porosity

List of books recommended for reference

- Hyne, N J., (2001) Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production, PennWell Corporation.
- Selley, R.C., (1998) Elements of Petroleum Geology, W.H. Freeman & Company, New York.
- North, F.K., 1(986) Petroleum Geology, Allen &UnWin, 607p
- Morris, J., (1985) Practical Petroleum Geology, The University of Texas at Austin - Petroleum Extension Service.
- Levorsen, A.I., (1967) Geology of Petroleum, W.H. Freeman and Company.

Course Title: **METAMORPHIC PETROLOGY**
Course Code: **GEL-V. E-11A**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

To provide essential concepts of metamorphism and metamorphic rocks.
To study metamorphic rocks w.r.t fabrics and types.
To understand the concept of facies.
Also to understand how metamorphism is related to plate tectonics

Course Outcomes

Upon completion of the course, the student will be able to :

- **CO1** Explain metamorphism and their upper and lower limits and study metamorphic concepts like factors, types of metamorphism and facies.
- **CO2** Apply fundamental principles of metamorphism to development of textures.
- **CO3** Classify metamorphic rocks based on mineral assemblage and fabric.
- **CO4** Relate the types of metamorphism with the product.
- **CO5** Represent metamorphic rocks graphically using Phase Diagrams.
- **CO6** Correlate deformation with grade of metamorphism.
- **CO7** Evaluate how the different factors like temperature, pressure, protolith, chemically active fluids and time control metamorphism.
- **CO8** Interpret tectonic setting of Metamorphic Belts based on field characters and kinematic stress indicators.
- **CO9** Interpret the metamorphic processes combining the evidences derived from hand specimens, microsections and protolith.
- **CO10** Differentiate between Barrovian and Buchan Zones
- **CO11** Apply the facies concept to progressive contact and regional including burial metamorphism.
- **CO12** Identify textures of metamorphic rocks in hand specimens.
- **CO13** Identify textures, structures, mineralogy of metamorphic rocks in thin sections

Module I **(15 hours)**

Definition and explanation of metamorphism (upper and lower limits) and metamorphic rocks.

Factors controlling metamorphism:

Heat (T): Geothermal gradient (in different crustal regions), Radioactivity, magmatic intrusions, tectonics;

Pressure (P): Deviatoric, Lithostatic, Hydrostatic, Fluid pressure

Chemically active fluids (X_f): H_2O and CO_2

Composition of the parent rocks (X): pelites, mafites, ultramafites, quartzofeldspathic, carbonate rocks, sandstones and greywackes.

Time (δt): Role of time in metamorphism.

Phase Rule and Phase diagrams Graphical representation of metamorphic rocks.

Protoliths.

Types of metamorphism: Regional metamorphism its characteristics and products, burial metamorphism its characteristics and products, contact metamorphism its characteristics and products.

Relationship of brittle and ductile deformation with grade of metamorphism metasomatism, cataclastic metamorphism and their products, impact/shock metamorphism.

Metamorphism in relation to plate tectonics:

Divergent(constructive) boundary

Convergent (Destructive) boundary: subduction zone (sensu lato)

Continent-Continent Collision zones

Intra-plate environments

Module II **(15 hours)**

Metamorphic textures: Inherited/Relict fabric lepidoblastic, nematoblastic, granoblastic, equigranular mosaic, Porphyroblastic; cataclastic and mylonitic textures.

Kinematic stress indicators and their role in interpreting tectonic history

Nomenclature and classification based on mineralogy and fabric

Field characters of metamorphic rocks:

Variations in mineralogy and fabric. Prograde and Retrograde metamorphism metamorphic zones and index/critical minerals, their significance in mapping and understanding tectonic history.

Module III **(15 hours)**

Facies: Concept after Goldschmidt and Eskola; Zonation in mineralogy – Buchanan (Low pressure) Barrovian (high pressure).

Facies of progressive contact metamorphism: characteristic mineral assemblages in pelites and carbonates (pure and impure) protolith

Facies of progressive regional metamorphism – characteristic mineral assemblages wrt facies (Zeolite, Prehnite-Pumpellyite, Greenschist, Amphibolite, Granulite,) in pelitic, mafic protolith.

Facies of burial metamorphism: Blueschist, Eclogite

Paired Metamorphic Belts

Practical Course: **1 credit**
Maximum Marks: 25

- Megascopic study and identification of metamorphic rocks w.r.t mineralogy, texture, type of metamorphism, facies, protolith.
- Microscopic study and identification of metamorphic rocks wrt to mineralogy, texture type of metamorphism, facies and protolith.
- Plotting ACF diagrams and commenting on the protolith.

List of books recommended for reference
Mandatory Reading

- Winter J D., (2011) Principles of Igneous and Metamorphic Petrology. PHI Learning Pvt. Ltd.
- Philpotts, A & Ague, J (2010) Principles of Igneous and Metamorphic Petrology. Cambridge University Press, New York
- Vernon, R H. and Clarke, G.L., (2008) Principles of Metamorphic Petrology, Cambridge University Press
- Best, M., (2003). Igneous and Metamorphic Petrology, Blackwell Publishing.
- Raymond, A. L., (1995) Petrology-The study of Igneous Sedimentary and Metamorphic rocks. Wm. C. Brown Communications, Inc.; USA.
- Yardley, B W. D., (1989) An introduction to Metamorphic Petrology, Longman Group Publishers Pvt. Ltd.
- Winkler, G. F., (1987) Petrogenesis of Metamorphic rocks 5th edition Narosa Publishing House, New Delhi.
- Turner, F., (1980) Metamorphic Petrology: Mineralogical, Field and Tectonic Aspects, CRC Press.

Supplementary Reading

- Frost B R and Frost C D., (2014) Essentials of Igneous and Metamorphic Petrology, Cambridge University Press.
- Bucher, K and Grapes, R., (2010) Petrogenesis of Metamorphic rocks, Springer-Heidelberg Dordrecht, London NY.
- Ernst, W G and Rumble D., (2008) Metamorphic Conditions along Convergent Plate Junctions: Mineralogy, Petrology, Geochemistry and Tectonics, Geological Society of Amer.
- Blatt, H; Tracy R. J and Owens B. E., (2006) Petrology- Igneous Sedimentary and metamorphic 3rd edition W H Freeman and Company New York.
- Miyashiro, A., (1994) Metamorphic Petrology, CRC Press.
- Roger, M., (1990). Petrology of the Metamorphic Rocks.Unwin Hyman Ltd, UK
- Miyashiro, A, (1978) Metamorphism and Metamorphic belts, The Greshman Press Old Woking, Surrey

Course Title: **REMOTE SENSING AND DIGITAL IMAGE PROCESSING**
Course Code: **GEL-V.E-12**
Credits: **3 (45 Contact hours)**
Marks: **75**
Mandatory requirement: **Individual Laptop with MS Windows OS**

Learning Objectives

This course is designed as an introduction to the use of remote imaging in geologic applications. The basic concepts of image production, processing and interpretations are covered.

Course Outcomes

Upon completion of the course, the student will be able to :

- **CO1** Explain remote sensing principles, purposes, advantages and limitations.
- **CO2** Define and describe electromagnetic spectrum and interactions with various types of media.
- **CO3** Describe characteristics of remote sensing imagery.
- **CO4** Describe sensors and image acquisition methods.
- **CO5** Search and download satellite imagery from online portals such as Bhuvan, USGS Earth explorer.
- **CO6** Explain the application of digital imagery for interpretation of lithology, Structure and geomorphology
- **CO7** Prepare various maps using Quantum GIS and Google Earth.

Module I **(15 hours)**

Energy Sources and Radiation Principles.
Electromagnetic Spectrum
Energy interactions in the Atmosphere: Scattering, Absorption.
Atmospheric windows
Energy interactions with earth surface features: Spectral Reflectance of rock, Soil water, and vegetation.
Photo recognition elements
The concept of resolution: Spatial, Spectral, Temporal and Radiometric.
Space Borne Imaging Systems- The Landsat, IRS, SPOT and High resolution Land Satellites (the characteristics of these satellites- orbits, sensors, and their resolutions)
Multispectral remote sensing and hyper spectral remote sensing

Module II **(15 hours)**

Concept of Digital numbers
Georeferencing
Image Rectification and Restoration.
Image Enhancement.: Low and high pass filter, directional filters
Contrast Manipulation.
Spatial Feature Manipulation.
Multi-Image Manipulation.

Module III **(15 hours)**
Image Classification: Unsupervised and Supervised Classification.
Supervised Classification:
The Training Stage.
The Classification Stage: Minimum-Distance to Means Classifier, Gaussian Maximum Likelihood Classifier.
Classification Accuracy Assessment and ground truth verification

Practical Course: 1 credit
Maximum Marks: 25

- Interpretation of Satellite Imagery for – landforms, geological structures, rock and soil types, man-made structures.
- Data Products and Meta data
- Digital Image Processing (using number matrix): enhancement, manipulation and classification.
- Digital image processing on Computer (demonstration)

List of books recommended for reference

- Heywood I, Sarah, Cornelius, Steve, Carver., (2011) An Introduction to Geographical Information Systems, Pearson Education Pvt. Ltd., New Delhi.
- Schowengerdt Robert A., (2006) Remote Sensing – Models and Methods for Image Processing, 2nd ed., Elsevier (Academic Press).
- George Joseph., (2005) Fundamentals of Remote Sensing, University press Private Ltd, Hyderabad.
- Lillesand, T. M., Ralph W. Kiefer and Jonathan W. Chapman., (2004) Remote Sensing and Image Interpretation, 5thed, Wiley.
- Mather Paul M., (2004) Computer Processing of Remotely Sensed Images- An Introduction, 3rd ed., John Wiley.
- Gupta, R P., (2003) Remote Sensing Geology. Springer-Verlag
- Lillesand T.M. and Kiefer R.W., (2002) Remote Sensing and Image Interpretation, John Wiley and Sons, New Delhi.
- Jensen John R., (2000) Remote Sensing of the Environment – An Earth Resource perspective, Pearson Education Series, Low Price Edition.
- Drury, S.A., (1993) Image Interpretation in Geology, 2nd ed., Chapman and Hall, London.
- Harold, R W., (1969) Aerial Stereo Photographs, Hubbard Press, USA.

Online resources

- Fundemental of remote sensing, Canada Centre for Mapping and Earth Observation , Natural Resources Canada. https://www.nrcan.gc.ca/node/9309
- DST-IGET, Remote Sensing Tutorials http://dst-iget.in/index.php/tutorialdetails/2/2

SEMESTER VI

Course Title: **IGNEOUS PETROLOGY**
Course Code: **GEL-VI.C-8A**
Credits: **3 (45 Contact hours)**
Marks: **75**

Learning Objectives

The course will help the students to understand petrologic processes and common rock types. In practical's, students learn to identify, describe and classify rocks using hand specimens and rock thin sections.

Course Outcomes

Upon completion of the course, the student will be able to :

- **CO1** Explain conceptual techniques wrt nucleation and growth of minerals thereby understanding the formation of a rock.
- **CO2** Identify igneous rocks in hand specimen.
- **CO3** Identify igneous rocks in thin sections
- **CO4** Classify igneous rocks
- **CO5** Evaluate a rock wrt its environment of formation (PT) conditions thereby assign a name.
- **CO6** Identify key textural and microstructures and their application related to geological processes.
- **CO7** Interpret ternary phase diagrams.
- **CO8** Classify rocks based on their chemical analysis.

Module I **(15 hours)**

Meteorites: Mineralogy and whole rock chemistry

Composition of the earth's interior = Primitive mantle Plate tectonics and igneous activity

Partial Melting and Generation of magma.

Magma Diversity:

- Partial Melting: Mafic, Ultramafics
  - Basalts: Magma types, Basalt Tetrahedron.
- Anatexis in Felsic rocks
  - Granites/Pegmatites: Mingling, Mixing and Crustal contamination
- Igneous layering - crystal settling
  - Gabbroic rocks, Anorthosite
- Layered complexes Differentiation: Fractional Crystallization, liquid immiscibility, flowage differentiation

Module II **(15 hours)**

Ascent and emplacement of magma

Textures and microstructures of igneous rocks:

a. Primary: Nucleation, Growth, Diffusion
b. Secondary: Oswald ripening, twinning, zoning

Classification and Description of Igneous Rocks:

The International Union of Geological Sciences (IUGS) Classification System:

Gabbros, Granites (QAPF diagram).

Ternary System: Diopside-Albite-Anorthite (Di-Ab-An)

Module III **(15hours)**

Study of the following rock types (mineralogy, petrography and petrogenesis)

Ophiolites
Granitoids
Carbonatites
Kimberlites

Practical: 1 credit

Maximum Marks: 25

- Study of igneous rocks in hand specimen.
- Study of igneous rocks in thin sections
- CIPW Normative calculations

List of books recommended for reference

Mandatory reading

- Frost B R and Frost C D., (2014) Essentials of Igneous and Metamorphic Petrology, Cambridge University Press.
- Gill, R., (2010). Igneous rocks and process – A Practical Guide, Wiley-Blackwell
- Winter, J.D., (2009) Principles of Igneous and Metamorphic Petrology, Prentice Hall

Supplementary reading

- Best, M.G., (2002). Igneous and Metamorphic Petrology, 2nd edn., Blackwell, Oxford.
- Bose, M.K., (1997). Igneous Petrology, The World Press, Kolkata.
- Raymond, A. L., (1995). Petrology-The study of Igneous Sedimentary and Metamorphic rocks. Wm. C. Brown Communications, Inc.; USA.
- MacKenzie, W. S., Donaldson, C H., and Guilford, C., (1982). Atlas of Igneous Rocks and Their Textures, Wiley

Course Title: **PHANEROZOICSTRATIGRAPHY OF INDIA**
Course Code: **GEL-VI.E-13B**
Credits: **3 (45 contact hours)**
Marks: **75**
Prerequisite:**GEL-V.E-9A**

Course Objectives
The course will help understanding the Indian stratigraphic units and to correlate International Geological Time Scale with Indian Stratigraphic Time Scale. Also to understand the geology, stratigraphy, fossil content, economic resources of the lithounits from the Phanerozoic Eon from the Indian context.

Course Outcomes
Upon completion of the course, the student will be able to :

- **CO1** Explain the Gondwana sedimentation and its economic significance.
- **CO2** Explain the geology and geotectonics of Triassic of Spiti.
- **CO3** Explain the geology and geotectonics of Jurassic of Kutch.
- **CO4** Explain the geology and geotectonics of Cretaceous of Trichinopoly.
- **CO5** Explain Deccan Flood Volcanism.
- **CO6** Analyse and interpret the Gondwana breakup.
- **CO7** Explain the geology and geotectonics of Tertiaries of Assam and its economic significance.
- **CO8** Explain the upheaval and evolution of Himalayas.
- **CO9** Relate boundary problems associated with Precambrian-Cambrian, Permian-Triassic, Cretaceous-Tertiary and Pleistocene-Holocene boundaries in India and their relation to mass extinctions.
- **CO10** Prepare lithostratigraphic maps.

Module I **(15 hours)**
Precambrian-Cambrian boundary
Cambrian Tal
Muth Quartzites
Gondwana sedimentation: Peninsular, Extra-Peninsular
Permian-Triassic boundary

Module II **(15 hours)**
Jurassic of Kutch
Cretaceous of Trichinopoly
Deccan Flood Basalt (Age and Stratigraphy)
Cretaceous-Paleocene boundary

Module III **(15 hours)**
Tertiaries of Assam
Rise and evolution of Himalayas
Siwaliks
Pleistocene-Holocene Boundary
Plant and animal life in relation to glacial and interglacial cycles during Quaternary.
Recent: Laterite Formations of Goa

Practical Course**: 1 credit**
Maximum Marks**: 25**

1. Preparation of lithostratigraphic maps of India showing distribution of important geological formations.
2. Study of type hand specimens from their stratigraphic position and age.
3. Stratigraphic map of Goa

List of books recommended for reference

- Nanda, H., (2014) Indian Stratigraphy, Anmol Publications Pvt. Ltd. New Delhi.
- Valdiya, K. S., (2010). The Making of India, Macmillan India Pvt. Ltd.
- Nichols, G., (2009) Sedimentology and Stratigraphy, Wiley-Blackwell and Sons Ltd.
- Sharma, R S., (2009) Cratons and Fold belts of India, Springer-Verlag Berlin Heidelberg.
- Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley.
- Ramakrishnan, M and Vaidynadhan, R., (1994) Geology of India, Geological Society of India Publication, Bangalore. Vol. I and II.

Course Title: **ROCK STRUCTURES AND DEFORMATION MICROSTRUCTURES**
Course Code: **GEL-VI. E-14B**
Credits: **3 (45 Contact hours)**
Marks: **75**
Prerequisite: **GEL-V.E-11A**

Learning Objectives
The course will help to study deformational history of rocks. This study includes the understanding of the deformation and metamorphic processes the rock has undergone with the aim to reconstruct its structural and metamorphic history.

Course Outcomes
Upon completion of the course, the student will be able to :

- **CO1** Explain the process and mechanisms of rock structures and rock deformation microstructures.
- **CO2** Interpret the significance of microstructures in Igneous, Sedimentary and Metamorphic rocks.
- **CO3** Apply the significance of features like foliation and lineation in field as well as in microsections in understanding microstructures and rock deformation.
- **CO4** Interpret Shear Sense Indicators in Mylonites.
- **CO5** Enhance application skills in relating deformation history to tectonism.
- **CO6** Interpret deformation features in field and in microsections.
- **CO7** Identify and Interpret the significance of rock structures in thin sections.
- **CO8** Identify and Interpret the significance of rock deformation microstructures in thin sections.

Module I (15 hours)
Introduction to microstructures, Microstructures of Igneous rocks – Nucleation, growth and shape of minerals, Mineral intergrowths, zoning, twinning.Microstructures of sedimentary rocks – size, sorting and shape of mineral grains.Fossils as strain markers.

Module II (15 hours)
Microstructures of metamorphic rocks – Grain shapes and growth of porphyoblasts, twining (growth, transformation), exsolution in silicate minerals, importance of symplectites in metamorphism, compositional zoning.
Deformed rocks – brittle deformation (frictional grain boundary sliding, Fracture processes) and ductile def. (crystal plasticity, diffusion creep, ductile grain boundary sliding).

Module III (15 hours)
Foliation (Continuous and spaced) and its significance; Lineation and its significance; Mylonites, Shear sense indicators in mylonites; Strain shadows.

Practical Course: 1 credit
Maximum Marks: 25

Study of the following microstructures (any 15)

Cuspate and lobate sutured boundaries,
Planar indentations
Pinning Structure
Bulging (BLG)
Subgrains, chessboard subgrains
Deformation twins, growth twins
Displaced twin lamellae
Recrystallized quartz ribbons.
Bending of cleavage planes,
Mineral (mica) fish,
Porphyroclasts, asymmetric porphyroclasts depicting shear sense,
Porphyroclasts with Pressure shadows.
Porphyroblasts with Pressure shadows,
Warping of foliation around porphyroclasts / porphyoblasts,
S-C fabric.
Mineral overgrowth
Ooids
Flame perthites
Myrmekites
Zoning

List of books recommended for reference

Mandatory reading

- Winter, J D., (2014) Principles of Igneous and Metamorphic Petrology, Pearson Education Limited.
- Trouw, R A., Passchier, C W and Wiersma, D J., (2010) Atlas of Mylonites - and related microstructures, Springer-Verlag Berlin Heidelberg
- Passchier, C. W and Trouw, R A., (2005) Microtectonics, Springer-Verlag Berlin Heidelberg
- Vernon, R H., (2004) A Practical Guide to Rock Microstructures, Cambridge University Press.
- Blenkinsop, T. (2002) Deformation microstructures and mechanisms in minerals and rocks, Kluwer Academic Publishers.

Supplementary Reading

- Mukherjee, S., (2013) Deformation Microstructures in rocks. Springer-Verlag Berlin Heidelberg

Course Title: **SURVEYING, MAPPING AND FIELD GEOLOGY**
Course Code: **GELVI.E-15A**
Marks: **75**
Credits: **3 (45 Contact hours)**
Mandatory requirement: **Individual Laptop with MS Windows OS**

Course Objectives
To Provide basic knowledge of surveying techniques
To upgrade and relate the theoretical knowledge of Geological aspects to field observations.
This course also introduces the basic principles and techniques of Geographic information Systems (GIS)

Course Outcomes
Upon completion of the course, the student will be able to :

- **CO1** Carry out dumpy level survey.
- **CO2** Carry out plane table survey.
- **CO3** Explain SOI Toposheet catalogue.
- **CO4** Learn to plan for a geology field trip.
- **CO5** Record detailed field observations systematically in their field diary and subsequently prepare a geologic field report of the same.

Module I **(15 hours)**
Surveying, Objectives of Survey;
Primary divisions of Surveying – Geodetic and Plane Surveys uses and Principles of Surveying.
Methods of locating a point
Plane Table Survey: Instruments, Procedures of Plane table surveys; Methods (Demonstrative): Radiation and Intersections, advantages and disadvantages of Plane Tabling.
Levelling, characteristics of land surveying instruments, Bench Marks, Change Points.
Levelling operations and steps in Levelling: Demonstration with exercises in the field.
Principles of Levelling: Simple and Differential,
Reduction of Levels: The Collimation, and Rise and Fall systems of Computation.
Theodolite survey: Principles and working,

Module II **(15 hours)**
SOI Toposheet Indexing scheme, Map symbol reading SOItoposheet map reading
Standard Symbols/colour for lithology and symbols related to structures
Munsell colour chart
Understanding map reliability
GPS surveys
Geological mapping
Basic field gear
Planning a field Project: Preparations for the field, Taking geologic notes in the field: Basic procedures at outcrops – noting characters of igneous, sedimentary and metamorphic rocks, Measuring strike and dip (attitude) of planar and linear features using a clinometer compass, a Brunton Compass.

Module III **(15 hours)**
Introduction to GIS
Components of GIS
Georeferencing
Digitizing: Point, line, polygon
Attribute data
Map layout and cartographic output

Practical course: 1 credit
Maximum Marks: 25

- The evaluation is to be based on preparation of portfolio that should include plans drawn using Plane table, a Levelling Exercise.
- Assessment to be based on presentation of Field diary, Field report, and field based viva voce on the localities visited for field work.
- Hands-on exercises in QGIS and Google Earth.

List of books recommended for reference
Mandatory reading

- Basak, N N., (2014) Surveying and Levelling, McGraw Hill Education.
- Lisle R., Brabham P and Barnes J., (2011) Basic Geological Mapping (Geological Field Guide), Wiley Blackwell.
- C.P.Lo and Albert K. W. Yeung., (2002) Concepts and Techniques of Geographic Information System, Prentice –Hall, India.
- Kang – Tsung – Chang., (2002) Introduction to Geographical Information System, , McGraw Hill.
- Gokhale, N W., (2001) A Guide to Field Geology, CBS Publishers & Distributors.
- Lambert, D A., (1998) Field Guide to Geology, Facts on File Inc.
- Burrough, P. A. and McDonnell, R. A., (2000) Principles of Geographical Information System, Oxford University Press.
- Kanetkar, T P & Kulkarni, S V., (1988) Surveying & Levelling (Part I), Pune VidyarthiGrihaPrakashan.
- Compton, R R., (1985) Geology in the Field, John Wiley & Sons, Inc.
- Compton, R R., (1962) Manual of Field Geology, John Wiley & Sons, Inc.
- Lahee, F H. (1962) Field Geology, McGraw – Hill Book Company, Inc.

Supplementary reading

- Robinson W F and Tallack., (2016) Surveying and Levelling Instruments Theoretically and Practically Described for construction, Qualities, Selection, Preservation, Adjustments and Uses: With other apparatus and Appliances used by Civil Engineers and Surveyors in the Field, Wentworth Press.
- Arora, K R., (2015) Surveying Vol-2 (13th edition). Standard Book House Unit of Rajsons Publication Pvt. Ltd.
- Penning, W H. and Jukes-Browne., (2011) A Textbook of Field Geology, Nabu Press.

- Coe, A, L., Argles, T W., Rothery, D A and Spicer, R A., (2010) Wiley-Blackwell, The Open University.
- McClay, K R., (2007) The Mapping of Geological Structures, John Wiley and Sons.
- Barnes, J W and Lisle, R J., (2004) Basic Geological Mapping, John Wiley and Sons

Online resources

- T. Sutton, O. Dassau, M. Sutton, A Gentle Introduction to GIS, Chief Directorate: Spatial Planning & Information, Department of Land Affairs, Eastern Cape, South Africa (ebook), http://download.osgeo.org/qgis/doc/manual/qgis-1.0.0_a-gentle-gis-introduction_en.pdf
- DST-IGET, QGIS Tutorials http://dst-iget.in/index.php/tutorialdetails/1/1

Course Title: **PRINCIPLES OF GEOPHYSICAL EXPLORATION AND MINING**
Course Code: **GEL-VI.E-16A**
Credits: **3 (45 Contact hours)**
Marks: **75**

Course Objectives

Mining being a key source of revenue generation for the Central as well as State governments, and an important job provider for Geologists, this course is designed to equip the undergraduate student with basic knowledge of key concepts of mining processes right from exploration to exploitation, together with an acquaintance of government regulations that control the mining and mineral conservation processes. In Geophysical exploration the student will gain first-hand knowledge dealing with the principles and their significance.

Course Outcomes

Upon completion of the course, the student will be able to :

- **CO1** Gain knowledge of key concepts of mining processes right from exploration to exploitation
- **CO2** Explain the difference between the nature of, and factors leading to the choice between, Open-cast and Underground mining methods.
- **CO3** Explain the different techniques of ore beneficiation.
- **CO4** Get acquainted with government agencies and regulations that control the mining and mineral conservation processes.
- **CO5** Explain the principles behind, and methods of Geophysical, Geochemical and Geobotanical exploration.
- **CO6** Draw cross - and longitudinal sections using bore-hole Data.
- **CO7** Estimate ore reserves using different methods.
- **CO8** Get a first-hand experience in core-logging

Module I **(15 hours)**

Mining Terminology
Classification of mining methods.
Factors influencing choice of mining method

- Open cast mining
- Underground mining
  - Coal mining methods
  - Alluvial mining

Ore Dressing or Beneficiation:

- Principles and methods
- Terminology of quantification of results

Environmental Impact of Mining
Brief outline of:

National Mineral Policy
Regulations and Acts
Regulating Agencies

Module II **(15 hours)**

Mineral Exploration: Sequence and phases

- Float ores and In situ ores
  - Pits, Trenches and Boreholes
    - Spacing
    - Drilling:
      - Core and non-core drilling
      - Equipment and accessories
      - Core drill sampling
      - core splitting
      - logging
      - Storage
      - Sludge
      - Combining Assay returns from sludge and core

Categories of reserves

Estimation of reserves

- Cross-sectional method
- Area of influence method
- Triangular method
- Weighted volume estimate method
- Estimation of stockpiles by prismoidal formula

Module III **(15 hours)**

Methods of Exploration: Geobotanical, Geochemical and Geophysical.

Geophysical Methods:

Self-potential method:, mechanism, equipment, interpretation of anomalies.

Gravity surveying: Gravity surveying, Interpretation

Magnetic surveying: concepts, Rock magnetism, Geomagnetic field, Magnetic anomalies, Instruments used, Corrections, Interpretation, Application.

Practical Course**: 1 credit**

Maximum Marks: **25**

- Drawing cross - and longitudinal sections using bore-hole data
- Problems based on estimation of ore reserves
- Interpretation of bouguer gravity anomaly maps, and magnetic data.
- Core logging

List of books recommended for references

- Keller, E. A., (2011) Environmental Geology, Pearson Prentice Hall.
- Sharma J. P., (2009) Environmental Studies, Laxmi Publications (P) Ltd, New Delhi.
- Lowrie, W., (2007) Fundamentals of Geophysics. Cambridge University Press.
- Marjoribanks, R., (1997) Geological Methods in Mineral Exploration and Mining, Springer-Science+Business Media
- Telford, W. M., Geldart, L. P., and Sheriff, R. E., (1990) Applied geophysics (Vol. I) Cambridge University Press.
- Bhimasarikaram V.L.S., (1990) Exploration Geophysics - An Outline by Association of Exploration Geophysicists, Osmania University, Hyderabad.
- Dobrin, M B and Savit C H., (1988) Introduction to Geophysical Prospecting, McGraw Hill Inc.
- Babu S. K. & Sinha D. K., (1988) Practical Manual of Exploration and Prospecting, CBS Publishers and Distributors, New Delhi.
- Peters, W C., (1987) Exploration and Mining Geology, Wiley
- Ramachandra Rao and Prasaranga, M B, (1975) Outlines of Geophysical Prospecting - A Manual for Geologists by University of Mysore, Mysore.
- Arogyaswamy, R. N. P., (1973) Courses in Mining Geology, Oxford & IBH Publishing Co.
- Sinha, R. K & Sharma N. L., (1970) Mineral Economics, Oxford & IBH Publishing Co.
- McKinstry H. E., (1948) Mining Geology, Prentice-Hill Inc.
- Indian Bureau of Mines (IBM) Publications.

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ANNEXURE A

(Summary of changes incorporated in the syllabus)

DEPARTMENT OF GEOLOGY

Semester	Course Title	Existing (Indicate only the unit where the change is proposed)	Changes Proposed	Specify the reason for the change
III	GEL-III.SEC-1 : Operational Geology and Gemmology	New SEC Course	NA	Introduced for the first time as Skill Enhancement Course
IV	GEL-IV.SEC.2 : GIS for Beginners	New SEC course	NA	Introduced for the first time as Skill Enhancement Course
VI	GEL-VI.E-14B : Rock Structures and Deformation Microstructures	Module I, II & III	All Modules reshuffled without revision of syllabus inorder to maintain the balance of lecture hours as 15 each	The hours consumed to complete Module I was more as compared to Module II & III.

Parvatibai Chowgule College of Arts and Science, Margao- Goa (Autonomous)

DEPARTMENT OF GEOLOGY

THREE YEAR B.Sc. DEGREE PROGRAMME IN GEOLOGY

(4th Revision- Implemented Academic Year 2021-2022)

COURSE STRUCTURE FOR SEMESTER I, III & V

SEM-ESTER	CORE COMPULSORY		CORE ELECTIVES				SKILL ENHANCEMENT COURSES (SEC)
I	**GEL-I.C-1** Fundamentals of Mineralogy	**GEL-I.C-2A** Earth's Dynamics and Tectonics					
III	**GEL-III.C-5A** Advanced Mineralogy and Geochemistry		**GEL-III.E-1** Physical Geology	**GEL-III.E-2** Groundwater and Hydrogeology	**GEL-III.E-3A** Ore Genesis	**GEL-III.E-4** Marine Geology	***GEL-III.SEC-1:*** *Operational Geology and Gemmology*
V	**GEL-V.C-7** Sedimentary Petrology		**GEL-V.E-9B** Precambrian Stratigraphy of India	**GEL-V.E-10** Petroleum Geology	**GEL-V.E-11A** Metamorphic Petrology	**GEL-V.E-12** Remote Sensing and Digital Image Processing	

COURSE STRUCTURE FOR SEMESTER II, IV & VI

SEM-ESTER	CORE COMPULSORY		CORE ELECTIVES				SKILL ENHANCEMENT COURSES (SEC)
II	**GEL-I.C-1** Fundamentals of Mineralogy	**GEL-I.C-2A** Earth's Dynamics and Tectonics					
IV	**GEL-IV.C-6** Structural Geology		**GEL-IV.E-5A** Engineering Geology	**GEL-IV.E-6A** Optical Mineralogy	**GEL-IV.E-7** Natural Hazards and Management	**GEL-IV.E-8** Geotectonics	***GEL-IV.SEC-2:*** *GIS for Beginners*
VI	**GEL-VI.C-8A** Igneous Petrology		**GEL-VI.E-13B** Phanerozoic Stratigraphy of India	***GEL-VI.E-14B*** *Rock Structures and Deformation Microstructures*	**GELVI.E-15A** Surveying, Mapping and Field Geology	**GEL-VI.E-16A** Principles of Geophysical Exploration and Mining	

Revised Course Structure and List of Core, Elective and Skill Enhancement Courses

COMPONENT A

SEM-ESTER	CORE COURSES		ELECTIVE COURSES				SEC
I	**GEL-I.C-1** Fundamentals of Mineralogy	**GEL-I.C-2A** Earth's Dynamics and Tectonics	-----	-----	-----	-----	
II	**GEL-II.C-3A** Elementary Petrology	**GEL-II.C-4** Principles of Stratigraphy and Paleontology	-----	-----	-----	-----	
III	**GEL-III.C-5A** Advanced Mineralogy and Geochemistry		**GEL-III.E-1** Physical Geology	**GEL-III.E-2** Groundwater and Hydrogeology	**GEL-III.E-3A** Ore Genesis	**GEL-III.E-4** Marine Geology	**GEL-III.SEC-1:** Operational Geology and Gemmology
IV	**GEL-IV.C-6** Structural Geology		**GEL-IV.E-5A** Engineering Geology	**GEL-IV.E-6A** Optical Mineralogy	**GEL-IV.E-7** Natural Hazards and Management	**GEL-IV.E-8** Geotectonics	**GEL-IV.SEC-2:** GIS for Beginners
V	**GEL-V.C-7** Sedimentary Petrology	**GEL-V.CP** Core Project	**GEL-V.E-9B** Precambrian Stratigraphy of India	**GEL-V.E-10** Petroleum Geology	**GEL-V.E-11A** Metamorphic Petrology	**GEL-V.E-12** Remote Sensing and Digital Image Processing	
VI	**GEL-VI.C-8A** Igneous Petrology	**GEL-VI.CP** Core Project	**GEL-VI.E-13B** Phanerozoic Stratigraphy of India	**GEL-VI.E-14B** Rock Structures and Deformation Microstructures	**GELVI.E-15A** Surveying, Mapping and Field Geology	**GEL-VI.E-16A** Principles of Geophysical Exploration and Mining	

Core Courses for students offering **Geology as the Minor**

SEMESTER I GEL-I.C-1: FUNDAMENTALS OF MINERALOGY
SEMESTER II GEL-II.C-3A: ELEMENTARY PETROLOGY
SEMESTER III GEL-III.C-5A: GEOCHEMISTRY AND SYSTEMATIC MINERALOGY
SEMESTER IV GEL-IV.C-6: STRUCTURAL GEOLOGY
SEMESTER V GEL-V.C-7A: SEDIMENTARY PETROLOGY
SEMESTER VI GEL-VI.C-8A: IGNEOUS PETROLOGY

PROGRAME OUTCOMES

After graduating in the subject of Geology, the student will be able to :

PO1 Explain the theoretical concepts involvedincourses likeMineralogy, Petrology and Structural Geology.

PO2 Apply theoretical concepts involved in mineral forming to confidently identify them in hand as well as in thin sections.

PO3 Analyse the theoretical concepts and apply them in interpreting the various petrographic features in rocks exhibited in hand specimens and in thin sections.

PO4 Create, analyse and interpret structural geological maps.

PO5 Make good field observations during field excursions and relate their understanding of various structural and petrological features learnt in classroom for correct interpretation.

PO6 Communicate confidently and write geological reports.

PO7 Demonstrate content knowledge appropriate to professional career goals.

SEMESTER I

Course Title : **FUNDAMENTALS OF MINERALOGY**
Course Code : **GEL-I. C-1**
Credits : **3 (45 Contact hours)**
Marks : **75**

Course Objectives

As minerals are building blocks of earth's material the course is designed to understand the basic concepts in mineralogy, their chemistry and identification of minerals in hand specimens. Further, the students will study crystallography in understanding the morphology, symmetry and the normal crystal classes.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Explain what is a mineral and its formation and describe the physical properties of minerals.
CO2 Compare and contrast the elemental and major oxide composition of the crust with the entire earth and relate crystal chemistry and chemical bonding to the formation of minerals.
CO3 Link how the internal atomic structure of minerals affects the external development of a crystal in terms of crystal symmetry, crystal system and crystal forms.
CO4 Identify rock- forming minerals in hand specimen using their physical properties.
CO5 Classify minerals into crystal systems based on crystal symmetry.

Module I **(15 hours)**

Minerals: Rock-forming minerals and ore minerals.
Common physical properties of minerals including electrical and magnetic properties.
Isomorphism, Polymorphism, Pseudomorphism
Silicate structures: (sorosilicate/ cyclosilicates/ nesosilicates/ inosilicate/ phyllosilicates/ tectosilicate)
Introduction to rock-forming mineral Olivine, Pyroxene, Amphibole, Mica, Feldspar, Quartz and its varieties.
Important and abundant mineral groups: aluminosilicates, sulfides, sulfates, carbonates; oxides; halides; native metals (with three examples each)

Module II **(15 hours)**

Elemental and major oxide composition of the earth's crust -
Types of Atomic bonds (Ionic/Covalent/Metallic/ Van der Waal).
Radius Ratio, Ionic Radius,
Co-ordination Number. Types of co-ordination.
Atomic arrangement (HCP/CCP)

Module III **(15 hours)**

Space lattice. Unit cell. External morphology of a crystal. Crystal Forms with examples.
Crystallographic axes and Crystal systems.
Symmetry in crystals. (Axis, Plane, Center)
Interfacial angles and Contact Goniometer.
Parameters and Indices

Practical: 1 credit
Maximum Marks: 25

1. Identifying and determining the crystal symmetry, class, system and forms in the normal class of the six systems.
2. Identification and study of minerals w.r.t their physical properties, occurrence, chemical composition and use.

List of books recommended for reference
Mandatory Reading

- Perkins, D., (2015), Mineralogy, Pearson Education Limited.
- Dana, J.D & Ford, W. E., (2010). Dana's Manual of Mineralogy. J. Wiley & Sons.
- Klein, C. and Dutrow, B., (2007). The Manual of Mineral Science, John Wiley & Sons, Inc.
- Read, H. H., (1988). Rutley's elements of Mineralogy, CBS Publications.
- Battey, M H. (1971), Mineralogy for students, Oliver & Boyd

Supplementary Reading

- Deer, W. A., Howie, R. A &Zussman, J., (2013). An Introduction to the rock forming minerals, John Wiley and Sons.

Course Title : **EARTH'S DYNAMICS AND TECTONICS**
Course Code : **GEL-II. C-2A**
Credits : **3 (45 contact hours)**
Marks : **75**

Course Objectives

This is a core branch of earth science which deals with basic concepts of natural internal forces shaping the earth. Earth's Dynamics and Tectonics aims at acquainting the student with these forces as well as the geological structures resulting from the action of these forces on rocks. The course also aims at providing an understanding of the processes in action on the earth's surface and their impact on man and his institutions.

Course Outcomes

Upon completion of the course, the student will be able to:

CO1 Explain the origin and nature of the earth, the internal layering, the earth's Gravity and magnetic field.

CO2 Differentiate between the different types of forces operating in the lithosphere, responses to these forces and relate them to geological hazards.

CO3 Explain the formation of structural features likes fold, faults, joints and unconformities.

CO4 Read and interpret geological maps and draw geological cross – sections.

CO5 Derive graphical solution to structural problems

Module I **(15 hours)**

Origin of Solar System (Nebular Concept) and formation of a layered Earth.
Size and shape of the Earth.
Internal structure of the Earth: Geosphere asthenosphere, lithosphere, hydrosphere, biosphere, atmosphere (anoxic to oxic conditions) wrt to earth dynamic
Earth's Gravity : Acceleration due to gravity, change with latitude and altitude.
Earth's Magnetism: Earth as a magnet; lines of force, Source of Earth's Magnetic field, Declination and inclination, Geomagnetic axis and Geographic axis.

Module II **(15 hours)**

Introduction to Plate Tectonics:
Concept of isostacy
Lithostatic or confining pressure, Differential forces: tension, compression, couple.
Concept of stress and strain: stages of deformation: Elastic, Plastic and Rupture.
Brittle and ductile substances.
Introduction to geological hazards: exogenous (floods, drought and cyclones) and endogenous (volcanic hazards, earthquakes and tsunamis, mass wasting)

Module III **(15 hours)**

Map and Scales

Stratification, Strike and dip (true and apparent dip) strike and dip symbols.

Outcrop patterns of Horizontal, Inclined & vertical strata on various types of grounds (horizontal ground, valley and spur).

Folds: Terminology, causes, types of folds; symmetrical, asymmetrical, overturned, recumbent, isoclinal, fan, chevron, monocline, structural terrace, plunging and non-plunging; significance. Outcrop pattern of folds on horizontal ground, valley and spur.

Faults: Definition & terminology, geometric classification, significance; horst and graben.

Joints: Geometric classification, map symbols, columnar joints and sheet structure, significance.

Unconformities: Stages of development, types, significance; outliers and inliers; overlap and offlap.

Practical: 1 credit
Maximum Marks: 25

1. Drawing cross-section and description of structural maps involving single series (Horizontal and Inclined)
2. Graphical solution to structural problems.

List of books recommended for reference

Mandatory reading

- Travis, H., 2012. Living with Earth, Phi Learning Pvt. Ltd., New Delhi.
- Press, Siever, Grotzinger and Jordan., 2003. Understanding the Earth (4^{th} edition).
- Charles C. Plummer and David McGeary., 2001. Physical Geology, (4^{th} edition), Wm C. Brown Publishers.
- Monroe and Wicander., 2001. The Changing Earth: Exploring Geology and Evolution (3^{rd} edition).
- Jain, A K .,Structural geology, , Geological Society of India.
- Holmes' Principles of Physical Geology edited by P.McL.D.Duff (ELBS).
- Hils, E. S., Elements of Structural Geology, Methuen.
- Mukerjee. P. K., A Textbook of Geology, World Press.

Supplementary Reading

- Zumberge J.H. & Nelson C.A., Elements of Geology (3^{rd} edition), John Wiley & Sons, New York.

SEMESTER II

Course Title : **ELEMENTARY PETROLOGY**
Course Code : **GEL-II.C-3A**
Marks : **75**
Credits : **3 (45 contact hours)**

Course Objectives

Petrology is the science of rocks. The course will help the students to exhibit an improved understanding of fundamental petrologic processes and common rock types. In practicals, students learn to identify, describe and classify rocks using hand specimens.

Course Outcomes

On completion of the course the students will be able to:

CO1 Explain the processes involved in the formation of Igneous rocks, identify their forms, textures, structures and classify them.

CO2 Explain the processes involved in the formation of Sedimentary rocks, identify their textures, structures and classify them.

CO3 Explain the processes involved in the formation of Metamorphic rocks, identify their agents, textures, structures and classify them.

CO4 Identify the different textures and structures of igneous, sedimentary and metamorphic rocks.

CO5 Describe the mineralogy and properties of igneous, sedimentary and metamorphic rocks and identify common rock types.

Module I **(15hours)**

- Rocks and rock cycle
    - Magma: Definition, formation, composition,
        - Properties: temperature, density, viscosity
        - Bowen's Reaction Series
    - Mode of occurrences of Igneous rocks
    - Plutonic: Batholiths (stocks, bosses and roof - pendants), Multiple and Composite intrusions.
    - Hypabyssal: Dykes (Radiating, Arcuate, Ring dykes,), Sills, Laccoliths, Lopoliths
    - Extrusive forms: pyroclastics, lava flows and Volcanic necks,
    - Central and Fissure type of eruptions
    - Structures of Igneous rocks : layering, flow banding
    - Textures of Igneous rocks aphanitic (glassy), : phaneritic: porphyritic, poikilitic, ophitic, sub ophitic; holocrystalline
        - Classification: Based on chemical composition (TAS diagram)

Module II **(15 hours)**

Weathering (, types – Chemical and Physical, and products), Erosion, Transportation and Deposition

Diagenesis

Udden-Wentworth classification based on grain size
Sedimentary structures: Primary (stratification), chemogenic and biogenic
Textures: clastic and non clastic
Sedimentary environments: aeolian, fluvial, glacial and marine

Module III **(15 hours)**
Factors controlling metamorphism.
Types of metamorphism: burial, regional and contact,
Metamorphic grade
Metamorphic textures and structures: Foliated and non-foliated.
Index minerals and Isograds
Nomenclature of metamorphic rocks
Protolith: recognition and types (Mafic, Quartzofeldspathic, Pelitic, Calcareous,)
Metasomatism

Practical: 1 credit
Maximum Marks: 25

- Megascopic study of Igneous, Sedimentary and Metamorphic rocks.

List of books recommended for reference
Mandatory Reading

- Winter, J D., (2014). Principles of Igneous and Metamorphic Petrology, Pearson Education Limited.
- Gill, R., (2010) Igneous rocks and process – A Practical Guide, Wiley-Blackwell
- Boggs S., (2009) Petrology of Sedimentary rocks (2nd edition), Cambridge University Press.
- Prothero, D. R., and Schwab, F.; (2004) Sedimentary Geology. Macmillan.
- Best, M., (2003). Igneous and Metamorphic Petrology, Blackwell Publishing.
- Tucker E.M. (2001) Sedimentary Petrology (3rd Edition), Blackwell Science Ltd.
- Pettijohn F.J., (1984) Sedimentary Rocks (3rd Edition), CBS Publishers, New Delhi.

Supplementary Reading

- Ehlers, E.G. and H. Blatt., 1982. Petrology, Igneous, Sedimentary and Metamorphic, W.H Freeman, San Francisco.
- Mahapatra G B. A Textbook of Geology, CBS
- Parbin Singh. A Textbook of Engineering and General Geology (Seventh Ed),
- Mukerjee, P K. A Textbook of Geology, World Press.

Course Title : **PRINCIPLES OF STRATIGRAPHY AND PALEONTOLOGY**
Course Code : **GEL-II. C-4**
Marks : **75**
Credits : **3 (45 Contact hours)**

Course Objectives

Stratigraphy and Paleontology, the two branches of Geology work together to unearth the secrets of age from rocks of the earth's crust. Stratigraphers study the composition and arrangement of layered or stratified rocks. Paleontologists study the remains of plants and animals which have been preserved in the earth's crust by natural processes. With these objectives in mind it becomes pertinent to understand the basic concepts of Stratigraphy and Palaeontology.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Explain principles of Stratigraphy, concept of Facies, correlation and measurements of geologic time.
CO2 Describe types of fossils, conditions and modes for fossilisation, how fossils can be used to locate economic deposits
CO3 Describe and explain morphology of the hard parts of body fossils belonging to the different phylum's and their geological time
CO4 Read maps, solve problems on bearings and handle clinometer compass.
CO5 Describe and identify fossils/casts/shells w.r.t their morphology and geological age.

Module I **(15 hours)**

Principles of stratigraphy: Uniformitarianism, Original horizontality, Order of superposition, Faunal succession, Cross-cutting relationship, Inclusions.
Principles of stratigraphic analysis, Facies concept in stratigraphy
Walther's Law of Facies.
Age of the earth:, radiometric dating; Principles.
Measurement of geologic time:
- Time Units: Eon-Era-Period-Epoch-Age
- Lithostratigraphic/ Rock Units: Group-Formation-Member-Bed
- Chrono-/ Time stratigraphic units: Erathem-System-Series-Stage
- Standard Stratigraphic Scale.

Correlation and methods of Correlation:
- Paleontological Criteria : Index/ Zone fossils
- Lithological Similarity: Marker/ Key bed
- Structural relations: Tectonic criteria

Brief account of the Geological Formations of Goa.

Module II **(15 hours)**

Fossils: Mega- Micro-Ichnofossils
Conditions for fossilization; Favourable environments for fossilization.

Modes of fossilization: Petrification, Carbonization, Natural moulds and casts
Frozen and mummified fossils.
Uses of fossils in locating coal and petroleum deposits.

Module III **(15 hours)**
Binomial Nomenclature of Organisms and Taxonomy
Morphology of the hard parts and geological time range of the following:
Phyllum: Arthropoda- Class: Trilobita
Phyllum: Mollusca- Class :Pelecypoda
:Gastropoda
:Cephalopoda- Nautiloidea
Ammonoidea
Belemnoidea
Phyllum: Brachiopoda
Phyllum:Echinodermata- Class: Echinoidea

Practical: 1 credit
Maximum Marks: 25

- Map reading
- Use of clinometer compass and exercises on Bearings
- Study of fossils/casts/shells w.r.t their morphology and geological age.

List of books recommended for reference
Mandatory Reading

- Dana, J.D., (2010), Manual of Geology, Anmol Publications.
- Monroe, J and Wicander, R., (1994). The Changing Earth: Exploring Geology and Evolution, Brooks/Cole
- Black. R M., (1989). The Elements of Palaeontology, Cambridge University Press.
- Spencer, E, W, Basic concepts of Historical Geology, Oxford & IBH Publishing Co.
- Koregave, M A., Fundamentals of Invertebrate Palaeontology, Book World Enterprises.

Supplementary Reading

- A Textbook of Geology, P.K Mukherjee (World Press).

SEMESTER III

Course Title : **ADVANCEDMINERALOGY AND GEOCHEMISTRY**
Course Code : **GEL-III.C-5A**
Credits : **3 (45 Contact hours)**
Marks : **75**

Course Objectives

The course provides geoscientific study of mineralogy in understanding the structure, chemistry, optical & physical properties, stability relations and genesis of minerals. With respect to geochemistry the student will understand the distribution of various elements and their abundances in the earth's crust.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Explain the concept of Gibbs Phase Rule, Collate structure, chemical composition with physical and optical properties of minerals of major silicate group of minerals, interpret stability relations of minerals using Phase diagrams of Olivine, Pyroxene and Feldspar Group of minerals. Explain how minerals originate and associate with each other in a rock

CO2 Collate structure, chemical composition with physical and optical properties of minerals of major silicate group of minerals and interpret stability relations of minerals of Feldspathoid, Silica, Amphibole and Mica Group of minerals.Explain how minerals originate and associate with each other in a rock

CO3 Describe the geochemical composition of the earth and describe how compatible and incompatible elements are involved in the various geochemical processes.

CO4 Calculate end-members for olivine, pyroxene and feldspar group of minerals and determine the structural Formula for the various silicate group of minerals.

CO5 Plotting of major oxides and trace elements on tectonic discriminant diagrams

Module I **(15 hours)**

Introduction to mineral chemistry, Gibbs Phase Rule, Phase diagram.

Structure, mineral chemistry, paragenesis, and Phase diagrams of the following silicate group of minerals:

Olivine group (Forsterite-Fayalite System)
Pyroxene group (Diopside-Anorthite System)
Feldspar group (Albite-Anorthite System; Orthoclase-Albite System)

MODULE II **(15 hours)**

Structure, mineral chemistry, paragenesis, and stability relations of the following silicate group of minerals:

- Feldspathoid group (Leucite-Silica System)
- Silica
- Amphibole
- Mica

MODULE III **(15 hours)**

- Whole rock analysis (major, trace REE)
- Concept of compatible and incompatible elements,
- Use of geochemistry in deducing tectonics.
- Primitive mantle normalized diagram and their significance in petrogenesis.

Practical: 1 credit
Maximum Marks: 25

1. Calculation of end-members for olivine, pyroxene and feldspar group of minerals.
2. Calculation of Structural Formula for the common silicate group of minerals
3. Plotting of major oxides and trace elements on tectonic discriminant diagrams

List of books recommended for reference

- Deer, W. A, Howie, R. A and Zussman. J., (2013). An Introduction to Rock-Forming Minerals, Mineralogical Society.
- Ford, W. E., (2006). Dana's Textbook of Mineralogy (with extended treatise Crystallography and Physical Mineralogy). CBS Publishers, New Delhi.
- Griffen, D. T, Phillips, W. R and William, R. Phillips., (2004). Optical Mineralogy: The Nonopaque Minerals. CBS Publishers, New Delhi.
- Mason and Berry, (2004). Mineralogy, CBS Publishers, New Delhi.
- Faure, G (1998) Principles and Applications of Geochemistry. Prentice Hall
- White, W M (1997) Geochemistry, Wiley-Blackwell
- Krauskopf, K B and Bird, D K (1995) Introduction to Geochemistry. McGraw-Hill
- Mason, B and Moore, C., (1982). Principles of Geochemistry, John Wiley & Sons.

CourseTitle : **PHYSICAL GEOLOGY**
Course Code : **GEL-III.E-1**
Credits : **3 (45 Contact hours)**
Marks : **75**

Course Objectives

The natural agencies like wind, rivers, glaciers have been moulding and remoulding the surface of the earth over millions of years. This paper aims at the understanding of the processes and the physical forces responsible in developing the surficial features and highlighting the role of these natural agencies in grading and degrading the land surface.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Explain the processes of weathering, erosion, transportation, deposition, and how these geological processes create desert landforms.

CO2 Identify and explain formation of various landforms created by geological action of streams and underground water .

CO3 Identify and explain formation of various landforms created by geological action of glaciers and the sea.

CO4 Assign stream order as per Strahler's Method and analyze various attributesof basin morphometry and drainage.

CO5 Prepare and analyze long and cross sections of river profiles from SOI Toposheet

Module I **(15 Hours)**

Weathering and erosion

- Earth Systems Affecting Weathering
- Mechanical Weathering – Pressure Release, Frost Action, Thermal Expansion and Contraction, Salt Growth, Impact of Organism
- Chemical Weathering – Organisms Role, Oxidation, Acid Action, Dissolution/Leaching, Hydrolysis, Spheroidal Weathering
- Factors Affecting rate of Weathering.
- Rate of Weathering versus Stability of Minerals

Weathering versus Erosion

Transportation and deposition

- Laminar and Turbulent Flow
- Agents of Transportation – Wind, Water, Glaciers, Gravity
- Modes of transportation – Bed Load (sliding, rolling, saltation), Suspension, dissolved load
- Factors Affecting Depositions

Action of Wind

- Generation of Winds,
- Characteristics of Desert.
- Problems Associated with Desertification.
- Sediment Transport – Lifting Mechanism, Bed Load and Suspended Load

Desert Landforms:
Depositional: sand dunes, Sand Seas/Ergs, Playa, sabkha
Erosional:Grooves, Ventifacts & Yardangs mushroom rock, Inselbergs, Mesas and Buttes, Deflation Basin, Desert Pavement and Lag Gravel

Module II **(15 Hours)**

Drainage Basin and River System –, Drainage Patterns –
Dynamics of Stream Flow – Discharge, Gradient, Velocity, Sediment Load, Base Level
Concept of Graded Stream
River System and Plate Tectonics

Geological Action of Rivers
Erosion by River

Process of Stream Erosion – Removal of Regolith, Downcutting, Headward Erosion.
Bradshaw Model
Erosional Feature in Upper Course - Steep Valleys, Gorges, Interlocking Spurs, Potholes, Waterfall and Rapid
Erosional Features in Middle and Lower Course – Meander, Ox Bow Lake, Hogbacks, Cuestas

Depositional Landforms by River

Floodplains – Meanders, Point Bars, Natural Levees, Backswamps, Braided Stream
Alluvial Valleys – Step Terraces
Deltas – Formation and Types
Alluvial Fans

Erosion by Groundwater

Karst Topography – Caves, Sinkholes, Solution Valleys, Disappearing Streams, Tower Karst

Deposition by Groundwater

Speleothems – Stalactites, Stalagmites

Module III **(15 Hours)**

Types of glaciers and Glacial Budget
Glacier Flow – Surging Glacier, Crevasses
Ablation – Melting, Evaporation, Calving

Geological Work of Glaciers
Erosional Features of Glaciers

Erosion Process– and erosional landforms related to valley and continental glaciation.

Depositional Features of Glaciers

Glacial Drift – Till and Stratified Drift

Action of Sea Waves
Erosional and depositional features of the coast.

PRACTICAL MODULE: 1 Credit

- Basin Morphometry Perimeter Calculation using rotameter
- Area Calculation – Square Grid/Planimeter/Area using triangles
- Stream Ordering (Strahler's Method)
- Drainage Network Morphology – Bifurcation and Length ratio
- Basin Geometry – Basin Circularity, Intensity of Dissection – Drainage Density, Stream Frequency, Hypsometric Curve
- Draw Inference for the Basin based on the result
- Long Profile and Cross Profile of River – Upper Course, Middle Course, Lower Course of river from SOI Toposheet. Field visit to nearby area to understand and describe the various physical geology features.

REFERENCE BOOKS:

- Monroe, S. J and R. Wicander., 2014. The Changing Earth: Exploring Geology and Evolution. Brooks Cole Publishers.
- Mathur, S. M., 2012. Physical Geology of India. National Book Trust
- Carlson, D.H., Plummer, C.C., McGeary, D., 2008. Physical Geology: Earth revealed. Higher Education.
- McConnell, D., Steer, D., Knight, C., Owens, K., Park, L., 2008. The Good Earth – Introduction to Earth Science. Higher Education.
- Monroe, J.S., Wicander, R., Hazlett, R., 2007. Physical geology – Exploring the Earth (6^{th} Ed.) Thomson Brooks/Cole.
- King, C.A.M., 2006: Techniques in Geomorphology, Edward Arnold, London

Course Title : **GROUNDWATER AND HYDROGEOLOGY**
Course Code : **GEL-III.E-2**
Credits : **3(45 contact hours)**
Marks : **75**

Course Objectives

To impart knowledge about groundwater, its movement, methods of its exploration, the criteria of its quality, methods of its conservation, recharge of groundwater, monitoring of groundwater quality and quantity.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Explain the concept of Groundwater, its sub- surface distribution and sources, describe the rock properties of porosity and permeability affecting the movement of groundwater and differentiate between the various types of aquifers.

CO2 Carry out groundwater exploration by resistivity method.

CO3 Explain the effects of over withdrawal of groundwater and waterlogging, and suggest mitigation measures.

CO4 Draw flow-nets from groundwater levels.

CO5 Determine water quality based on various parameters.

Module I **(15 hours)**

Hydrologic cycle and its components
Factors controlling all the components: Evaporation, precipitation, runoff, Infiltration
Hydrologic budget
Vertical distribution of ground water
Types of Groundwater: soil water, vaddose, capillary water, Meteoric water
Rock properties affecting movement of ground water:
1) Porosity(primary and secondary), effective porosity, specific retention, controlling factors of porosity
2) Permeability: Darcy's law, laboratory methods of measurement of permeability (constant head, falling head), specific yield, Relation between grain size, porosity, specific yield and specific retention.
Definition of an aquifer, aquiclude, aquitard, aquifuge, and types of aquifers: Unconfined, Confined (Artesian), Perched aquifer.

Module II **(15 hours)**

Groundwater Exploration: Resistivity methods
Groundwater levels and Flow nets
Aquifer parameters: 1) Transmissivity, 2) Storativity,3) Hydraulic conductivity: methods of determination (pumping test and tracer test)
Drawdown and cone of depression

Groundwater quality:

- Parameters :physical ,chemical and biological
- Major, minor and trace constituents.
- I.S.I standards for drinking water

Module III **(15 hours)**

Effects of withdrawal, effects of waterlogging
Artificial recharge
Saline water intrusion in aquifer
Ghyben-Hertzberg relation
Pollution of ground water: Arsenic and Fluoride

Practical: 1 credit
Maximum Marks: 25

- Drawing flow nets
- Determination of depth to water table from bore hole data.
- Numerical problems on determination of porosity, bulk density, saturation percentage and void ratio of sample
- Problems based on Ghyben –Hertzberg formulae
- Graphical presentation of chemical data of water
- Resistivity survey (demonstration)

List of books recommended for reference

Mandatory Reading

- Todd , D.K and Mays, L.W., 3rd edition , 2012. Groundwater Hydrology, Wiley India Pvt. Ltd.
- Keller, E.A., 4th edition, 2011. Environmental Geology, CBS Publishers, New Delhi.
- Hiscock, K and Bense, V F. Hydrogeology: Principles and Practice.
- Valdiya K.S., 1987, Environmental Geology: Indian Context, Tata-McGraw Hill
- Ragunath H.M., 1983, Groundwater, Wiley Eastern Ltd, New Delhi.

Course Title : **ORE GENESIS**
Course Code : **GEL-III.E-3A**
Credits : **3 (45 contact hours)**
Marks : **75**

Course Objectives

The course aims at understanding the various types of mineral deposits, classification, their mode of occurrence, geologic & geographical distribution and genesis. It primarily focuses on the processes of formation of ore deposits. Furthermore, it also aims at identification of economic minerals in hand specimens.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Classify and differentiate the stages of ore-formation and ores, explain the igneous origin of ore minerals.
CO2 Explain the role of hydrothermal solutions and submarine volcanism forming ore-deposits. Also, describe sedimentation process in creating ore deposits.
CO3. Describe various ore minerals and deposits found in India.
CO4 Identify various industrial minerals with the help of their physical properties.
CO5 Identify various ore minerals on determining their physical properties.

Module I **(15 hours)**

Goldsmith geochemical Classification
Tenor, Prospects, Resource & Reserves of ore minerals
Classification of Ore Deposits:
- Modified Lindgren's Scheme; Bateman Scheme; Based on Tectonic Setting

Processes Forming Mineral Deposits
- Requirements for Ore deposit formation
- Syngenetic & Epigenetic deposits

Magmatic Ore Forming Processes
- Orthomagmatic ore formation (Bushveld; Sudbury)
- Ore deposits at mid-ocean ridges (Black & White Smokers) and in ophiolites (podiform chromites)
- Ore formation related to alkaline magmatic rocks, carbonatites and kimberlites
- Ore deposits in pegmatites

Module II **(15 hours)**

Magmatic-Hydrothermal Ore Forming Systems
- Hydrothermal ore formation (Source of Hydrothermal Solutions; Textures & Structures; Host rock alteration)
- Volcanogenic ore deposits (VMS; Terrestrial epithermal gold, silver and base metal)
- Porphyry copper (Mo-Au-Sn-W) deposits
- Hydrothermal-metasomatic ore deposits
- Skarn, Greisen

Supergene Ore Formation Systems
- Residual (eluvial) ore deposits
- Supergene enrichment by descending (vadose) solutions

Sedimentary Ore Formation Systems
- Black shales in metallogenesis (European Copper Shale)
- Autochthonous iron and manganese Deposits
- Sediment-hosted & submarine-exhalative (sedex) base metal deposits
- Mississippi Valley type (MVT) Lead-Zinc deposits
- Placer deposits

Metamorphic Ore Forming System
- Orogenic Cu-Zn-Au deposits

Ore Deposits in Space and time
- Metallogenic Epochs
- Plate Tectonic Setting of Ore Deposits

Module III **(15 hours)**

Indian occurrences of
- Metallic Deposits:
  - Iron
  - Manganese
  - Chromium
  - Copper-Lead-Zinc
  - Gold
- Non metallic Deposits:
  - Diamond, Baryte, Bauxite,
- Nuclear Minerals
- Industrial Minerals (Refractory, Abrasives, Cement, Fertilizer, Electrical and Electronics).

PRACTICAL MODULE = 1 Credit
- Descriptive evaluation of ore minerals in hand sample
- Introduction to reflected light microscopy of ore minerals (demonstration) Site visits to local mineralized geology

REFERENCE BOOKS

For Ore Forming Process: (E-books Available of All)

1. Pohl, L.W., 2011. Economic Geology – Principles and Practice. Wiley-Blackwell
2. Robb, L., 2005. Introduction to Ore-Forming Processes. Blackwell Publishing
3. Evans, A.M., 1993. Ore Geology and Industrial Minerals – An Introduction (3rd Ed.) Blackwell Publishing
4. Edwards, R. & Atkinson, K., 1986. Ore Deposit Geology and its influence on Mineral Exploration. Chapman and Hall Ltd.
5. Hutchison, C., Economic Deposits and their Tectonic Setting.

For Ore Deposits in Indian Context:

1. Prasad, U., 2014. Economic Geology: Economic Mineral Deposits (2^{nd} Ed.), CBS Publishers, New Delhi
2. Srivastav, J.P., 2012. Introduction to Ore Microscopy. Prentice Hall India Learning Private Limited
3. Tiwari, A.K., 2010. Ore Geology, Economic Minerals and Mineral Economics. Atlantic
4. Gokhale, G.V.G.K., 1983. Ore Deposits of India. CBS Publishers, New Delhi

Mandatory Reading

Principle Reference books used for course preparation will be Economic Geology by Walter Pohl and Economic Geology by Umeshwar Prasad.

Course Title : **MARINE GEOLOGY**
Course Code : **GEL-III.E-4**
Credits : **3 (45 Contact hours)**
Marks : **75**

Course Objectives
To provide knowledge on essential concepts of oceanography.
To study the tectonics, geology, economic resources w.r.t. the oceans.

Course Outcomes
Upon completion of the course, the student will be able to :

CO1 Describe ocean bathymetry and learn to identify features of the ocean floor such as mid ocean ridges, seamounts, guyots, hydrothermal vents, pillow basalts, trenches and Relate the ocean features to theirtectonic origin.

CO2 Describe the various processes which give rise to ocean circulation.

CO3 Classify marine sediments into four broad categories based on their origin i.e., lithogenous, hydrogenous, biogenous, cosmogenous and Identify the characteristics of important marine resources from marine sediments for the future such as polymetallic nodules and gas hydrates.

CO4 Recognise how near shore geological processes shape coastlines over time.

Module I **(15 hours)**
Ocean basins: Shape, size of the Pacific, Atlantic and Indian Oceans
Coriolis Effect
Ocean circulation
Ocean salinity
Techniques used to study ocean bathymetry
Concept of Plate Tectonics and ocean floor spreading,
Magneto stratigraphy

Module II **(15 hours)**
Marine Provinces
Morphological features of the ocean floor;
- Mid Oceanic Ridges and its features;
- Abyssal plains and its features
- Ocean trench and its features
- Continental slope and shelf and their features
- Ocean islands: Hot spot, Atolls

Module III **(15 hours)**
Clastic Sedimentation in different marine environments:
- Biogenic sedimentation
- Chemogenic sedimentation

Near coastal geological processes
Coastal Zone Regulations (CRZ), Exclusive Economic Zone (EEZ); Minerals in the EEZ of India.
Mineral deposits

Practicals = 1 credit

- Preparation of salinity and ocean current map.
- Drawing and labeling of ocean profile.
- Preparation of ocean resource distribution maps
- Visits to National Laboratories engaged in Ocean Research such as NIO and NCAOR.

List of books recommended for references:

- Trujillo, A. P and Thurman H., 2013. Essentials of Oceanography, Eastern Economy Edition, PHI Learning Pvt. Ltd, New Delhi.
- Pinet, R. P., 2009. Invitation to Oceanography,(5TH Edition), Jones and Bartlett Publishers, London.
- Thurman, H V. and Trujillo A., 2003, Introductory Oceanography, Prentice Hall.
- Qasim, S.Z., 1996, India's Exclusive Economic Zone, Omega Scientific Roonwal, G.S. Publishers.
- Kennett J P., 1981. Marine Geology, Prentice Hall.

Online resources

- https://oceanexplorer.noaa.gov/edu/learning/welcome.html , Date: 15/3/19
- http://www.nio.org/index/option/com_nomenu/task/show/id/134 , Date: 15/3/19
- https://pubs.usgs.gov/gip/dynamic/dynamic.html ,

SKILL ENHANCEMENT COURSE (SEC)

Course Title : **OPERATIONAL GEOLOGY AND GEMMOLOGY**
Course Code : **GEL-III.SEC-1**
Credits : **4 (60 Contact hours)**
Marks : **100**

Prerequisites **:** Students should have their own laptops
XII level knowledge of Physics

Course Objectives

The objective of the course is to provide skills to equip students with the basic skills of data management and analysis in MS Excel.
The course deals with introduction to simple Excel functions and tools that are commonly used in day-to-day data management.
Further the course deals with using Excel for Drill hole database management.
To introduce students to the study of gemstones.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Manage any data in a systematic manner in Excel spreadsheet and perform basic data analysis using Excel tools.

CO2 Explain the processes involved in drilling project, the type of data generated and create a drill hole database in Excel.

CO3 Decide on the factors deciding cost of a gemstone, explain the causes of colours in gemstones.

CO4 Explain how gemstones are synthesized, explain how gemstones are enhanced from low-grade to saleable quality, and explain the styles of cuts preferred for different gemstones

Module I **(15 hours)**

Introduction to Excel

Overview of the User Interface, Overview of Workbooks, Editing and Formatting Worksheets
Excel Tables: creation, editing, sorting and filtering of data, conditional formatting, Text to column, Merging and splitting of data.
Formulas and Functions
Statistical functions: mean, mode, variance, standard deviation, Kurtosis
Introduction to charts and Graphs
Setting page layout for printing

Module II **(15 hours)**

Drill hole data management in Excel
Overview of drilling project: Surveying, geological mapping, Borehole logging, sampling process.
Survey data collection
Sampling data- Quality assurance and Quality control (QAQC): data collection and data analysis, scatter plots and control charts.
Management of drill hole data in excel: types of files (mandatory and optional files)
Data collection, entry and modification and validation.

Module III **(15 hours)**

Introduction to Gemmology
Association of Gemstones with rocks
Factors deciding the cost of a gemstone
Causes of colour in gemstones
International grading of diamonds
Composites

Module IV **(15 hours)**

Enhancement and Treatments of gemstones
Synthesis of gemstones
Need for Faceting
Styles of cut
Visual observation of gemstones

List of books recommended for reference

For Operational Geology

- Berk N. and Carey M.,(2004) Data Analysis with Microsoft® Excel Updated for Office 2007®
- Marjoribanks, R., (1997) Geological Methods in Mineral Exploration and Mining, Springer-Science+Business Media

For Gemmology

- Fernandes S. and Choudhary G., (2010) Understanding Rough Gemstones, Indian Institute of Jewellery.
- Karanth, R V; (2000) Gem and Gem deposits of India, Geological Society of India.
- Read, P. G., (1991). Gemmology, Butterworth-Heinemann Ltd.
- Sinkankas, J., (1969) Mineralogy: A First Course, Van Nostrand Reinhold Company.
- Webster, R., edited by Anderson, B, W., (1983) Gems: Their Sources, Descriptions and Identification, Butterworth-Heinemann Ltd.

SEMESTER IV

Course Title : **STRUCTURAL GEOLOGY**
Course Code : **GEL-IV.C-6**
Marks : 75
Credits : 3 (45 Contact hours)

Course Objectives

The course is designed for the students to understand the geometry and mechanics of the various geological structures that result through the deformative processes operative within the earth.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Apply knowledge on primary and secondary structures in rocks to stratigraphic problems; also, relate stress and strain in explaining the geometry in rocks

CO2 Explain the mechanisms involved in the creation of different geologic features.

CO3 Classify different kinds of rock structures and describe the mechanisms of their generation.

CO4 Draw cross-sections across geologic maps, and also, create geologic maps from data provided.

Module I **(15 hours)**

Primary and secondary structures.
Concept of rock deformation.
Stress and Strain in rocks, 2-D stress and strain analysis;
Strain ellipses of different types and their geological significance.

Module II **(15 hours)**

Unconformities.
Joints: Joints and fracture mechanics, classification of joints.
Faults: Terminology, classification, criteria for faulting.
Diapirs (salt domes)

Module III **(15 hours)**

Cleavage and foliation: types, origin and relation to major structures.
Lineations- Description and origin of lineation.
Folds- morphology; Geometric and genetic classification; Mechanics and causes of folding
Lineation and relationship with folds

Practicals : Credit 1
Maximum Marks: 25

Solving Geological Maps
Stereographic Projection of Structural Data
Graphical Solution for Structural Problems

List of recommended reference books:

Mandatory Reading

- Hobbs, B and Alison, O. R. D., 2014. Structural Geology: The Mechanics of Deforming Metamorphic Rocks, Elsevier Science Publishing Co. Inc
- Fossen, H., 2010. Structural Geology, Cambridge University Press.
- Twiss, R. J and Moores, E. M., (2006). Structural Geology, W H Freeman and Company.
- Pollard, D. D and Fletcher, R. C., (2005). Fundamentals of Structural Geology, Cambridge University Press.
- Davis, G. H., (1996). Structural Geology of Rocks and Regions, Wiley
- Hatcher, R., (1995). Structural Geology: Principles, Concepts and Problems. Pearson.

Course Title : **ENGINEERING GEOLOGY**
Course Code : **GEL-IV.E-5A**
Marks : **75**
Credits : **3 (45 contact hours)**

Course Objective

To impart sufficient knowledge of engineering geology so as to be able to anticipate the technical problems related to geology of various engineering sites and suggest possible remedial measures.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Explain the engineering properties of rocks and soil to determinetheir suitability for engineering works.

CO2 Explain the role of a geologist and the methods involved in geotechnical investigations needed for selection of site for engineering works.

CO3 Explain geological aspects that needs to be considered while construction of major civil structures like dams, bridges and tunnels.

CO4 Solve numerical problems on ultimate strength of
Rocks, RQD and describe Physical properties of core samples.

CO5 Compute reservoir area, catchment area, reservoir capacity and assess site feasibility based on geological maps.

Module I **(15 hours)**

Aim of engineering geology
Porosity and permeability of rocks
Principles of mechanical behaviour of rock materials
Engineering properties of rocks; specific gravity, compressive strength, hardness, toughness.
Soil profile and Engineering properties of soil;
Role of structures (joints, fractures, folds, faults) and water/fluids in engineering geology
Use of rocks / aggregates in construction

Module II **(15 hours)**

Role of engineering geologists in planning, design and construction of major man-made civil structural features.
Methods of site investigation
Introduction to core logging
Geological investigations/geotechnical problems related to groundwater occurrence,

Module III **(15 hours)**

Geological investigations for landslides, bridges and tunnels -design and construction.
Geological investigations in dams and reservoirs.
Case studies of dam failures
Site improvement methods

Practical: 1 credit
Maximum Marks: 25

- Site feasibility based on geological map.
- Physical and mineralogical descriptions of cores,
- Relationship of core log to RQD values
- Computation of reservoir area, catchment area, reservoir capacity
- Numerical problems on ultimate strength of rocks

List of recommended reference books.

- Parthsarthy, A, Panchapakesan, V., Nagarajan, R., (2013) Engineering Geology, Wiley.
- Price, D.G.,(2009), Engineering Geology Principles and Practice, Springer.
- Bell, .F.G, (2007). Engineering Geology, Butterworth-Heineman
- Narayanswami S.B.S. (2000), Engineering Geology, Dhanpat Rai & Co, India.
- Sathya, N S., (1992). Engineering Geology, B.S, Dhanpat Rai and Co. Pvt Ltd.
- Gupte R.B. (1992). A Textbook of Engineering Geology., Pune Vidyarthi GrihaPrakashan.

Course Title : **OPTICAL MINERALOGY**
Course Code : **GEL-IV.E-6A**
Marks : **75**
Credits : **3 (45 Contact hours)**

Course Objectives

The objective of the course is to provide the basics of geoscientific studies in Optical Mineralogy involving optical properties of minerals in plane polarized light, in between crossed polars and convergent light. Further, it will strengthen their knowledge in understanding of optical indicatrices and determination of optic sign of minerals.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Explain basic concepts in optical mineralogy and relate them to study of minerals in Plane Polarised Light (PPL)

CO2 Explain basic concepts in optical mineralogy and relate them to study of minerals Between Crossed Polars (BXP).

CO3 Distinguish Uniaxial and Biaxial Indicatrix and study behaviour of minerals under convergent light.

CO4 Identify major rock-forming minerals in microsections.

CO5 Detect Optic Sign for Uniaxial and Biaxial Minerals using Interference Figures, Determine Anorthite content of Plagioclase and calculate Optic Axial Angle.

Module I **(15 hours)**

Introduction: Nature of light, Polarized light, Refractive Index, Critical angle and Total Internal reflection, Wave Surface, Double Refraction.

Parts and working of a Polarizing / Petrological microscope

Properties of minerals in Plane Polarised Light (PPL): Colour, Form, Cleavage/Cracks; Relief, Twinkling; Pleochroism,

Pleochroic halos.

Module II **(15 hours)**

Optical characters of minerals: Isotropism and Anisotropism

Properties of minerals Between Crossed Polars (BXP): Interference colours: Formation, Newton's Scale, Anomalous interference colours;

Extinction and Extinction types.

Twinning and Zoning

Alteration, Inclusions.

Module III **(15 hours)**

Optical accessories

Uniaxial indicatrix

Biaxial indicatrix

Convergent Light: Principle
Uniaxial Interference Figure
Biaxial Interference Figure
Optic sign of Uniaxial and Biaxial Minerals
2V and 2E

Practical: 1 credit
Maximum Marks: 25

- Identification of common rock forming minerals based on optical properties
- Determination of Optic signfor Uniaxial and Biaxial Minerals
- Determination of An-content using extinction angles
- Determining 2V using Mallards Method.

List of books recommended for reference

Mandatory Reading

- Perkins, D., (2015). Mineralogy. Pearson New International Edition
- Nesse, D. W., (2012), Introduction to Optical Mineralogy, Oxford University Press.
- Kerr, P., (1977), Optical Mineralogy, McGraw Hill Publishers.
- MacKenzie, W. S and Guilford, C., Atlas of Rock forming minerals in thin section_

Supplementary reading

- Cornelis, K and Cornelis, H. (1993). Manual of Mineralogy, John Wiley and Sons Ltd.

Course Title : **NATURAL HAZARDS AND MANAGEMENT**
Course Code : **GEL-IV.E-7**
Marks : **75**
Credits : **3 (45 Contact hours)**
Prerequisites : **GEL-III.E-1**

Course Objectives

The course is designed with an aim to give the student an understanding about: various natural hazards; stages in management aimed at avoiding and /or reducing loss to life and property; and Agencies involved in mitigation and management of damage due to hazards.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Describe the influence of mitigation, preparation, response and recovery on natural hazards such as droughts, floods, cyclones, volcanic eruptions, tsunami, landslides & subsidence, salinity hazards and coastal erosion.

CO2 Compare and critically analyze recent disasters caused by natural events.

CO3 Analyze how geologic hazards impact our everyday lives and understand the science behind geologic events that are frequently reported in the media.

Module I **(15 hours)**

Classification of hazards: Natural and man-made disasters

Droughts: types, causes, mitigation

Floods: causes and effects, prediction, Cloud burst/Flashfloods, remedial measures

Cyclones: Structures, origin, effects, prediction, path tracking and early warning systems.

Module II **(15 hours)**

Volcanic eruption: Types, localization, volcanic hazards and mitigation

Earthquakes: Causes, Magnitude and intensity, Recording, effects and preparedness, Earthquake Zonation Map.

Tsunamis: relation of Tsunamis to tectonics; Damage due to tsunamis, Co-ordinated approach to early warning of tsunamis.

Landslides and Avalanches: Classification of mass wasting, mechanics, causes of landslides and stabilizing methods of slopes; civil engineering measures.

Subsidence: Causes, slow and brisk types

Module III **(15 hours)**

Salinity hazards: Inland and coastal

Coastal erosion and mitigatory measures

CRZ act and its impact on disaster mitigation

National Disaster Management: national and international support

Planning strategy: co-operative plan, identifying resources, setting priorities.

Hazard coping operations and rehabilitation
Proposed operational processes for individual Natural Disasters mentioned above.
Case study of Parvatibai Chowgule College Disaster Plan

Practical: 1 credit
Maximum Marks: 25

- Hazard zonation map of India: ,earthquakes, floods droughts, landslides and Cyclone
- Discussing disaster management plan for Parvatibai Chowgule College
- Land-use land cover mapping

List of books recommended for reference
Mandatory reading

- Paul, K, B., 2011, Environmental Hazards and Disasters: Context, Perspectives and Management, Wiley-Blackwell, West Sussex.
- Keller, E. A., 2011, Environmental Geology, Santa Barbara Prentice Hall.
- Hess, D., 2012, Mc Knight's Physical Geography, PHI learning, Pvt Ltd, New Delhi.
- Sethi, V. K., 2009, Disaster Management, Essential Books PW, New Delhi.
- Joshi M.V., 2004, Environmental Disaster, Causes, Impacts and Remedies, Adhyayan Publishers.
- Krynine, D. and Judd W., 1998, Principles of Engineering Geology and Geotectonics, McGraw Hill.
- Holmes, A., edited by Duff P.M.D.,1993, 4th edition, Physical Geology, E.L.B.S Publications.
- Valdiya K.S., 1987, Environmental Geology: Indian Context, Tata-McGraw Hill

Online resources

- https://ndma.gov.in/en/national-policy.html Date:19/3/19
- The Gazette of India : extraordinary [part ii—sec. 3(i)] ministry of environment, forest and climate change notification New Delhi, the 18th January, 2019 G.S.R. 37(e).— [18/01/2019]- coastal regulation zone notification.

http://www.moef.nic.in/sites/default/files/GSR%2037(E)%20DATED%2018.01.2019.pdf,

Course Title : **GEOTECTONICS**
Course Code : **GEL-IV.E-8**
Marks : **75**
Credits : **3 (45 Contact hours)**

Course Objectives

Ever since the creation of the earth, there have been marked changes in the distribution of land and sea. The dynamics of these changes are stupendous. The subject of Geotectonics aims at understanding the mechanism of such changes and explaining the structure of the earth and the processes responsible for the movement and redistribution of continents and seas.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Gain an insight into the earth's interior and generation of its magnetic field.
CO2 Understand the theory of Continental Drift along with supporting evidences.
CO3 Explain mountain building (orogenesis) and its relation with plate tectonics.
CO4 Identify and plot various tectonic features on the earth's surface.
CO5 Apply the concept of plate tectonics to gain insight into earthquakes and hotspots.

Module I **(15 hours)**

Interior of the earth:

Clues from the study of earthquake and density;
The earth's layers; the crust-continental crust and oceanic crust;
Crust-mantle boundary
Structure of the mantle
Low Velocity Zone (LVZ)
Core-mantle boundary; P wave shadow zone,
Nature of the core; S wave shadow zone.

Earth's Magnetic field:

Origin and nature
Dynamo hypothesis and Herndon's Georeactor Theory.
Geocentric axial dipole,
Paleomagnetism,
Marine magnetic anomalies,
Magnetic reversals and magnetic stripes

Module II **(15 hours)**

Continental drift:

Wegener's hypothesis.
- Evidences: Continental fit; similarity of rock sequences and mountain ranges; glacial evidence, fossil evidence;

Paleomagnetism and Polar wandering.

Plate tectonics:

Plate margins, plate boundaries and associated activities,

Triple junctions;

Divergent, Oceanic Ridges, Sea floor spreading, transform faults; hotspots.

Convergent: oceanic–oceanic, oceanic-continental, continental-continental; oceanic trenches, subduction zones

Transform boundaries;

Wilson Cycle (Rift valleys, the Red sea and the Gulf of Aden)

Geometrical aspects and mechanism of plate motion.

Module III **(15 hours)**

Mountain building: Orogenesis

Plate boundaries and orogenesis: Orogenesis at oceanic-oceanic plate boundaries, oceanic-continental plate boundaries and continental-continental plate boundaries.

Case study: Tracking the rise of Himalayas.

Case study: Frequency of Earthquakes in North India

Case Study: Occurrence of Tsunami in SE Asia

Practical: 1 credit

Maximum Marks: 25

- Plotting of oceanic ridges, trenches, subduction zones, sea mounts, plate boundaries
- Exercises in plate tectonics.

List of books recommended for reference

Mandatory reading

- Monroe, S. J and R. Wicander., 2014. The Changing Earth: Exploring Geology and Evolution, Brooks Cole Publishers.
- Marshak, S., 2011. Earth: Portrait of a Planet, W. W. Norton & Company.
- Prasad, C. V. R. K., 2005. Elementary Exercises in Geology, Universities Press.
- Skinner, J. B and S, C. Porter., 2003. The Dynamic Earth: An Introduction to Physical Geology, John Wiley and Sons.
- Condie, K. C., 1997. Plate Tectonics and Crustal Evolution, Butterworth-Heinemann.
- Duff, D and Holmes, A., 1993, Holmes Principles of Physical Geology, Springer.

SKILL ENHANCEMENT COURSE (SEC)

Course Title	:	**GIS FOR BEGINNERS**
Course Code	:	**GEL-IV.SEC-2**
Credits	:	**4 (60 Contact hours)**
Marks	:	**100**

Requisites

Students should have their own laptops compatible with the latest long term release of QGIS, Google Earth.

Basic knowledge of computers.

Strong desire to learn new technologies and innovative thinking.

Course Objectives

To impart GIS training in Spatial data visualization techniques, Creating Geospatial datasets, Working with mobile Global Positioning System (GPS) data, tabular data, and raster data, Accessing open source data, Visual image interpretation, Terrain analysis.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Understand the fundamental concepts of GIS.

CO2 Create/extract geospatial data from hardcopy maps, open-source GIS portals and field surveys.

CO3 Visually identify various features such as landforms, geologic structures, manmade structures etc. on satellite imagery.

CO4 Apply GIS techniques such as those used for analysing and presenting water quality data, Terrain data, geologic data etc to prepare aesthetically pleasing and informative maps.

CO5 Prepare and execute a simple GIS project in their domain of study.

Tools exposed:

We will use open source GIS – QGIS software, Google Earth Pro®, GPS Essentials (for Android phones) throughout the programme.

Module I – Basics of GIS **(15 hours)**

What is GIS? - Installing QGIS, QGIS interface

Spatial Data Model Concepts: Raster and Vector data - Loading spatial data and visualization in QGIS

Coordinate Reference Systems Concept - Projecting and re-projecting data in QGIS.

Concept of Georeferencing - Georeferencing a Toposheet: Using GCP's, Image to Image Registration.

Data creation: Digitization - Data handling and storage in GIS, Creating Data Layers: Point, Line and Polygon, Editing Tools and Functionalities, Symbology/Styling

Working with Mobile GPS - GPS essentials app, collecting Geotagged photographs and data.
From excel to GIS - CSV TO Point layer, Attribute joins from table.

Module II – Visual Image Interpretation and Open source data **(15 hours)**
Overview of Google Earth pro - Installing Google Earth Pro, Interface and working in Google earth pro.
Elements of Visual Image Interpretation: Tone, Texture, Pattern, Shape, Size, Association - Image interpretation using Google Earth Satellite Imagery: Manmade features.
Elements of Visual Image Interpretation: Tone, Texture, Pattern, Shape, Size, Association - Image interpretation using Google Earth Satellite Imagery: Coastal features.
Elements of Visual Image Interpretation: Tone, Texture, Pattern, Shape, Size, Association - Image interpretation using Google Earth Satellite Imagery: Geological Features and landforms.
QGIS plugins - Open Street Maps, Open Layers, MapLibrary
Open Source Data - Overview of Bhuvan portal

Module: III –GIS Analysis and Cartography [Map making] **(15 hours)**
Working with Tabular Data - Field Calculator:Calculating area under a polygon, generate Simple statistics of a vector field, selecting features by expressions.
Working with vector data - Convex Hull, Clipping, Buffer, Dissolve, Merge Shapefiles
Working with Raster Data using DEM - Raster merge and clip using DEM, Reprojecting DEM
Terrain Analysis – Hillshade, Slope, Aspect, Creating layer mask, Profile tool, 3D modelling
Working with groundwater data - Interpolation and Contouring from point data.
Advance cartography and styling - Blending modes, styling by attribute size,symbols, Labels, colour schemes,transparency, textured polygons.
Map Creation - Map Composer- TODALS
Web maps - Google MyMaps

Module IV – GIS applications Case studies and Project **(15 hours)**
Students are expected to execute a meaningful GIS project with their own data or data from open source databases preferable in their subject domain.

References
Online resources

- T. Sutton, O. Dassau, M. Sutton, A Gentle Introduction to GIS, Chief Directorate: Spatial Planning & Information, Department of Land Affairs, Eastern Cape, South Africa (ebook)

http://download.osgeo.org/qgis/doc/manual/qgis-1.0.0_a-gentle-gis-introduction_en.pdf

- QGIS Tutorials

http://www.dst-iget.in./
https://www.qgistutorials.com/en/index.html

Books

- Burrough, P. A. and McDonnell, R. A., (2000) Principles of Geographical Information System, Oxford University Press.
- C.P.Lo and Albert K. W. Yeung., (2002) Concepts and Techniques of Geographic Information System, Prentice –Hall, India.
- Heywood I, Sarah, Cornelius, Steve, Carver.,(2011) An Introduction to Geographical Information Systems, Pearson Education Pvt. Ltd., New Delhi.

SEMESTER V

Course Title : **SEDIMENTARY PETROLOGY**
Course Code : **GEL-V. C-7A**
Credits : **3 (45 Contact hours)**
Marks : **75**

Course Objectives

To provide an understanding of the origin of sedimentary rocks, the relationship of sedimentary processes to plate tectonics, and the use of sedimentary rocks in the study of the geological past.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Explain the origin of sedimentary rocks and relate it to the associated textures and environments of deposition.

CO2 Gain insight into the process of formation of sedimentary rocks by studying the various sedimentary structures.

CO3 Explain the various classes of sedimentary rocks.

CO4 To identify, describe and classify rocks using hand specimens and rock thin sections.

CO5 To calculate various textural parameters of sedimentary rocks.

Module I **(15 hours)**

The Origin of Sedimentary Rocks**:**

Erosion, transportation and deposition of sediments.
Hjulstrom's diagram

Provenance

Components of clastic sediments: Heavy, Clay, Quartz, Feldspars, other minerals

Environment of deposition and sedimentary facies

Basins - Plate tectonics and sedimentation

Sedimentary Textures

Grain Size, Udden-Wentworth Size Scale, Phi Scale, Roundness and Sphericity.
Maturity: Textural, Mineralogical and Chemical

Classification of Sedimentary rocks (Folk's and Dunham's, Okhadas)

Module II **(15 hours)**

Primary sedimentary structures

Depositional, Erosional

Secondary sedimentary structures

Chemical, biogenic

Soft sediment deformations

Module III **(15 hours)**

Clastic Sedimentary Rocks

Sandstones, Breccias and Conglomerates**:**

Textures, Structures, Mineral composition, Textural maturity,

Mudrocks:

Structures, Colour, Mineral composition;

Non-clastic Sedimentary Rocks

Limestones and Dolomites:

Textures; Mineralogy; Structures; Diagenesis, Reefs and Palaeoclimate; Dolomites: Dolomitization.

Residual: (Laterite and Bauxite)

Origin and Climate.

Carbonaceous sediments:

Nature and form of organic residues; The Coal series

Practical Course: 1credit
Maximum Marks: 25

- Study and identification of sedimentary rocks w.r.t textures, structures, their classification.
- Study of sedimentary rocks in thin sections
- Exercises in grain size and shape analysis.

List of books recommended for reference

- Boggs S., (2009) Petrology of Sedimentary rocks (2nd edition), Cambridge University Press.
- Blatt H; Tracy R. J and Owens B. E., (2006) Petrology- Igneous Sedimentary and Metamorphic 3rd edition W H Freeman and Company New York.
- Boggs, Jr., (2005) Principles of Sedimentology and Stratigraphy (4 edition), Prentice Hall.
- Prothero, D. R., and Schwab, F.; (2004) Sedimentary Geology. Macmillan.
- Tucker E.M. (2001) Sedimentary Petrology (3rd Edition), Blackwell Science Ltd.
- Raymond A L (1995) Petrology-The study of Igneous Sedimentary and Metamorphic rocks. Wm. C. Brown Communications, Inc.; USA.
- Greensmith, J. (1989) Petrology of the Sedimentary rocks (7th Edition), CBS Publishers, New Delhi.
- Ehlers G.E. and Blatt H., (1987) Petrology – Igneous, Sedimentary and Metamorphic, CBS Publishers, New Delhi.
- Pettijohn F.J., (1984) Sedimentary Rocks (3rd Edition), CBS Publishers, New Delhi.
- Colinson, J D & Thompson, (1982) Sedimentary Structures, Allen & Unwin.

CourseTitle : **PRECAMBRIAN STRATIGRAPHY OF INDIA**
Course Code : **GEL-V.E-9B**
Credits : **3 (45 Contact hours)**
Marks : **75**

Course Objectives

The Peninsular India is a shield comprising of composite crustal blocks of Archean antiquity and therefore it preserves record of the various tectonic events that this land has witnessed. This course aims at providing a basic understanding of the various stratigraphic units and the correlation of International Geological Time Scale with Indian Stratigraphic Time Scale. It aims to provide understanding of the Precambrian geology, stratigraphy, fossil content and the economic resources of the lithounits from the Peninsular India.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Subdivide India physiographically on the basis of their characters, and explain the tectonics and evolution of cratons and mobile belts of Indian shield.
CO2 Enact the stratigraphic history and lithologic sequences of Dharwar craton.
CO3 Describe the Proterozoic geology of Peninsular India.
CO4 Classify the various kinds of rocks of Goa.
CO5 Assign various rock Formations of Peninsular India to their respective geologic age of Formation.

Module I **(15 hours)**

Physiographic subdivisions of India and their distinctive characters.
Geology of India
Cratonic provinces of Peninsular India shield: (Dharwar craton/ Singhbhum craton,/Bundelkhand craton/, Aravalli craton,/ Bastar craton) and their economic importance, with emphasis on the Dharwar craton.
Mobile Belts of Peninsular India: Eastern Ghat Mobile Belt, Satpura Mobile Belt, Pandayan Mobile Belt

Module II **(15 hours)**

Gorur Gneiss
SargurSupracrustals
Dharwar craton: Eastern Dharwar Craton (Deccan Batholith) and Western Dharwar Craton (Peninsular Gneiss)
Greenschist/Greenstone Belts of Peninsular India:
Dharwar type Greenstone Belt: Dharwar Supergroup: Bababudan Group, Chitradurga Group
Goa Group of rocks
Kolar type greenstone Belt: Kolar

Module III **(15 hours)**

Proterozoic Basins of Peninsular India:

Vindhyan Supergroup;
Cuddapah Supergroup;
Kaladgi Supergroup.

Outline of Bhīma Supergroup, Delhi Supergroup, Kurnool Supergroup

Practical: 1 credit

Maximum Marks: 25

- Study of specimens representing rock formations of Goa.
- Assigning stratigraphy Formations based on fossils.
- Maps related to Indian Geology/ Problems in stratigraphic correlation.

List of books recommended for reference

Mandatory Reading

- Dessai, A G (2018). Geology and Mineral resources of Goa. New Delhi Publishers
- Mascarenhas, A and Kalavampara, G., (2015). Natural Resources of Goa: A Geological Perspective. Geological Society of Goa.
- Ramakrishnan, M and Vaidynadhan, R., (1994), Geology of India, Geological Society of India Publication, Bangalore. Vol. I and II.

Supplementary Reading

- Valdiya, K. S., (2015). The making of India: Geodynamic evolution, Springer
- Nanda, H., (2014), Indian Stratigraphy, Anmol Publications Pvt. Ltd. New Delhi.
- Sharma, R. S., (2009). Cratons and fold belts of India, Springer

Course Title : **PETROLEUM GEOLOGY**
Course Code : **GEL-V.E-10**
Credits : **3 (45 Contact hours)**
Marks : **75**

Course Objectives

The course aims to provide the students an understanding of essential and basic concepts of Petroleum Geology, the process and the operations involved in Petroleum exploration & extraction and to provide knowledge on the petroliferous basins of India.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Describe the properties and the mode of formation of Hydrocarbons
CO2 Compare various exploration techniques involved in hydrocarbon detection.
CO3 Explain the process of drilling & completion of a Petroleum well and determining distribution of major oil deposits in Indian and in world.
CO4 Prepare isopach maps and analyze well logs.
CO5 Delineate and describe the petroliferous domains in India.

Module I **(15 hours)**

Introduction and Aspects of Petroleum Geology, Characteristics of Hydrocarbons (Physical and Chemical properties), Petroleum System, Composition, Origin (Types of Kerogen), Occurrence, Migration and Accumulation of Petroleum; Petroleum traps (Stratigraphic and Structural); Reservoir rocks, conditions & mechanisms.
Functions of Petroleum Geologist
Understanding oil and gas: Exploration, Drilling and Completion, Production, Services

Module II **(15 hours)**

Surface indications and direct detection of Hydrocarbons
Surface and Subsurface exploration techniques: Concept
Geophysical methods of exploration: Gravity and Seismic methods
Types of rigs and its selection
Rotary drilling system and equipment's
Drilling sequence: Coring; Casing and Cementation and Drilling fluids;

Module III **(15 hours)**

GeoLogging and Well logs (Electric, Radioactive and Acoustic);
Formation evaluation and Testing
Well Completion and Stimulation
An outline of the oil belts of the world; Global geographic and stratigraphic distributions of oil and gas;
Important Onshore and Offshore Petroliferous basins of India.
Recent trends in Petroleum Geology.

Practical Course**: 1 credit**
Maximum Marks**: 25**

- Plotting of Petroliferous basins on maps (World and India)
- Problems based on Well log interpretation
- Creation of carbonate isopachous maps
- Problems on mud circulation
- Observations of well cuttings and cores samples
- Demonstration/Determination of porosity

List of books recommended for reference

- Hyne, N J., (2001) Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production, PennWell Corporation.
- Selley, R.C., (1998) Elements of Petroleum Geology, W.H. Freeman & Company, New York.
- North, F.K., 1(986) Petroleum Geology, Allen &UnWin, 607p
- Morris, J., (1985) Practical Petroleum Geology, The University of Texas at Austin - Petroleum Extension Service.
- Levorsen, A.I., (1967) Geology of Petroleum, W.H. Freeman and Company.

Course Title : **METAMORPHIC PETROLOGY**
Course Code : **GEL-V. E-11A**
Credits : **3 (45 Contact hours)**
Marks : **75**

Course Objectives
To provide essential concepts of metamorphism and metamorphic rocks.
To study metamorphic rocks w.r.t fabrics and types.
To understand the concept of facies.
Also to understand how metamorphism is related to plate tectonics.

Course Outcomes
Upon completion of the course, the student will be able to :

CO1 Explain metamorphism, factors and relate to types of metamorphism with the products, represent metamorphic rocks graphically using Phase Diagrams and explain metamorphism wrt tectonics.

CO2 Apply fundamental principles of metamorphism to development of textures, classify metamorphic rocks based on mineral assemblage and fabric, interpret tectonic setting of Metamorphic Belts based on field characters and kinematic stress indicators.

CO3 Explain types of metamorphism. Also, differentiate between Barrovian and Buchan Zones, Apply the facies concept to progressive contact and regional including burial metamorphism.

CO4 Identification of metamorphic rocks w.r.t mineralogy, texture, type of metamorphism, facies, protolith megascopically and microscopically.

Module I **(15 hours)**
Definition and explanation of metamorphism (upper and lower limits) and metamorphic rocks.
Factors controlling metamorphism:
Heat (T): Geothermal gradient (in different crustal regions), Radioactivity, magmatic intrusions, tectonics;
Pressure (P): Deviatoric, Lithostatic, Hydrostatic, Fluid pressure
Chemically active fluids (X_f): H_2O and CO_2
Composition of the parent rocks (X): pelites, mafites, ultramafites, quartzofeldspathic, carbonate rocks, sandstones and greywackes.
Time (δt): Role of time in metamorphism.
Phase Rule and Phase diagrams Graphical representation of metamorphic rocks.
Protoliths.
Relationship of brittle and ductile deformation with grade of metamorphism metasomatism, cataclastic metamorphism and their products, impact/shock metamorphism.
Metamorphism in relation to plate tectonics:
Divergent(constructive) boundary
Convergent (Destructive) boundary: subduction zone (sensulato)
Continent-Continent Collision zones
Intra-plate environments

Module II **(15 hours)**

Metamorphic textures: Inherited/Relict fabric lepidoblastic, nematoblastic, granoblastic, equigranular mosaic, Porphyroblastic; cataclastic and mylonitic textures.

Kinematic stress indicators and their role in interpreting tectonic history

Nomenclature and classification based on mineralogy and fabric

Field characters of metamorphic rocks:

Variations in mineralogy and fabric. Prograde and Retrograde metamorphism metamorphic zones and index/critical minerals, their significance in mapping and understanding tectonic history.

Module III **(15 hours)**

Facies: Concept after Goldschmidt and Eskola; Zonation in mineralogy – Buchanan (Low pressure) Barrovian (high pressure).

Contact metamorphism its characteristics and products.

Facies of progressive contact metamorphism: characteristic mineral assemblages in pelites and carbonates (pure and impure) protolith

Regional metamorphism its characteristics and products.

Facies of progressive regional metamorphism – characteristic mineral assemblages wrt facies (Zeolite, Prehnite-Pumpellyite, Greenschist, Amphibolite, Granulite,) in pelitic, mafic protolith.

Burial metamorphism its characteristics and products.

Facies of burial metamorphism: Blueschist, Eclogite

Paired Metamorphic Belts

Practical Course: **1 credit**

Maximum Marks: 25

- Megascopic study and identification of metamorphic rocks w.r.t mineralogy, texture, type of metamorphism, facies, protolith.
- Microscopic study and identification of metamorphic rocks wrt to mineralogy, texture type of metamorphism, facies and protolith.
- Plotting ACF diagrams and commenting on the protolith.

List of books recommended for reference

Mandatory Reading

- Winter J D., (2011) Principles of Igneous and Metamorphic Petrology. PHI Learning Pvt. Ltd.
- Philpotts, A & Ague, J (2010) Principles of Igneous and Metamorphic Petrology. Cambridge University Press, New York
- Vernon, R H. and Clarke, G.L., (2008) Principles of Metamorphic Petrology, Cambridge University Press

- Best, M., (2003). Igneous and Metamorphic Petrology, Blackwell Publishing.
- Raymond, A. L., (1995) Petrology-The study of Igneous Sedimentary and Metamorphic rocks. Wm. C. Brown Communications, Inc.; USA.
- Yardley, B W. D., (1989) An introduction to Metamorphic Petrology, Longman Group Publishers Pvt. Ltd.
- Winkler, G. F., (1987) Petrogenesis of Metamorphic rocks 5th edition Narosa Publishing House, New Delhi.
- Turner, F., (1980) Metamorphic Petrology: Mineralogical, Field and Tectonic Aspects, CRC Press.

Supplementary Reading

- Frost B R and Frost C D., (2014) Essentials of Igneous and Metamorphic Petrology, Cambridge University Press.
- Bucher, K and Grapes, R., (2010) Petrogenesis of Metamorphic rocks, Springer-Heidelberg Dordrecht, London NY.
- Ernst, W G and Rumble D., (2008) Metamorphic Conditions along Convergent Plate Junctions: Mineralogy, Petrology, Geochemistry and Tectonics, Geological Society of Amer.
- Blatt, H; Tracy R. J and Owens B. E., (2006) Petrology- Igneous Sedimentary and metamorphic 3rd edition W H Freeman and Company New York.
- Miyashiro, A., (1994) Metamorphic Petrology, CRC Press.
- Roger, M., (1990). Petrology of the Metamorphic Rocks.Unwin Hyman Ltd, UK
- Miyashiro, A, (1978) Metamorphism and Metamorphic belts, The Greshman Press Old Woking, Surrey

Course Title : **REMOTE SENSING AND DIGITAL IMAGE PROCESSING**
Course Code : **GEL-V.E-12**
Credits : **3 (45 Contact hours)**
Marks : **75**

Mandatory requirement: **Individual Laptop with MS Windows OS**

Course Objectives

This course is designed as an introduction to the use of remote imaging in geologic applications. The basic concepts of image production, processing and interpretations are covered.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Explain remote sensing fundamental principles, purposes, advantages and limitations.
CO2 Describe the basic characteristics of optical remote sensing imagery.
CO3 Perform visual image interpretation of satellite imagery.
CO4 Apply basic procedures of Digital Image processing for Remote sensing image enhancements analysis.
CO5 Perform image classification and create a map.

Module I **(15 hours)**

Energy Sources and Radiation Principles.
Electromagnetic Spectrum
Energy interactions in the Atmosphere: Scattering, Absorption.
Atmospheric windows
Energy interactions with earth surface features: Spectral Reflectance of rock, Soil water, and vegetation.
Photo recognition elements
The concept of resolution: Spatial, Spectral, Temporal and Radiometric.
Space Borne Imaging Systems- The Landsat, IRS, SPOT and High resolution Land Satellites (the characteristics of these satellites- orbits, sensors, and their resolutions)
Multispectral remote sensing and hyper spectral remote sensing

Module II **(15 hours)**

Concept of Digital numbers
Georeferencing
Image Rectification and Restoration.
Image Enhancement.: Low and high pass filter, directional filters
Contrast Manipulation.
Spatial Feature Manipulation.
Multi-Image Manipulation.

Module III **(15 hours)**

Image Classification: Unsupervised and Supervised Classification.

Supervised Classification:

The Training Stage.

The Classification Stage: Minimum-Distance to Means Classifier, Gaussian Maximum Likelihood Classifier.

Classification Accuracy Assessment and ground truth verification

Practical Course: 1 credit

Maximum Marks: 25

- Interpretation of Satellite Imagery for – landforms, geological structures, rock and soil types, man-made structures.
- Data Products and Meta data
- Digital Image Processing (using number matrix): enhancement, manipulation and classification.
- Digital image processing on Computer (demonstration)

List of books recommended for reference

- Heywood I, Sarah, Cornelius, Steve, Carver., (2011) An Introduction to Geographical Information Systems, Pearson Education Pvt. Ltd., New Delhi.
- Schowengerdt Robert A., (2006) Remote Sensing – Models and Methods for Image Processing, 2nd ed., Elsevier (Academic Press).
- George Joseph., (2005) Fundamentals of Remote Sensing, University press Private Ltd, Hyderabad.
- Lillesand, T. M., Ralph W. Kiefer and Jonathan W. Chapman., (2004) Remote Sensing and Image Interpretation, 5thed, Wiley.
- Mather Paul M., (2004) Computer Processing of Remotely Sensed Images- An Introduction, 3rd ed., John Wiley.
- Gupta, R P., (2003) Remote Sensing Geology. Springer-Verlag
- Lillesand T.M. and Kiefer R.W., (2002) Remote Sensing and Image Interpretation, John Wiley and Sons, New Delhi.
- Jensen John R., (2000) Remote Sensing of the Environment – An Earth Resource perspective, Pearson Education Series, Low Price Edition.
- Drury, S.A., (1993) Image Interpretation in Geology, 2nd ed., Chapman and Hall, London.
- Harold, R W., (1969) Aerial Stereo Photographs, Hubbard Press, USA.

Online resources

- Fundemental of remote sensing, Canada Centre for Mapping and Earth Observation , Natural Resources Canada. https://www.nrcan.gc.ca/node/9309
- DST-IGET, Remote Sensing Tutorials http://dst-iget.in/index.php/tutorialdetails/2/2

SEMESTER VI

Course Title : **IGNEOUS PETROLOGY**
Course Code : **GEL-VI.C-8A**
Credits : **3 (45 Contact hours)**
Marks : **75**

Course Objectives

The course will help the students to understand petrologic processes and common rock types. In practical's, students learn to identify, describe and classify rocks using hand specimens and rock thin sections.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Explain the composition of the Earth and relate it to magma generation.

CO2 Gain insight into the crystallization of melts by studying the various textures and microstructures.

CO3 Explain the diversity and differentiation of magmas to deduce the formation of various rock types and its associated characteristics.

CO4 Identify, describe and classify igneous rocks using hand specimen and thin sections.

CO5 Explain the formation of normative minerals from the chemical composition of an igneous rock.

Module I **(15 hours)**

Meteorites: Mineralogy and whole rock chemistry

Composition of the earth's interior = Primitive mantle Plate tectonics and igneous activity

Partial Melting and Generation of magma.

Magma Diversity:

- Partial Melting: Mafic, Ultramafics
  - Basalts: Magma types, Basalt Tetrahedron.
- Anatexis in Felsic rocks
  - Granites/Pegmatites: Mingling, Mixing and Crustal contamination
- Igneous layering - crystal settling
  - Gabbroic rocks, Anorthosite
- Layered complexes Differentiation: Fractional Crystallization, liquid immiscibility, flowage differentiation

Module II **(15 hours)**

Ascent and emplacement of magma

Textures and microstructures of igneous rocks:

a. Primary: Nucleation, Growth, Diffusion
b. Secondary: Oswald ripening, twinning, zoning

Classification and Description of Igneous Rocks:

The International Union of Geological Sciences (IUGS) Classification System: Gabbros, Granites (QAPF diagram).

Ternary System: Diopside-Albite-Anorthite (Di-Ab-An)

Module III **(15hours)**

Study of the following rock types (mineralogy, petrography and petrogenesis)

Ophiolites
Granitoids
Carbonatites
Kimberlites

Practical: 1 credit

Maximum Marks: 25

- Study of igneous rocks in hand specimen.
- Study of igneous rocks in thin sections
- CIPW Normative calculations

List of books recommended for reference

Mandatory reading

- Frost B R and Frost C D., (2014) Essentials of Igneous and Metamorphic Petrology, Cambridge University Press.
- Gill, R., (2010). Igneous rocks and process – A Practical Guide, Wiley-Blackwell
- Winter, J.D., (2009) Principles of Igneous and Metamorphic Petrology, Prentice Hall

Supplementary reading

- Best, M.G., (2002). Igneous and Metamorphic Petrology, 2nd edn., Blackwell, Oxford.
- Bose, M.K., (1997). Igneous Petrology, The World Press, Kolkata.
- Raymond, A. L., (1995). Petrology-The study of Igneous Sedimentary and Metamorphic rocks. Wm. C. Brown Communications, Inc.; USA.
- MacKenzie, W. S., Donaldson, C H., and Guilford, C., (1982). Atlas of Igneous Rocks and Their Textures, Wiley

Course Title : **PHANEROZOICSTRATIGRAPHY OF INDIA**
Course Code : **GEL-VI.E-13B**
Credits : **3 (45 contact hours)**
Marks : **75**

Prerequisite : **GEL-V.E-9A**

Course Objectives

The course will help understanding the Indian stratigraphic units and to correlate International Geological Time Scale with Indian Stratigraphic Time Scale. Also to understand the geology, stratigraphy, fossil content, economic resources of the lithounits from the Phanerozoic Eon from the Indian context.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Explain the transitionary changes in the Indian regions from the Precambrian to the beginning and end of Paleozoic Era. Also, enact the history of evolution and lithologic sequences of Gondwana basins in India.

CO2 Explain the origin of Ocean Flood Basalts; also, relate the paleogeography of Peninsular India to the occurrences of sedimentary sequences of rocks in the region.

CO3 Describe the phases involved in the evolution of Himalayas and to enact the lithologic history of Assam and Siwalik hills.

CO4 Prepare lithostratigraphic maps of India.

CO5 Identify giving their geologic age to different rocks of India based on their fossil content, if any.

Module I **(15 hours)**

Precambrian-Cambrian boundary
Cambrian Tal
Muth Quartzites
Gondwana sedimentation: Peninsular, Extra-Peninsular
Permian-Triassic boundary

Module II **(15 hours)**

Jurassic of Kutch
Cretaceous of Trichinopoly
Deccan Flood Basalt (Age and Stratigraphy)
Cretaceous-Paleocene boundary

Module III **(15 hours)**

Tertiaries of Assam
Rise and evolution of Himalayas
Siwaliks
Pleistocene-Holocene Boundary

Plant and animal life in relation to glacial and interglacial cycles during Quaternary.
Recent: Laterite Formations of Goa

Practical Course**: 1 credit**
Maximum Marks**: 25**

1. Preparation of lithostratigraphic maps of India showing distribution of important geological formations.
2. Study of type hand specimens from their stratigraphic position and age.
3. Completion of Outcrops

List of books recommended for reference

- Nanda, H., (2014) Indian Stratigraphy, Anmol Publications Pvt. Ltd. New Delhi.
- Valdiya, K. S., (2010). The Making of India, Macmillan India Pvt. Ltd.
- Nichols, G., (2009) Sedimentology and Stratigraphy, Wiley-Blackwell and Sons Ltd.
- Sharma, R S., (2009) Cratons and Fold belts of India, Springer-Verlag Berlin Heidelberg.
- Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley.
- Ramakrishnan, M and Vaidynadhan, R., (1994) Geology of India, Geological Society of India Publication, Bangalore. Vol. I and II.

Course Title : **ROCK STRUCTURES AND DEFORMATION MICROSTRUCTURES**
Course Code : **GEL-VI. E-14B**
Credits : **3 (45 Contact hours)**
Marks : **75**

Prerequisite :**GEL-V.E-11A**

Course Objectives
The course will help to study deformational history of rocks. This study includes the understanding of the deformation and metamorphic processes the rock has undergone with the aim to reconstruct its structural and metamorphic history.

Course Outcomes
Upon completion of the course, the student will be able to :

CO1 Explain deformation, its process and mechanisms of rock structures and rock deformation microstructures.

CO2 Apply the significance of features like foliation and lineation in field as well as in microsections in understanding microstructures and rock deformation. Interpret Shear Sense Indicators in Mylonites.

CO3 Interpret the significance of microstructures in Igneous, Sedimentary and Metamorphic rocks.

CO4 Identify and Interpret the significance of rock and deformation microstructures in thin sections.

Module I **(15 hours)**
Introduction to microstructures, Microstructures of Igneous rocks – Nucleation, growth and shape of minerals, Mineral intergrowths, zoning, twinning. Microstructures of sedimentary rocks – size, sorting and shape of mineral grains. Fossils as strain markers.

Module II **(15 hours)**
Microstructures of metamorphic rocks – Grain shapes and growth of porphyoblasts, twining (growth, transformation), exsolution in silicate minerals, importance of symplectites in metamorphism, compositional zoning.
Deformed rocks – brittle deformation (frictional grain boundary sliding, Fracture processes) and ductile deformation (diffusion creep,crystal plasticity, grain boundary sliding).

Module III **(15 hours)**
Foliation (Continuous and spaced) and its significance; Lineation and its significance; Mylonites, Shear sense indicators in mylonites; Strain shadows.

Practical Course: 1 credit
Maximum Marks: 25
Study of the following microstructures (any 15)
Cuspate and lobate sutured boundaries,

Planar indentations
Pinning Structure
Bulging (BLG)
Subgrains, chessboard subgrains
Deformation twins, growth twins
Displaced twin lamellae
Recrystallized quartz ribbons.
Bending of cleavage planes,
Mineral (mica) fish,
Porphyroclasts, asymmetric porphyroclasts depicting shear sense,
Porphyroclasts with Pressure shadows.
Porphyroblasts with Pressure shadows,
Warping of foliation around porphyroclasts / porphyoblasts,
S-C fabric.
Mineral overgrowth
Ooids
Flame perthites
Myrmekites
Zoning

List of books recommended for reference

Mandatory reading

- Winter, J D., (2014) Principles of Igneous and Metamorphic Petrology, Pearson Education Limited.
- Trouw, R A., Passchier, C W and Wiersma, D J., (2010) Atlas of Mylonites - and related microstructures, Springer-Verlag Berlin Heidelberg
- Passchier, C. W and Trouw, R A., (2005) Microtectonics, Springer-Verlag Berlin Heidelberg
- Vernon, R H., (2004) A Practical Guide to Rock Microstructures, Cambridge University Press.
- Blenkinsop, T. (2002) Deformation microstructures and mechanisms in minerals and rocks, Kluwer Academic Publishers.

Supplementary Reading

- Mukherjee, S., (2013) Deformation Microstructures in rocks. Springer-Verlag Berlin Heidelberg

Course Title : **SURVEYING, MAPPING AND FIELD GEOLOGY**
Course Code : **GELVI.E-15A**
Marks : **75**
Credits : **3 (45 Contact hours)**

Mandatory requirement: **Individual Laptop with MS Windows OS**

Course Objectives
To Provide basic knowledge of surveying techniques
To upgrade and relate the theoretical knowledge of Geological aspects to field observations.
This course also introduces the basic principles and techniques of Geographic Information Systems (GIS)

Course Outcomes
Upon completion of the course, the student will be able to :

CO1 Perform preliminary surveys such as those used in mining e.g. Plane table survey, Levelling survey, GPS survey etc.

CO2 Work independently in the field of geology performing tasks such as data collection, note keeping, mapping and geologic report preparation

CO3 Perform basic GIS tasks using open source software.

Module I (15 hours)
Surveying, Objectives of Survey;
Primary divisions of Surveying – Geodetic and Plane Surveys uses and Principles of Surveying.
Methods of locating a point
Plane Table Survey: Instruments, Procedures of Plane table surveys; Methods (Demonstrative): Radiation and Intersections, advantages and disadvantages of Plane Tabling.
Levelling, characteristics of land surveying instruments, Bench Marks, Change Points.
Levelling operations and steps in Levelling: Demonstration with exercises in the field.
Principles of Levelling: Simple and Differential,
Reduction of Levels: The Collimation, and Rise and Fall systems of Computation.
Theodolite survey: Principles and working,

Module II (15 hours)
SOI Toposheet Indexing scheme, Map symbol reading SOI toposheet map reading
Standard Symbols/colour for lithology and symbols related to structures
Munsell colour chart
Understanding map reliability
GPS surveys
Geological mapping
Basic field gear

Planning a field Project: Preparations for the field, Taking geologic notes in the field: Basic procedures at outcrops – noting characters of igneous, sedimentary and metamorphic rocks, Measuring strike and dip (attitude) of planar and linear features using a clinometer compass, a Brunton Compass.

Module III **(15 hours)**

Introduction to GIS
Components of GIS
Georeferencing
Digitizing: Point, line, polygon
Attribute data
Map layout and cartographic output

Practical course: 1 credit
Maximum Marks: 25

- The evaluation is to be based on preparation of portfolio that should include plans drawn using Plane table, a Levelling Exercise.
- Assessment to be based on presentation of Field diary, Field report, and field based viva voce on the localities visited for field work.
- Hands-on exercises in QGIS and Google Earth.

List of books recommended for reference

Mandatory reading

- Basak, N N., (2014) Surveying and Levelling, McGraw Hill Education.
- Lisle R., Brabham P and Barnes J., (2011) Basic Geological Mapping (Geological Field Guide), Wiley Blackwell.
- C.P.Lo and Albert K. W. Yeung., (2002) Concepts and Techniques of Geographic Information System, Prentice –Hall, India.
- Kang – Tsung – Chang., (2002) Introduction to Geographical Information System, , McGraw Hill.
- Gokhale, N W., (2001) A Guide to Field Geology, CBS Publishers & Distributors.
- Lambert, D A., (1998) Field Guide to Geology, Facts on File Inc.
- Burrough, P. A. and McDonnell, R. A., (2000) Principles of Geographical Information System, Oxford University Press.
- Kanetkar, T P & Kulkarni, S V., (1988) Surveying & Levelling (Part I), Pune VidyarthiGrihaPrakashan.
- Compton, R R., (1985) Geology in the Field, John Wiley & Sons, Inc.
- Compton, R R., (1962) Manual of Field Geology, John Wiley & Sons, Inc.
- Lahee, F H. (1962) Field Geology, McGraw – Hill Book Company, Inc.

Supplementary reading

- Robinson W F and Tallack., (2016) Surveying and Levelling Instruments Theoretically and Practically Described for construction, Qualities, Selection, Preservation, Adjustments and Uses: With other apparatus and Appliances used by Civil Engineers and Surveyors in the Field, Wentworth Press.
- Arora, K R., (2015) Surveying Vol-2 (13th edition). Standard Book House Unit of Rajsons Publication Pvt. Ltd.
- Penning, W H. and Jukes-Browne., (2011) A Textbook of Field Geology, Nabu Press.
- Coe, A, L., Argles, T W., Rothery, D A and Spicer, R A., (2010) Wiley-Blackwell, The Open University.
- McClay, K R., (2007) The Mapping of Geological Structures, John Wiley and Sons.
- Barnes, J W and Lisle, R J., (2004) Basic Geological Mapping, John Wiley and Sons

Online resources

- T. Sutton, O. Dassau, M. Sutton, A Gentle Introduction to GIS, Chief Directorate: Spatial Planning & Information, Department of Land Affairs, Eastern Cape, South Africa (ebook), http://download.osgeo.org/qgis/doc/manual/qgis-1.0.0_a-gentle-gis-introduction_en.pdf
- DST-IGET, QGIS Tutorials http://dst-iget.in/index.php/tutorialdetails/1/1

Course Title : **PRINCIPLES OF GEOPHYSICAL EXPLORATION AND MINING**
Course Code : **GEL-VI.E-16A**
Credits : **3 (45 Contact hours)**
Marks : **75**

Course Objectives

Mining being a key source of revenue generation for the Central as well as State governments, and an important job provider for Geologists, this course is designed to equip the undergraduate student with basic knowledge of key concepts of mining processes right from exploration to exploitation, together with an acquaintance of government regulations that control the mining and mineral conservation processes. In Geophysical exploration the student will gain first-hand knowledge dealing with the principles and their significance.

Course Outcomes

Upon completion of the course, the student will be able to :

CO1 Explain processes involved in Open-cast and Underground mining and the regulations that control these processes.
CO2 Explain the stages involved in mineral exploration and the process of estimation of reserves
CO3 Explain the principles behind, and methods of Geophysical, Geochemical and Geobotanical exploration
CO4 Draw cross - and longitudinal sections using bore-hole Data and estimate ore reserves using different methods.
CO5 Interpret bouguer gravity anomaly maps and magnetic data.

Module I **(15 hours)**

Methods of Exploration: Geobotanical, Geochemical and Geophysical.

Geophysical Methods:

Self-potential method:, mechanism, equipment, interpretation of anomalies.
Gravity surveying: Gravity surveying, Interpretation
Magnetic surveying: concepts, Rock magnetism, Geomagnetic field, Magnetic anomalies, Instruments used, Corrections, Interpretation, Application.

Module II **(15 hours)**

Mineral Exploration: Sequence and phases

- Float ores and In situ ores
    - Pits, Trenches and Boreholes
        - Spacing
        - Drilling:
            - Core and non-core drilling
            - Equipment and accessories
            - Core drill sampling
            - core splitting

- logging
- Storage
- Sludge
- Combining Assay returns from sludge and core

Categories of reserves
Estimation of reserves
- Cross-sectional method
- Area of influence method
- Triangular method
- Weighted volume estimate method
- Estimation of stockpiles by prismoidal formula

Module III **(15 hours)**
Mining Terminology
Classification of mining methods.
Factors influencing choice of mining method
- Open cast mining
- Underground mining
  - Coal mining methods
  - Alluvial mining

Ore Dressing or Beneficiation:
- Principles and methods
- Terminology of quantification of results

Environmental Impact of Mining
Brief outline of:
National Mineral Policy
Regulations and Acts
Regulating Agencies

Practical Course**: 1 credit**
Maximum Marks: **25**
- Drawing cross - and longitudinal sections using bore-hole data
- Problems based on estimation of ore reserves
- Interpretation of bouguer gravity anomaly maps, and magnetic data.
- Core logging

List of books recommended for references

- Keller, E. A., (2011) Environmental Geology, Pearson Prentice Hall.
- Sharma J. P., (2009) Environmental Studies, Laxmi Publications (P) Ltd, New Delhi.
- Lowrie, W., (2007) Fundamentals of Geophysics. Cambridge University Press.
- Marjoribanks, R., (1997) Geological Methods in Mineral Exploration and Mining, Springer-Science+Business Media

- Telford, W. M., Geldart, L. P., and Sheriff, R. E., (1990) Applied geophysics (Vol. I) Cambridge University Press.
- Bhimasarikaram V.L.S., (1990) Exploration Geophysics - An Outline by Association of Exploration Geophysicists, Osmania University, Hyderabad.
- Dobrin, M B and Savit C H., (1988) Introduction to Geophysical Prospecting, McGraw Hill Inc.
- Babu S. K. & Sinha D. K., (1988) Practical Manual of Exploration and Prospecting, CBS Publishers and Distributors, New Delhi.
- Peters, W C., (1987) Exploration and Mining Geology, Wiley
- Ramachandra Rao and Prasaranga, M B, (1975) Outlines of Geophysical Prospecting - A Manual for Geologists by University of Mysore, Mysore.
- Arogyaswamy, R. N. P., (1973) Courses in Mining Geology, Oxford & IBH Publishing Co.
- Sinha, R. K & Sharma N. L., (1970) Mineral Economics, Oxford & IBH Publishing Co.
- McKinstry H. E., (1948) Mining Geology, Prentice-Hill Inc.
- Indian Bureau of Mines (IBM) Publications.

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MATHEMATICS

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)

DEPARTMENT OF MATHEMATICS

COURSE STRUCTURE
THREE YEARS B.A. DEGREE COURSE IN MATHEMATICS

SEMESTER	CORE COMPULSORY		CORE ELECTIVE			
I	**MAT-I.C-1** Basic Algebra	**MAT-I.C-2** Basic Real Analysis	-	-	-	-
II	**MAT-II.C-3** Matematical Analysis	**MAT-II.C-4** Co-Ordinate Geometry	-	-	-	-
III	**MAT-II.C-5** Abstract Algebra	-	**MAT-III.E-1** Number Theory	**MAT-III.E-2** Numerical Methods	**MAT-III.E-3** Functions Of Several Variables	**MAT-III.E-4** Pedagogy Of Mathematics
IV	**MAT-II.C-6** Differential Equations	-	**MAT-IV.E-5** Graph Theory	**MAT-IV.E-6** Advanced Analysis	**MAT-IV.E-7** Metric Spaces	**MAT-IV.E-8** Relativity
V	**MAT-II.C-7** Linear Algebra	-	**MAT-V.E-9** Advanced Statistics	**MAT-V.E-10** Operational Research -1	**MAT-V.E- 11** Complex Analysis	**MAT-V.E-12** Coding Theory & Criptography
VI	**MAT-II.C-8** Vector Analysis	-	**MAT-III.E-13** Advanced Differential Equations	**MAT-III.E-14** Operational Research -2	**MAT-III.E-15** Computers For Mathematics	**MAT-III.E-16** Combinatorics

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)

MATHEMATICS PROPOSED SYLLABUS FOR FIRST YEAR BACHELOR OF SCIENCE F.Y.B.Sc. (SEMESTER-I & II)

Paper Title: **BASIC ALGEBRA**

Paper Code: **MAT-I.C-1**

Name of Faculty: Danielle Monteiro

Marks: 100

Credits: 4

Course Objectives: Introduction to the basic concepts of Algebra which are used in mathematics.

Learning outcome: Student will be well equipped with all the concepts that are useful to understand and solve mathematics.

1. Sets (3 lectures)

Definition- Subsets - Power sets - Equality of sets - Finite and Infinite sets - Set operations - De-Morgan's laws - Cartesian product of sets.

2. Relations and Functions (12 lectures)

Relations, Types of relations, Binary relation, Equivalence relation, Relation between equivalence relation and partition, Congruent modulo n, Mappings, One-One and onto mappings. Composition of Mappings, Identity and Inverse mappings. Binary Operations in a set.

3. Logic (5 lectures)

Logical statements - connectives - truth tables - tautologies operations

4. Matrices and determinants (20 lectures)

Equality of matrices. Addition of Matrices. Multiplication of two Matrix, Properties of multiplication, Transpose of matrix, Conjugate of a matrix, Determinant of a square matrix, minor of an elements, co-factor Ad joint of a square matrix, Inverse of a square matrix Singular and non-singular matrix. Symmetric and skew symmetric matrices, Hermitian and skew Hermitian matrices.

Minor of Order K of a matrix, Rank of a matrix, Elementary Row, Column operations, Elementary operations, inverse of a matrix using elementary operations. Row, Column equivalent matrix, Row-Echelon matrix, Row rank and column rank of a matrix. Linear Equation: Equivalent system, system of homogeneous equations, Consistency and solution of a system of linear equations by matrix method.

5. Equations (20 lectures)

Algebraic equations, general properties, Nature of roots of an equation (surd or complex roots occur in pairs), Statement of Descartes' rule of signs and applications, relations between roots and co-efficients, transformation of equations, reciprocal equations, algebraic solution of cubic equation-Cardan's method

References:

- R.D. Bhatt, Algebraic Structures, Vipul Prakashan
- Shanti Narayan and P.K.Mittal, A textbook of Matrices, S. Chand and Company
- K.B.Datta, Matrix and Linear Algebra, PHI
- H.S. Hall and S.R.Knight, Higher Algebra, AITBS Publishers

Paper Title: BASIC REAL ANALYSIS

Paper Code: **MAT-I.C-2**

Name of Faculty: Rovan Vaz

Marks: 100

Credits: 4

Aim :- Introduction to Real numbers and real valued functions of a Real variable.

Learning Outcome :- Students will be well versed with all properties of real numbers, geometry of real line, notations, functions .

Methodology:- Lecturing . Standard examples to make ideas clear, proving results for self study.

Course Duration: (60 Lectures)

Topics :-

1) **Preliminaries**: Prepare students with the required background for real analysis (8 Lectures)

   a. Set theory: Sets, operations on sets, sets of number systems

   b. Functions: Maps and relations, Function, Inverse, Compositions, restriction and extensions of functions, How to graph a function

   c. Counting: - Principle of Mathematical induction. Finite & infinite sets, countable sets and their properties.

2) **The Real number system R**: Introduce the real number system. (12 Lectures).

   a. Algebraic Properties, Order Properties

   b. Inequalities (Triangle and associated inequalities

   c. Neighborhood, Intervals and their properties

   d. What is an ε-neighborhood

   e. Supremum and Infimum,Bounded functions and their properties, Archimedean Property, Density Property, R is uncountable

3) **Limits**: Introduce the concept of limit used in analysis. (8 Lectures)

   a. Concept of limit point and cluster point

   b. Limit theorems

   c. One sided limits, Infinite limits

4) **Sequences of Reals**: To introduce Real sequences (14 Lectures)

   a. Definitions and limit: - Definition, Limit of a sequence. What do you mean by convergence of sequence, Tail of a sequence.

   b. Algebra of Sequences: - Algebra of limits, Inequalities, Sandwich theorem.

   c. Monotone Sequences Monotone convergence theorem.

d. Subsequences, Bolzano Weirstrass Theorem for sequences.

e. Cauchy Sequences:- What is a Cauchy Sequence, Properties, Cauchy General principle for convergence of sequences , R is complete.

f. Sequential convergence criterion for limit of functions.

5) **Continuous Functions**: To study the behavior of continuous functions (12 Lectures)

a. Definition and concept of continuous functions, Sequential criterion for continuity of functions, Algebra of continuous functions, Behavior on Intervals, Concept of uniform continuity.

b. Graphs of Some continuous functions (Monotone, Inverse, Power/Root function)

6) **Series**: Introduce Series of Reals (6 Lectures)

- Definition, Properties, Test for convergence (n^{th} term test, Comparison test Ratio test, Root test, Leibnitz test.

References:

1) ,R.G.Bartle and D. Sherbert, Introduction to Real Analysis, Wiley

2) Robert Sticartz, The Way of Analysis, Jones and Bartlett Publishers

3) T. Apostol, Calculus (volume I), Wiley Eastern Ltd.

4) S.C. Malik, Savita Arora, Mathematical Analysis, New Age International Publishers

5) J.R. Munkres, Topology,Prentice Hall of India.

Paper Title: MATHEMATICAL ANALYSIS

Paper Code: **MAT-II.C-3**

Name of Faculty: Rakhi Karapurkar

Marks: 100

Credits: 4

Course Objective: To Study

1. The differentiable functions, their properties and some applications.
2. The idea of Riemann integration and some rules of integration.

Learning Outcomes:

To make the students comfortable with the differentiations and integrations that are essential in almost all the branches and also can make use of these ideas for Geometry.

Syllabus

I. Derivatives of Functions (8 lectures)

- Definitions

  Derivative at a point, Differentiability in an interval, Derivative of a function, meaning of the sign of derivative, Geometrical meaning of the derivative and higher order derivatives.
- A necessary condition for the existence of a finite derivative (theory and problems)

II. Uses Properties of differentiable functions: (14 lectures)

- Algebra of derivatives
- Derivative of the inverse function
- Darboux property, Darboux theorem and intermediate value theorem.
- Rolle's Theorem, Lagrange's Mean value theorem, Couchy's MVT and their applications, Taylor's and Maclaurin's theorem.
- Increasing and decreasing functions.

III. Applications (14 Lectures)

- Approximations
- Extreme values of a function : investigation of the points of maximum and minimum values.
- L' hospital's rule (Indeterminate form, 0/0 form, 00/00 forms etc) and some problems.

IV. Riemann Integration: (24 lectures)

4.1 Some basic terminology and notations:

Partition of an interval, upper and lower sums of bounded real valued function over I, Refinement of a partition.

4.2 Properties of partitions

4.3 Upper and lower integrals, Riemann integrals functions and some problems.

4.4. Riemann criterion for integrability and some applications based on it.

- Properties of Riemann integrable functions.
- Indefinite integral, fundamental theorems of integral calculus.
- Improper Integrals (Type I, Type II and Type III)

References:

- Malik S.C. and Arora Sarita. *Mathematical Analysis*, Second edition. Wiley Eastern Ltd, 1994.
- Apostol Tom, *Calculus Vol. I*. Second Edition. Wiley Students Edition, India, 2012.
- Bartle Robert G. and Sherbert Donald R. *Introduction to Real Analysis*, Third Edition. Wiley Student edition.
- Narayan Shanti. *Differential Calculus*. S. Chand and Company Pvt. Ltd. 1988.
- Goldberg Richard R., *Methods of Real Analysis*. Oxford and IBH Publishing Co. Pvt. Ltd. Indian Edition, 1970.
- Bhat R.D. *A Textbook of Mathematical Analysis II*. Vipul Prakashan, First Edition.

Paper Title: **CO-ORDINATE GEOMETRY**

Paper Code: **MAT-II.C-4**

Name of Faculty: Anand Masur

Marks: 100

Credits: 4

Aim :- Introduction to the geometry and the concepts which are used to understand the functions and used while integration.

Learning Outcomes :- Student can visualize, sketch, interpret and use graphs of different functions of one, two and three variables.

Contents

1. Co-ordinate systems:- Cartesian, Polar and Spherical systems, Relations between them. (3 Lectures)
2. Concepts of tangent, normal, tangent plane, intersections and angles using Line, Plane, Sphere, Cone and Cylinder. (10 Lectures)
3. Central conicoids :- ellipsoid , paraboloid and hyperboloid. (10 Lectures)
4. General equation of second degree:- General conicoids (4 Lectures)
5. Change of origin, rotation of axis and translation of axis. (5 Lectures)
6. Tracing of curves using concepts of derivatives, concavity-convexity, singular points (double point, cusp, node), increasing-decreasing function, polar co-ordinates, asymptotes. (12 Lectures)
7. Space Curves :- Parameter, Arc-length, Velocity, Acceleration, Tangent, Normal, Bi-Normal, Curvature, Torsion, Evolutes, Convolutes (16 Lectures)

References:-

- **P.K.Jain, Khalil Ahmad-** Analytic Geometry of three dimension- 2nd edition –Wiley Eastern Ltd. (1991)
- **Loney S.L.** - The Elements of Coordinate Geometry (Part I): Cartesian Coordinates – MacMillan
- **Shanti Narayan, P.K.Mittal –** Differential Calculus – S. Chand Publications.

PART B:

As suggested, following distribution of papers is to be adopted.

The Core papers

Sem III	Linear Algebra
Sem IV	Differential Equations
Sem V	Functions of Several Variables
Sem VI	Vector Analysis

The Elective papers

Sem III	Algebra I	Number Theory I	Numerical Methods	Pedagogy of Mathematics
Sem IV	Operation Research	Advanced Analysis	Computers for Mathematics	Combinatorics I
Sem V	Algebra II	Number Theory II	Graph Theory	Metric Spaces
Sem VI	Advanced Differential Equations	Complex Analysis	Combinatorics II	Coding Theory and Cryptography

The papers for minor in mathematics

Sem III	Basic Real Analysis
Sem IV	Mathematical Analysis
Sem V	Pedagogy of Mathematics/ Number Theory I
Sem VI	Operation Research/ Differential Equations

Paper Title: LINEAR ALGEBRA

Paper Code: MAT-III.C-3

Marks: 100

Credits: 4

Course Objectives: This course aims to impart emphasis on Vector spaces.

Learning outcome: Students will be familiar with Vector Spaces, linear transformations and inner product spaces

Prerequisites: Basic Algebra

Unit 1 : **(15 lectures)**
Vector space [Definition and examples], subspaces, sum and direct sum of subspaces. Linear span, linear dependence, independence and their properties. Finite dimensional vector Space Basis, dimension of a vector space. Dimension of sum of subspaces. Existence of complementary subspace of a finite dimensional vector space. Quotient space and its dimension.

Unit 2 : **(15 lectures)**
Linear transformation, Kernel and Range of a Linear Transformation. Matrix representation of linear transformation, composition of linear maps, change of basis, similar matrices, Rank Nullity theorem.

Unit 3 : **(15 lectures)**
Eigen values and Eigen vectors of a linear transformation and matrices. Eigen space, Algebraic and Geometric Multiplicity of an eigenvalue. Diagonalisabilty of an n x n matrix over IR

Unit 4 : **(15 lectures)**
Inner products spaces. Cauchy- Schwarz inequality, Triangle inequality, orthogonal vectors, orthogonal complement, orthogonal sets and bases, Gram-Schmidt Process

Refrences:

1. Anton H, Elementary Linear Algebra, Wiley Pvt. Ltd.
2. Hoffman K. & Kunze R., Linear Algebra , PHI
3. Kumaresan S., Linear Algebra: A Geometric Approach, PHI
4. Strang G., Linear Algebra and its Applications, Cengage Learning
5. Vasishtha A.R., Linear Algebra, Krishna Prakashan

Paper Title: ALGEBRA-I

Paper Code: MAT-III.E-1

Marks: 100

Credits: 4

Course Objectives: This course aims to impart emphasis on concepts of groups and rings

Learning outcome: Students will be familiar with groups, rings and their characteristics.

Prerequisites: Basic Algebra

1. **Groups** **(30 Lectures)**
   Definition of a group, with examples and simple properties-Groups of Matrices- Direct Product of Groups-Subgroups—Order of a Group-Order of an element of a group- Cyclic groups-Coset decomposition-Lagrange's theorem and its consequences-Normal subgroup and Quotient groups. Permutation groups-Cycles and transpositions-Even and odd permutations-Alternating groups
2. **Homomorphisms** **(10 lectures)**
   Group Homomorphism-Isomorphism- kernel of a homomorphism-The homomorphism theorems-The isomorphism theorems - Cayley's theorem
3. **Rings** **(20 lectures)**
   Rings and their elementary properties-Integral domain-Field-Field of quotients-Characteristic of a ring-Subrings-Ideals and their properties-Quotient Rings-Homomorphism of Rings- Prime Ideal and Maximal Ideal- Rings of Polynomials.

References:

1. Fraleigh J.B., A First Course in Abstract Algebra
2. Gallian J, Contemporary Abstract Algebra, Narosa, New Delhi
3. Gopalkrishnan N.S., University Algebra
4. Herstein I.N , Topics in Algebra,(2012) John Wiley & Sons., 2ndEdition

Paper Title: NUMBER THEORY-I

Paper Code: MAT-III.E-2

Marks: 100

Credits: 4

Course Objectives: To learn about basic concepts in number theory that will help the students.

Learning outcome: Students will be able to understand congruence and number theoretic functions.

1. **Divisibility:** **(10 lectures)**
   Division Algorithm, Greatest Common divisor, Eucledian Algorithm, Fundamental Theorem of Arithmetic
2. **Congruence:** **(15 lectures)**
   Basic properties, Linear Congruence, Chinese Remainder Theorem, Quadratic Congruence.
3. **Fermat's Theorem:** **(10 lectures)**
   Fermat's and Wilson's Theorem
4. **Number Theoretic Functions:** **(15 lectures)**
   Sum and number of divisors, Mobius function, Mobius Inversion, greatest integer function, Euler's phi function
5. **Diophantine Equations:** **(10 lectures)**
   Linear Diophantine equations ax+by=c, the equation $x^2 + y^2 = z^2$, Fermat's Last Theorem.

Refrences:

1. Adams & Goldstein, Introduction to Number Theory, Prentice Hall
2. Baker Alan, A concise introduction to the Theory of Numbers, Cambridge University Press
3. Burton David, Elementary Number Theory, 2012, Mc Graw Hill, 7^{th} Edition.
4. Niven & Zuckerman, An Introduction to the Theory of Numbers, Wiley Publications.
5. Telang S.G. & Nadkarni M.D, Number Theory

Paper Title: NUMERICAL METHODS

Paper Code: MAT-III.E-3

Marks: 100

Credits: 4

Course Objectives: This course covers the basic methods for finding the finite difference, solution of simultaneous equations and the techniques of Numerical Differentiation and Numerical Integration. It also deals with solution of Algebraic and Transcendental equations.

Learning outcome: The student will be able to solve numerically various equations.

I: Error Analysis **(8 lectures)**

Approximate numbers, significant figures, rounding off numbers, Error- Absolute, relative and percentage

II: Finite Differences **(8 lectures)**

Operators- Δ, ∇ and E (Definitions and some relations among them), finite difference tables, fundamental theorem on differences of a polynomial and examples.

III: Interpolation and Extrapolation **(8 lectures)**

Newton Gregory Forward and backward interpolation formulae (with deduction of formulae) and examples (for equal intervals)

For unequal intervals- Lagrange's Formula and Newton's divided difference formula (No proof) and examples

IV: Numerical Integration and differentiation **(12 lectures)**

Trapezoidal rule, Simpson's $1/3^{rd}$ and $3/8^{th}$ rules (with proof) and problems. Weddle's rule (no proof , only problems)

Numerical differentiation and examples

V: Numerical Solutions of Equations **(8 lectures)**

To find a real root of an algebraic or transcendental equation using Bisection method, regular falsi method, Newton Raphson method with geometrical significance and problems and method of iteration

VI: Curve fitting **(8 lectures)**

Method of least squares- fitting a line, second degree polymomial, exponential curve and examples

VII: Solution of System of Equations **(8 lectures)**

Gauss Elimination, Gauss- Seidal Iteration method, Iteration method

References:

1. Atkinson K., An Introduction to Numerical Analysis, John Wiley & Sons
2. Chatterji P.N, Numerical Analysis
3. Comte S.D and Carl de Boor, Elementary Numerical analysis - An Algorithmic approach, McGraw Hill
4. Hildebrand F.B, Introduction to Numerical Analysis, McGraw Hill
5. Sastry S.S, Introductry Methods of Numerical Analysis, Prentice Hall India
6. Scarborough J.B, Numerical Mathematical Analysis, Oxford and IBH Publishing Company, New Delhi.

Paper Title: PEDAGOGY OF MATHEMATICS

Paper Code: MAT-III.E-4

Marks: 100

Credits: 4

Course Objectives: To make the students aware of the different methods used for the teaching of mathematics.

Learning outcome: Students will be able to teach mathematics to school level children better.

1. **Meaning and History of Mathematics** **(10 lectures)**
   - i) Meaning of Mathematics
   - ii) Branches of Mathematics
   - iii) Historical Development of Mathematics
2. **Methodology of Teaching Methods** **(40 lectures)**
   - i) Inductive - Deductive
   - ii) Analytic- Synthetic
   - iii) Heuristic/ Discovery
   - iv) Project
   - v) Open Ended Approach
   - vi) Investigative Approach
   - vii) Problem Solving
   - viii) Concept Attainment Model

   With applications in different topics in School level Mathematics syllabus
3. **Techniques of Teaching** **(8 lectures)**
   - i) Assignments
   - ii) Drill work
   - iii) Remedial teaching
   - iv) Accelerated teaching
4. **Qualities of a good Mathematics Teacher** **(2 lectures)**

References:

1. Bell E.T, Men of Mathematics, Touchstone
2. Ediger M, Essays on teaching mathematics, Discovery Publishing Pvt.Ltd
3. Goel R.G., Teaching of Mathematics, Lotus Press
4. James A., Methods of teaching Mathematics, Neelkamal
5. Kline Morris, Mathematical Thought From Ancient to Modern Times, Oxford University Press
6. Krantz S, How to teach Mathematics, American Mathematical Society
7. Polya G, How to Solve It, Penguin UK
8. Sidhu Kulbir Singh., Teaching of Mathematics, Sterling Publishers Pvt. Ltd
9. Stillwell J, Mathematics and its History, Springer
10. Zubair P.P., Teaching of Mathematics, Aph Publishing

Differential Equations

Paper Title: Differential Equations

Paper Code: MAT-IV.C-4

Marks: 100

Credits: 4

Course Pre Requisites:- Mathematical Analysis

Aim:- To introduce some methods of solving ODE of first and higher order, Applications of the same in different fields.

Learning outcome:- Students can solve ODE with constant coefficients , given a simple situation can make an ODE.

Unit 1:- **(8 lectures)**
Introduction. Some simple situations where we come across ODE, Geometrical Meaning of ODE, Solutions of an ODE. Picard's Existence and Uniqueness theorem.

Unit 2:- **(15 lectures)**
First order ODE. Variable separable, Homogeneous , Non- Homogeneous, Exact differential equations, Integrating factor, linear differential equations, Bernoulli equations.

Unit 3:- **(17 lectures)**
Second order differential equations, Homogeneous and non-homogeneous differential equations, complementary function, particular integral, Wronskian, Solution space, General solution, complex solutions. Some methods of solving second order differential equations (undetermined coefficients, variation of parameters, Using one solution to find other) .

Unit 4:- **(8 lectures)**
Linear differential equations of higher order, simple examples of non-homogenous differential equations.

Unit 5 :- **(12 lectures)**
Some application of differential equations, LR / LCR circuits , SHM (simple-damped- forced) , Equation of Catenaries, Planetary Motions – Kepler's Laws .

Textbook:- Simmons G.F., Differential Equations with historical Notes , Tata McGraw Hill

References

1. Boyce W.E. & DiPrima R.C., Elementary Differential Equations and Boundary Valued Problems, John Wiley Pvt Ltd.
2. Braun C, Differential Equations and Their Applications: An Introduction to Applied Mathematics (Texts in Applied Mathematics) , springer.
3. Coddington E., Theory of Ordinary Differential Equations, Tata McGraw Hill
4. Rainville E.D., Elementary Differential Equations, Pearson

Paper Title: Operation Research

Paper Code: MAT-IV.E-5

Marks: 100

Credits: 4

Course Objectives: This course aims to teach linear programming

Learning outcome: Students will be able to solve linear programing problems

1. Linear Programming Problem **(5 lectures)**

Definition of standard form, formulation of LPP, convex set and their properties, extreme points. Graphical solution of LPP (Only two variables).

2. Simplex Method: **(25 lectures)**

Theorems related to simplex method .and problems .Cases pertaining to existence of multiple solutions, unbounded and no feasible solution.Big M method and Two phase Simplex method

3. Transportation Problems: **(8 lectures)**

Mathematical formulation, condition for existence of feasible solution, rank of transportation matrix, Initial basic feasible solution by (i) NWC method (ii) Matrix-minima and (iii) VAM, Modi's method to find an optimal solution, balanced and unbalanced transportation problems.

4. Assignment Problems: **(7 lectures)**

Mathematical formulation, Hungarian methods to solve assignment problems, balanced & unbalanced assignments problems

5. Game Theory **(15 lectures)**

Optimal Solution of Two-Person Zero-Sum Games, Solution of Mixed Strategy Games, Converting Game theory into LPP

References:

1. Kanti Swarup, Gupta P.K, Man Mohan, Operations research, S Chand
2. Loomba, Linear Programming
3. Taha H, Operation Research, Pearson
4. Vajda, Game Theory

Paper Title: ADVANCED ANALYSIS

Paper Code: MAT-IV-E-6

Marks: 100

Credits: 4

Course Objectives: To develop the understanding of point wise and uniform convergence of sequence and series of real valued functions.

To understand Power Series and Fourier Series

Learning outcome: The student will be able to understand series and sequences of real valued functions

Prerequisites: Basic Real Analysis, Mathematical Analysis

I: Sequences of Real valued Functions **(20 lectures)**

Pointwise and uniform convergence and examples, M_n test for uniform convergence and examples, Cauchy's criterion for uniform convergence and examples.
Properties of uniformly convergent sequence of functions: uniform convergence and continuity, uniform convergence and differentiability, uniform convergence and integrability and examples
(i)Weierstrass Approximation Theorem
(ii)C[a,b] is complete, where C[a,b] is a class of continuous functions on C[a,b]

II: Series of Real Valued Functions **(12 lectures)**

Pointwise and uniform convergence and examples, Cauchy's criterion for uniform convergence, Weierstrass M-test and examples
Properties: (i) uniform convergence and continuity, (ii) uniform convergence and differentiability, (iii) uniform convergence and integrability and examples

III: Power Series **(16 lectures)**

Definition of Power Series and examples. Uniform convergence of Power Series and examples, Theorems on Power series, radius and interval of convergence
Theorem: Power series can be integrated and differentiated in its interval of convergence, examples
Trigonometric functions (sine and cosine), exponential functions and logarithmic functions and their properties.
Binomial Series

IV: Fourier Series **(12 lectures)**

Definition of trigonometric series and Fourier series on $[\pi,\pi],[0,2\pi]\&[-l,l]$ and examples. Results on odd and even functions, Examples on derivations of Fourier Series expansion, Half range series and examples
Bessel's inequality and Parseval's Identity, Dirichlet conditions, Theorem on convergence of Fourier series (only statement) and examples

References:

1. Bartle R.G, Sherberf D.R, Introduction to Real Analysis (Third Edition), Wiley
2. Berberian S.K., A First Course in Real Analysis,Springer
3. Bhatia R., Fourier Series, Hindustan Book Agency
4. Goldberg R.R, Methods of Real Analysis, Oxford and lbh
5. Kumaresan S & Kumar A, A Basic Course in Real Analysis, CRC Press
6. Malik S.C. and Arora, Mathematical Analysis, New Age
7. Pugh C.C., Real Mathematical Analysis,Springer
8. Rudin W., Principles of Mathematical Analysis, Tata McGraw Hill
9. Shanti Narayan, P.K.Mittal, A Course of Mathematical Analysis, S Chand
10. Somasundaram, Mathematical Analysis
11. Stein E.M & Shakarchi R., Fourier Analysis: An Introduction, Princeton University Press

Paper Title: Computers for Mathematics

Paper Code: MAT-IV.E-7

Marks: 100

Credits: 4

Course prerequsites: Basic knowledge of computers, a basic course in ODE, Numerical analysis. Familarity with computer programming will be helpful but not compulsory.

Course objectives:- To train students to use computers for mathematical typing, computing and plotting. Helping them understand theory using computational methods.

Learning Outcome :- Students will be able to use these free packages for writing and drawing mathematical papers . Also can understand some basic aspects of programming.

1.Introduction to LaTeX **(15 Lectures)**

- **i.** Mathematical typing in MS Word 07/13
- ii. Short comings of Word , need of some other package of writing .
- iii. LaTeX Installation and packages
- iv. Document Editing using LaTeX :- Text formatting, Paragraph formatting
- v. Fonts and colours, special characters, Tables, Page layout, importing graphics, footnotes, referencing
- vi. Beamer Presentations

2.Mathematical typesetting in LaTeX **(10Lectures)**

- i. Mathematical environments and packages
- ii. Symbols, Greek letters and operators, Powers and indices, fractions, Roots, Sums, integrals and derivatives, Brackets, Matrices

3. **Python** **(15 lectures)**

Some basics of programming, algorithms, flowcharts, syntax, do s and don’t s, Python programming.

4. Scilab/ Matlab **(5Lectures)**

Introduction to Scilab, familiarizing with the Scilab, Scilab syntax, Variables, functions, plotting graphs

5. Geogebra **(3 lectures)**

6. Numerical methods using Scilab/ Python **(12Lectures)**

- finding roots of algebraic and transcendental equations
- Interpolation
- Numerical integration and differentiation
- fitting of data

- Numerical ODE
- Solutions of simultaneous equations

Refrences:

1. Alley, Michael The Craft of ScientificPresentations, Springer (2003).
2. Booth, W C, Colomb, G G, and Williams, J M: The Craft of Research (Chicago Guides to Writing, Editing, and Publishing) Univ. of Chicago Press, 2008.
3. Graetzer, George: Math into LaTex, An introduction to LaTex and AMS-LaTex, Birkhauser, 1996.
4. Knuth, Donald E.; Larrabee, Tracy E.; Roberts, Paul M.: Mathematical writing, Mathematical Association of America, 1989.
5. Krantz, S.: A Primer of Mathematical Writing: Being a Disquisition on Having Your Ideas Recorded, Typeset, Published, Read & Appreciated, American Mathematical Society, 1996.
6. Krantz, S.: How to Teach Mathematics, American Mathematical Society, 1999.
7. Lamport, Leslie: LaTex, a document preparing system, Addison-Wesley, 1994.
8. Strunk Jr., William; White, E. B.: The Elements of Style, Fourth Edition, Longman; 4th edition (1999).

Paper Title: Combinatorics

Paper Code: MAT-IV.E-8

Marks: 100

Credits: 4

Course Pre Requisites:- Basic set theory, Basic Algebra, Concepts of sequences and Series.

Aim:- This paper is introduced to inculcate lateral thinking ability in students, to give them some basic techniques to solve combinatorial problems and make them realize that there may not be readymade solutions to all the problems .

Learning Outcome:- Students will be able to tackle some combinatorial problems and also can analyze given problem to find a way to solve it.

Unit I :- Counting principles (20Lectures)

Rules of sum and product, Permutation – Combination, Distributions of distinct/ identical objects, Stirling numbers of 1^{st} and 2^{nd} kind Stirling's formula., Pigeon hole Principle

Unit II :- Generating Functions (15Lectures)

Generating functions for combinations, Enumerators for permutations, distribution of distinct objects in to identical cells, Partitions of integers, relations. Exponential generating function

Unit III :- Recurrence Relations (15Lectures)

Linear recurrence relations with constant coefficients, Characteristic equation method, Solutions by technique of generating function, recurrence relations with two indices.

Unit IV :- The principle of inclusion and exclusion (10Lectures)

The general formula, derangements, Permutations with restrictions on relative positions, The rook polynomials, permutations with forbidden positions.

Text book :- Liu C.L., Introduction to Combinatorial Mathematics, McGraw-Hill Book Company.

References:

1. Berge C, Principles of Combinatorics, Academic Press
2. Brualdi R.A., Introductory Combinatorics, Pearson
3. Chuan-Chong Chen & Khee-Meng Koh, Principles and techniques in Combinatorics, World Scientific Publishing
4. Knuth, Graham, Patashnik, Concrete Mathematics: A Foundation for Computer Science, Addison Wesley
5. Kolman B, Discrete mathematical structures, Pearson Education
6. Liu C.L, Discrete mathematical structures, McGraw-Hill Book Company.
7. Stanley R., Enumerative Combinatorics Volume 1, Springer
8. Tucker Alan, Applied Combinatorics, Wiley Pvt. Ltd.

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)

BOS APPROVED MATHEMATICS SYLLABI OF INTERDISCIPLINARY COURSE

Course Title: Quantitative Aptitude for Competitive Examination
Course Code :
Credits : 4
No. of hours : 60 hrs.

Course Objective :- To make students aware of different types of questions asked in Competitive Entrance examination, logical thinking, data interpretation.

Course Outcome:- Students will be better equipped for Competitive Entrance Examinations and also it will improve their thinking ability.

Contents: -

1. Numerals (integers, rationales, real numbers) Place values, face values, Prime numbers, Composite numbers, co-prime numbers, Binary Numbers.
2. Divisibility test for 2,3,4, 5, 6, 8, 9 etc. Division algorithm, Progressions, ratio, proportions (direct, indirect), Percentages, LCM, HCF.
3. Averages, Square root, cube root, square, cube, surds and indices, logarithms. Linear – Quadratic equations, Simultaneous Equations, Some special cases of higher degree polynomial equations.
4. Time and work, Time and distance, speed and velocity, Trains and boats & streams problems, pipes & container.
5. Problems on Ages, Averages, simple & compound interest, profit& loss, Partnership, stock & shares, True discount, Banker's discount.
6. Calendar, clock, race, games and logical problems, Logical gates.
7. Area, volumes, surface area, three-dimensional perspectives, Height & distance.
8. Permutation & combinations, Probability, odd man out & series.
9. Data interpretation, Tables, bar graphs, pie charts, line graphs, curves.

Note : Since multiple choice questions are asked in Competitive Entrance Examinations, more emphasis will be on solving problems.
All Examinations conducted should be MCQ type. Basic school mathematics should be revised.

Any topic that might be pointed out by a particular examination could be explained.

Teaching of mathematical concepts will be about 30-35 hours. Remaining lectures are for tests, class-work, attending to peculiar topics and giving some shortcut methods wherever possible.

There are many books available in the library. Students are advised to solve from as many books as they can.

REFERENCES :

1. Mathematics for all competitive exams SSC (Pre/ Mains) by Ramniwas Mathuriya; Sunita Publications.
2. Mathematics for higher level competitive exams by Santanu Roy R : Gupta's Publications.
3. Mathematics Formulae for competitive examinations : Formulae that solve problems in a jiffy by Sunita Bose ; V & S Publishers.

Course Structure for Mathematics Major

	Core	Core					
Sem-I	Basic Algebra	Basic Real Analysis	---------	---------	---------	---------	
Sem-II	Coordinate Geometry	Mathematical Analysis	---------	---------	---------	---------	
			Elective-I	**Elective-II**	**Elective-III**	**Elective-IV**	**Elective-V**
Sem-III		Differential Equations- I	Abstract Algebra-I	Number Theory-I	Combinatorics	Numerical Methods	
Sem-IV		Linear Algebra	Advanced Analysis	Abstract Algebra-II	Operations Research	Cryptography	
Sem-V		Functions of Several Variables	Metric Spaces	Differential Equations-II	Graph Theory	Pedagogy of Mathematics	
Sem-VI		Vector Analysis	Complex Analysis	Number Theory-II	Probability Theory	Computers for Mathematics	Computational Linear Algebra

Syllabus

Course Title:BASIC REAL ANALYSIS

Course Code: MAT-I.C-2

Marks: 100

Credits: 4

Aim :- Introduction to Real numbers and real valued functions of a Real variable.

Learning Outcome :- Students will be well versed with all properties of real numbers, geometry of real line, notations, functions .

Methodology:- Lecturing . Standard examples to make ideas clear, proving results for self study .

Course Duration: 60 Lectures

Unit 1:Preliminaries: (4 Hrs.)

Prepare students with the required background for real analysis

a. Set theory: Sets, operations on sets, sets of number systems
b. Counting :- Principle of Mathematical induction. Finite & infinite sets, countable sets and their properties.

Unit 2: The Real number system $\mathbb{R}$: Introduce the real number system. (12 Hrs.)

a. Order and Algebraic Properties of $\mathbb{R}$: Algebraic properties, Order Properties, Inequalities (Triangle and associated inequalities
b. Intervals: Neighborhood, Intervals and their properties
c. Concept of Supremum and completeness: Supremum and Infimum, Archimedean Property, Density Property, $\mathbb{R}$ is uncountable,$\mathbb{R}$ is complete.

Unit 3: Sequences of Reals: To introduce Real sequences (14 Hrs.)

a. Definitions and limit: :- Definition,Limit of a sequence, Tail of a sequence
b. Algebra of Sequences :- Algebra of limits, Inequalities, Sandwich theorem
c. Monotone Sequences: Monotone sequences, Monotone convergence theorem
d. Subsequences: Subsequences, Bolzano Weirstrass Theorem for sequences
e. Cauchy Sequences: Cauchy Sequence, Properties, Cauchy General principle for convergence of sequences

Unit 4: Continuous Functions: (12 Hrs.)

To study the behavior of continuous functions

a. Functions: Maps and relations, function, inverse, compositions of functions, bounded functions and their properties
b. Definition and concept of continuous functions
c. Sequential criterion for continuity of functions
d. Algebra of continuous functions,
e. Behaviour on Intervals, IVT
f. Concept of uniform continuity
g. Graphs of Some continuous functions :Monotone, Inverse, Power/Root function

Unit 5: Limits:Introduce the concept of limit used in analysis. (10 Hrs.)

a. Concept of limit point and cluster point
b. Limit theorems: Algebra of limits
c. One sided limits, Infinite limits

Unit 6: Series: Introduce Series of Reals (8 Hrs.)

a. Definition
b. Properties
c. Series with non-negative terms,
d. Test for convergence :n^{th} term test, Comparison test Ratio test, Root test

References:

1) R.G.Bartle and D. Sherbert, Introduction to Real Analysis, Wiley
2) Robert Sticartz, The Way of Analysis, Jones and Bartlett Publishers
3) T. Apostol, Calculus (volume I), Wiley Eastern Ltd.
4) S.C. Malik, Savita Arora, Mathematical Analysis, New Age International Publishers
5) J.R. Munkres, Topology,Prentice Hall of India

Paper Title: Co-ordinate Geometry

Paper code: MAT-II.C1

Marks:100

Credits: 4

Aim: To learn the different 2 and 3 dimensional geometry and tracing of curves

Learning Outcome: the student will be able to identify and trace the various conic sections, trace curves in Cartesian and polar coordinates

Unit1: Co-ordinate systems **(3 Hrs.)**

Cartesian,Polar, Cylindrical and Spherical coordinates systems, Relations between them.

Unit 2: Tangents and Normal **(10 Hrs.)**

Concepts of tangent, normal, line, Plane, Sphere, Cone and Cylinder. Equation of all and forming equation under desired conditions, relationship between them.

Unit 3:Central conics **(12 Hrs.)**

Ellipse , parabola and hyperbola . Their equations, properties and their graphs.

Unit 4: General equation of second degree: **(12 Hrs.)**

General conics, conic sections their equations, properties and their graphs.

Unit 5: Transformation of Axis **(8 Hrs.)**

Change of origin, rotation of axis and translation of axis and its effect on equation of geometrical object.

Unit 6: Tracing of curves **(15 Hrs.)**

Tracing of curves using concepts of derivatives, concavity-convexity, singular points (double point, cusp, node), monotonicity of function, polar co-ordinates, asymptotes.

References:-

• P.K.Jain, Khalil Ahmad- Analytic Geometry of three dimension- 2nd edition –Wiley Eastern Ltd. (1991)

• Loney S.L.- The Elements of Coordinate Geometry (Part I): CartesianCoordinates – MacMillan

• ShantiNarayan, P.K.Mittal – Differential Calculus – S. Chand Publications.

• Gibson C.G. Elementary Euclidean Geometry: An undergraduate introduction- Cambridge University Press.

Paper Title: NUMERICAL METHODS

Paper Code: MAT-III.E-3

Marks: 100

Credits: 4

Course Objectives: This course covers the basic methods for finding the finite difference, solution of simultaneous equations and the techniques of Numerical Differentiation and Numerical Integration. It also deals with solution of Algebraic and Transcendental equations.

Learning outcome: The student will be able to solve numerically various equations.

Unit 1: Error Analysis (7 Hrs.)

Approximate numbers, significant figures, rounding off numbers, Error- Absolute, relative and percentage

Unit 2: Finite Differences (7 Hrs.)

Operators- Δ, ∇ and E (Definitions and some relations among them), finite difference tables, fundamental theorem on differences of a polynomial and examples.

Unit 3: Interpolation and Extrapolation (7 Hrs.)

Newton Gregory Forward and backward interpolation formulae (with deduction of formulae) and examples (for equal intervals)

For unequal intervals- Lagrange's Formula and Newton's divided difference formula (No proof) and examples

Unit 4: Numerical Integration and differentiation (11 Hrs.)

Trapezoidal rule, Simpson's $1/3^{rd}$ and $3/8^{th}$ rules (with proof) and problems. Weddle's rule (no proof , only problems)

Numerical differentiation and examples

Unit 5: Numerical Solutions of Equations (7 Hrs.)

To find a real root of an algebraic or transcendental equation using Bisection method, regular falsi method, Newton Raphson method with geometrical significance and problems and method of iteration

Unit 6: Curve fitting **(7 Hrs.)**

Method of least squares- fitting a line, second degree polymomial, exponential curve and examples

Unit 7: Solution of System of Equations **(7 Hrs.)**

Gauss Elimination, Gauss- Seidal Iteration method, Iteration method

Unit 8: Solution of Differential Equations **(7 Hrs.)**

Euler's Method, Runge Kutta Method

References:

1. Atkinson K., An Introduction to Numerical Analysis, John Wiley & Sons
2. Chatterji P.N, Numerical Analysis
3. Comte S.D and Carl de Boor, Elementary Numerical analysis - An Algorithmic approach, McGraw Hill
4. Hildebrand F.B, Introduction to Numerical Analysis, McGraw Hill
5. Sastry S.S, Introductry Methods of Numerical Analysis, Prentice Hall India
6. Scarborough J.B, Numerical Mathematical Analysis, Oxford and IBH Publishing Company, New Delhi.

Paper Title: ADVANCED ANALYSIS

Paper Code: MAT-IV-E-6

Marks: 100

Credits: 4

Course Objectives: To develop the understanding of point wise and uniform convergence of sequence and series of real valued functions.

To understand Power Series and Fourier Series

Learning outcome: The student will be able to understand series and sequences of real valued functions

Prerequisites: Basic Real Analysis, Mathematical Analysis

Unit 1: Sequences of Real valued Functions (20 Hrs.)

Pointwise and uniform convergence and examples, M_n test for uniform convergence and examples, Cauchy's criterion for uniform convergence and examples.

Properties of uniformly convergent sequence of functions: uniform convergence and continuity, uniform convergence and differentiability, uniform convergence and integrability and examples

(i)Weierstrass Approximation Theorem

(ii)C[a,b] is complete, where C[a,b] is a class of continuous functions on C[a,b]

Unit 2: Series of Real Valued Functions (20 Hrs.)

Revision of series of real numbers, Alternating Series, Leibnitz test, rearrangement of terms of series, Pointwise and uniform convergence and examples, Cauchy's criterion for uniform convergence, Weierstrass M-test and examples

Properties: (i) uniform convergence and continuity, (ii) uniform convergence and differentiability, (iii) uniform convergence and integrability and examples

Unit 3: Power Series (20 Hrs.)

Definition of Power Series and examples. Uniform convergence of Power Series and examples, Theorems on Power series, radius and interval of convergence

Theorem: Power series can be integrated and differentiated in its interval of convergence, examplesTrigonometric functions (sine and cosine), exponential functions and logarithmic functions and their properties, Binomial Series

References:

1. Bartle R.G, Sherberf D.R, Introduction to Real Analysis (Third Edition), Wiley
2. Bhatia R., Fourier Series, Hindustan Book Agency
3. Goldberg R.R, Methods of Real Analysis, Oxford and lbh
4. Kumaresan S & Kumar A, A Basic Course in Real Analysis, CRC Press
5. Malik S.C. and Arora, Mathematical Analysis, New Age
6. Pugh C.C., Real Mathematical Analysis,Springer
7. Rudin W., Principles of Mathematical Analysis, Tata McGraw Hill
8. Shanti Narayan, P.K.Mittal, A Course of Mathematical Analysis, S Chand
9. Somasundaram, Mathematical Analysis

Course Title: COMPUTATIONAL LINEAR ALGEBRA

Course Code: 04

Max Marks: 100

Course Objectives: To learn more of linear algebra in computational form.

Learning Outcome: The student will be able to do computational Linear algebra

Course Prerequisites: Linear Algebra

Unit 1: Review of Gaussian Elimination (10 Hrs.)

Unit 2: Orthogonality (15 Hrs.)

Orthogonal vectors and subspaces, projections and least squares, QR Factorizations

Unit 3: Positive Definite Matrices (20 Hrs.)

Maxima, minima and saddle points, test for positive definiteness, singular value decompositions, Lagrange multipliers and Rayleigh quotients, finite element method

Unit 4: Matrix norm and Condition Number (15 Hrs.)

References:

1. G. Strang, Linear Algebra and its Applications

Approved Syllabus and rearranged course structure.

Basic Real Analysis

Aim:- To introduce number system with its geometrical properties and axioms of real numbers.

Course outcome:- After completion of this course students will be able to

1] relate geometry with real number system.

2] use axioms of real numbers in analysis.

3] draw and recognize graphs of some elementary but important functions.

4] use technical terminology and some basic tools in analysis.

1] Numbers :- Simple Algebraic development from Natural numbers to Real numbers. (5)

2] Geometry of Real numbers :- Representation of real numbers on a line, Tricotomy Law, Order on R, Archimedes property, Hausdorff property, distance concept: absolute value (all inequalities ex. Triangle inequality). Subsets of R : bounded-unbounded sets, bounded sets, lub. glb. Completeness axiom, intervals, open-closed intervals, open/closed nbd. of a point, limit points, dense set (Q and Q' only), concept of infinity, (15)

3] Functions :- Examples with graphs (log , a^x,x^n, trigonometric functions, step function, absolute value function, polynomial / rational functions, signum function.) Inverse function:- How /why to restrict domain/ co-domain (range), graphs of inverses of above functions, Compositions, addition, product of functions. (7)

4] Sequences:- definition , examples, convergence/ divergence of sequence, types of sequences, Cauchy sequences, Sub sequences, absolute convergence, all theorems, Bolzano Weierstrass theorem. (17)

5] Series :- Definition, Examples, alternate series, Convergence, Cauchy criteria, absolute convergence, rearrangement of series, All theorems for testing the convergence (absolute and non absolute), (17)

Mathematical Analysis- I

Aim:- To introduce two important families of functions (continuous and differentiable)

Course Outcome:- After completion of this course students will be able to

1] use the properties of continuous (differentiable) function to solve problem in real life situation.

2] illustrate and reproduce all theorems and properties continuous (differentiable) functions.

1] Continuous functions:- Limit of a function (Limit at ∞ and lim ---› ∞) , Algebra of limits, continuous functions($\varepsilon-\delta$ definition), types of discontinuity, sequential continuity, continuous functions on closed and bounded intervals , their properties, All results of continuous function, IVT and bisection method to find root of a continuous functions, uniform continuity, (25)

2] Differentiable functions :- Definition, properties, theorems, increasing/decreasing functions, Taylor's theorem, Newton's Method, L'Hospital's rules, maxima-minima, MVTs. , convex / concave functions, singular points. (25)

3] Use of differentiation in Physics, Economics and other subjects. (10)

Mathematical Analysis- II

Aim:- To introduce one more family of functions, Integrable functions.

Course outcome:- After completion of this course students will be able to

1] Identify Integrable functions.

2] Classify and evaluate improper integrals.

3] Integrate functions numerically.

1] Riemann integrals:- Tagged partition, Riemann sum, Riemann integrable functions, some simple results on integrable functions using Riemann sum. (10)

2] Darboux integrals:- Upper/lower sum, integrable function, Riemann criteria of integrable function, classes of integrable functions, (15)

3] Fundamental theorems of integration and their applications (chain rule, substitution and product rule theorems) (12)

4] Improper integration (type I, type II and type III), **α** and **β** functions. (8)

5] Numerical integration – Quadrature Rules, Trapezoidal, Mid-point, Simpson's and Weddle's rules of integration. (15)

Advance Analysis

Aim:- To introduce some approximations of continuous/differentiable functions.

Course outcome :- After completion of this course students will be able to

1] Analyze sequence and series of functions.

2] Use some basic techniques to represent continuous functions as polynomials.

1] Sequence of functions:- convergence, uniform convergence, interchange theorems. (15)

2] Series of functions:- Convergence, uniform convergence, interchange theorems. Power series and their radius of convergence, Cauchy-Hadamard theorem, Differentiation and uniqueness theore. (15)

3] Some special functions.(exponential, logarithmic and trigonometric) (12)

4] Continuity and Gauges, δ-fine partition, step function, inverse function theorem, Weierstrass approximation theorem (using Bernstein polynomials), Dini's theorem. (18)

New Course Structure is as follows

	Core	**Core**				
Sem-I	Basic Algebra	Basic Real Analysis	---------	---------	---------	---------
Sem-II	Coordinate Geometry	Mathematical Analysis-I	---------	---------	---------	---------
			Elective-I	**Elective-II**	**Elective-III**	**Elective-IV**
Sem-III		Mathematical Analysis-II	Abstract Algebra-I	Number Theory-I	Combinatorics	Numerical Methods
Sem-IV		Linear Algebra	Advanced Analysis	Number Theory-II	Cryptography	Probability Theory
Sem-V		Functions of Several Variables	Metric Spaces	Differential Equations-II	Graph Theory	Pedagogy of Mathematics
Sem-VI		Vector Analysis	Complex Analysis	Abstract Algebra-II	Computational Linear Algebra	Computers for Mathematics

Apart from this Two Skill Enhancement Courses

1] Differential Equation-I in ODD SEMESTER

2] Operations Research in EVEN SEMESTER

Course Structure for Mathematics Minor

Semester	**Core (Minor)**
I	Basic Algebra
II	Coordinate Geometry
III	Basic Real Analysis
IV	Mathematical Analysis-I / Linear Algebra
V	Graph Theory / Numerical Methods
VI	Probability Theory/ Vector Calculus

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Gogol, Margao, Goa

Department of Mathematics

Course Structure and Syllabus

Course Structure for Mathematics Major

	Core	**Core**					
Sem-I	Basic Algebra	Basic Real Analysis	---------	---------	---------	---------	
Sem-II	Coordinate Geometry	Mathematical Analysis	---------	---------	---------	---------	
			Elective-I	**Elective-II**	**Elective-III**	**Elective-IV**	**Elective-IV**
Sem-III		Differential Equations- I	Abstract Algebra-I	Number Theory-I	Combinatorics	Numerical Methods	
Sem-IV		Linear Algebra	Advanced Analysis	Abstract Algebra-II	Operations Research	Cryptography	
Sem-V		Functions of Several Variables	Metric Spaces	Differential Equations-II	Graph Theory	Pedagogy of Mathematics	
Sem-VI		Vector Analysis	Complex Analysis	Number Theory-II	Probability Theory	Computers for Mathematics	Computational Linear Algebra

Course Structure for Mathematics Minor

Semester	**Core (Minor)**
I	Basic Algebra
II	Coordinate Geometry
III	Real Analysis/ Differential Equations –I
IV	Mathematical Analysis/ Linear Algebra
V	Graph Theory / Numerical Methods
VI	Operations Research/ Probability Theory/ Vector Calculus

SYLLABUS

Course Title: BASIC ALGEBRA

Course Code: MAT-I.C-1

Marks: 100

Credits: 4

Course Objectives: Introduction to the basic concepts of Algebra which are used in mathematics.

Learning outcome: Student will be well equipped with all the concepts which are useful to understand mathematics

1) **Sets** **(3 lectures)**

Notion of Sets- Subsets - Power sets - Equality of sets - Finite and Infinite sets - Set operations - De-Morgan's laws - Cartesian product of sets

2) **Relations and Functions** **(9 lectures)**

Relations - Types of relations - Binary relation - Equivalence relation - Equivalence classes and partitions- Congruence modulo *n* – Mappings - One-One and onto mappings - Composition of Mappings - Identity and Inverse mappings - Binary Operations in a set.

3) **Logic** **(3 lectures)**

Logical statements - connectives - truth tables - tautologies

4) **Matrices and determinants** **(25 lectures)**

Equality of matrices- Addition of Matrices- Multiplication of Matrices- Properties of multiplication- Transpose of matrix- Conjugate of a matrix- Determinant of a square matrix- Singular and non-singular matrices- Symmetric and skew symmetric matrices- Hermitian and skew Hermitian matrices- minor and cofactor of an element of a matrix- Ad joint of a square matrix- Inverse of a square matrix- orthogonal and unitary matrices- Elementary Row, Column operations- Elementary matrices- inverse of a matrix using elementary operations- Gaussian Elimination- Linear Equation: system of homogeneous equations- Consistency and solution of a system of linear equations- -inverse of a square matrix using Gaussian Elimination- Rank of a Matrix- Normal Form- Row-Echelon matrix- Row rank and column rank of a matrix

5) **Equations** **(20 lectures)**

Algebraic equations- general properties- Fundamental theorem of Algebra(statement only)- Nature of roots of an equation (surd or complex roots occur in pairs)- Statement of Descartes' rule of signs and applications- relations between roots and co-efficients- transformation of equations- reciprocal equations- algebraic solution of cubic equation-Cardan’s method-Multiplicity of roots.

References:

1. R.D. Bhatt, Algebraic Structures, Vipul Prakashan
2. C.L.Liu, Discrete Mathematical Structures,
3. Shanti Narayan and P.K.Mittal, A textbook of Matrices, S. Chand and Company
4. H.S. Hall and S.R.Knight, Higher Algebra, AITBS Publishers
5. K.B.Datta, Matrix and Linear Algebra, PHI
6. M. Artin, Algebra, PHI
7. S. Lang, Introduction to Linear Algebra, Second Ed., Springer-Verlag

CourseTitle: BASIC REAL ANALYSIS

Course Code: MAT-I.C-2

Marks: 100

Credits: 4

Aim: - Introduction to Real numbers and real valued functions of a Real variable.

Learning Outcome: - Students will be well versed with all properties of real numbers, geometry of real line, notations, and functions.

Methodology: -Lecturing. Standard examples to make ideas clear, proving results for self-study.

Course Duration: 60 Lectures

Unit 1: Preliminaries: (4 Lectures)

Prepare students with the required background for real analysis

a. Set theory: Sets, operations on sets, sets of number systems
b. Functions: Maps and relations, Function, Inverse, Compositions, restriction and extensions of functions, How to graph a function
c. Counting: - Principle of Mathematical induction. Finite & infinite sets, countable sets and their properties.

Unit 2: The Real number system R: Introduce the real number system. (12 Lectures).

a. Algebraic Properties, Order Properties
b. Inequalities (Triangle and associated inequalities

c. Neighborhood, Intervals and their properties
d. What is an ε-neighborhood
e. Supremum and Infimum, Bounded functions and their properties, ArchimedeanProperty, Density Property, R is uncountable

Unit 3: Limits: Introduce the concept of limit used in analysis. (8Lectures)

d. Concept of limit point and cluster point
e. Limit theorems
f. One sided limits, Infinite limits

2) **Sequences of Reals**: To introduce Real sequences (14Lectures)

a. Definitions and limit: :- Definition, Limit of a sequence, What do you mean by convergence of sequence, Tail of a sequence
b. Algebra of Sequences :- Algebra of limits, Inequalities, Sandwich theorem
c. Monotone Sequences Monotone convergence theorem
d. Subsequences, Bolzano Weirstrass Theorem for sequences
e. Cauchy Sequences: - What is a Cauchy Sequence, Properties, Cauchy General Principle for convergence of sequences, R is complete.
f. Sequential convergence criterion for limit of functions

3) **Continuous Functions**: To study the behaviour of continuous functions (12Lectures)

a. Definition and concept of continuous functions, Sequential criterion for continuity of functions, Algebra of continuous functions, Behaviour on Intervals, Concept of uniform continuity
b. Graphs of Some continuous functions (Monotone, Inverse, Power/Root function)

4) **Series**: Introduce Series of Reals (6 Lectures)

- Definition, Properties, Series with non-negative terms, Test for convergence (n^{th} term test, Comparison test Ratio test, Root test).

References:

1) ,R.G.Bartle and D. Sherbert, Introduction to Real Analysis, Wiley
2) Robert Sticartz, The Way of Analysis, Jones and Bartlett Publishers
3) T. Apostol, Calculus (volume I), Wiley Eastern Ltd.
4) S.C. Malik, Savita Arora, Mathematical Analysis, New Age International Publishers
5) J.R. Munkres, Topology,Prentice Hall of India

Course Title: Coordinate Geometry

Course code: MAT-II C3

Marks: 100

Credits: 4

Aim: To learn the different 2 and 3 dimensional geometry, tracing of curves and space curve

Learning Outcome: the student will be able to identify and trace the various conic sections, trace curves in Cartesian and polar coordinates

1. Co-ordinate systems: -Cartesian, Polar, Cylindrical and Spherical coordinates systems, Relations between them. **(3 lectures)**

2. Concepts of tangent, normal, line, Plane, Sphere, Cone and Cylinder. Equation of all and forming equation under desired conditions, relationship between them. **(10 lectures)**

3. Central conics: -ellipse, parabola and hyperbola. Their equations, properties and their graphs. **(12 lectures)**

4. General equation of second degree: - General conics, conic sections their equations, properties and their graphs. **(15 lectures)**

5. Change of origin, rotation of axis and translation of axis and its effect on equation of geometrical object. **(5 lectures)**

6. Tracing of curves using concepts of derivatives, concavity-convexity, singular points (double point, cusp, and node), and monotonicity of function, polar co-ordinates, and asymptotes.

(15 lectures)

References: -

• P.K.Jain, Khalil Ahmad- Analytic Geometry of three dimension- 2nd edition –Wiley Eastern Ltd. (1991)

• Loney S.L. - The Elements of Coordinate Geometry (Part I): CartesianCoordinates – MacMillan

• Shanti Narayan, P.K.Mittal – Differential Calculus – S. Chand Publications.

• Gibson C.G. Elementary Euclidean Geometry: An undergraduate introduction- Cambridge University Press.

Course Title: MATHEMATICAL ANALYSIS

Course Code: MAT-II.C 4

Marks: 100

Credits: 4

Course Objective: To Study

The differentiable functions, their properties and some applications.

The idea of Riemann integration and some rules of integration.

Learning Outcomes:

To make the students comfortable with the differentiations and integrations that are essential in almost all the branches and also can make use of these ideas for Geometry

I. Derivatives of Functions (8 lectures)

- Definitions

Derivative at a point, Differentiability in an interval, Derivative of a function, meaning of the sign of derivative, Geometrical meaning of the derivative and higher order derivatives.

- A necessary condition for the existence of a finite derivative (theory and problems)

II. Uses Properties of differentiable functions: (14 lectures)

- Algebra of derivatives
- Derivative of the inverse function
- Darboux property, Darboux theorem and intermediate value theorem.
- Rolle's Theorem, Lagrange's Mean value theorem, Cauchy's MVT and

Their applications, Taylor's and Maclaurin's theorem.

- Increasing and decreasing functions.

III. Applications (14 Lectures)

- Approximations
- Extreme values of a function: investigation of the points of maximum and minimum values.
- L' hospital's rule (Indeterminate form, 0/0 form, 00/00 forms etc.) and some problems.

IV. Riemann Integration: (24 lectures)

4.1 Some basic terminology and notations:

Partition of an interval, upper and lower sums of bounded real valued function over I, Refinement of a partition.

4.2 Properties of partitions

4.3 Upper and lower integrals, Riemann integrals functions and some problems.

4.4. Riemann criterion for integrability and some applications based on it.

- Properties of Riemann integrable functions.

- Indefinite integral, fundamental theorems of integral calculus.
- Improper Integrals (Type I, Type II and Type III)

References:

1. Malik S.C. and Arora Sarita. *Mathematical Analysis*, Second edition. Wiley Eastern Ltd, 1994.
2. Apostol Tom, *Calculus Vol. I*. Second Edition. Wiley Students Edition, India, 2012.
3. Bartle Robert G. and Sherbert Donald R. *Introduction to Real Analysis*, Third Edition. Wiley Student edition.
4. Narayan Shanti. *Differential Calculus*. S. Chand and Company Pvt. Ltd. 1988.
5. Goldberg Richard R., *Methods of Real Analysis*. Oxford and IBH Publishing Co. Pvt. Ltd. Indian Edition, 1970.
6. Bhat R.D. *A Textbook of Mathematical Analysis II*. Vipul Prakashan, First Edition.

Course Title: Differential Equations I

Course Code: MAT-IV.C-5

Marks: 100

Credits: 4

Course Pre Requisites: - Mathematical Analysis

Aim: - To introduce some methods of solving ODE of first and higher order, Applications of the same in different fields.

Learning outcome: - Students can solve ODE with constant coefficients, given a simple situation can make an ODE.

Unit 1:- **(8 lectures)**

Introduction. Some simple situations where we come across ODE, Geometrical Meaning of ODE, Solutions of an ODE. Picard's Existence and Uniqueness theorem.

Unit 2:- **(15 lectures)**

First order ODE. Variable separable, Homogeneous, Non- Homogeneous, Exact differential equations, integrating factor, linear differential equations, Bernoulli equations.

Unit 3:- **(17 lectures)**

Second order differential equations, Homogeneous and non-homogeneous differential equations, complementary function, particular integral, Wronskian, Solution space, General solution, complex solutions. Some methods of solving second order differential equations (undetermined coefficients, variation of parameters, using one solution to find other).

Unit 4:- **(8 lectures)**

Linear differential equations of higher order, simple examples of non-homogenous differential equations.

Unit 5 :- **(12 lectures)**

Some application of differential equations, LR / LCR circuits, SHM (simple-damped-forced), Equation of Catenaries, Planetary Motions – Kepler's Laws.

Textbook: - Simmons G.F., Differential Equations with historical Notes, Tata McGraw Hill

References

1. Boyce W.E. & DiPrima R.C., Elementary Differential Equations and Boundary Valued Problems, John Wiley Pvt Ltd.

2. Braun C, Differential Equations and Their Applications: An Introduction to Applied Mathematics (Texts in Applied Mathematics), springer.

3. Coddington E., Theory of Ordinary Differential Equations, Tata McGraw Hill

4. Rainville E.D., Elementary Differential Equations, Pearson

Course Title: ALGEBRA-I

Course Code: MAT-III.E-1

Marks: 100

Credits: 4

Course Objectives: This course aims to impart emphasis on concepts of groups and rings

Learning outcome: Students will be familiar with groups, rings and their characteristics.

Prerequisites: Basic Algebra

1. Groups **(30 Lectures)**

Definition of a group, with examples and simple properties-Groups of Matrices- Direct Product of Groups-Subgroups—Order of a Group-Order of an element of a group- Cyclic groups-Coset decomposition-Lagrange's theorem and its consequences-Normal subgroup and

Quotient groups. Permutation groups-Cycles and transpositions-Even and odd permutations-Alternating groups

2. **Homomorphisms** **(10 lectures)**

   Group Homomorphism-Isomorphism- kernel of a homomorphism-The homomorphism theorems-The isomorphism theorems - Cayley's theorem

3. **Rings** **(20 lectures)**

   Rings and their elementary properties-Integral domain-Field-Field of quotients-Characteristic of a ring-Subrings-Ideals and their properties-Quotient Rings-Homomorphism of Rings-Prime Ideal and Maximal Ideal- Rings of Polynomials.

References:

1. Fraleigh J.B., A First Course in Abstract Algebra
2. Gallian J, Contemporary Abstract Algebra, Narosa, New Delhi
3. Gopalkrishnan N.S., University Algebra
4. Herstein I.N , Topics in Algebra,(2012) John Wiley & Sons., 2ndEdition

Course Title: NUMBER THEORY-I

Course Code: MAT-III.E-2

Marks: 100

Credits: 4

Course Objectives: To learn about basic concepts in number theory that will help the students.

Learning outcome: Students will be able to understand congruence and number theoretic functions.

1. **Divisibility:** **(10 lectures)**

   Division Algorithm, Greatest Common divisor, Eucledian Algorithm, Fundamental Theorem of Arithmetic

2. **Congruence:** **(15 lectures)**

   Basic properties, Linear Congruence, Chinese Remainder Theorem, Quadratic Congruence.

3. **Fermat's Theorem:** **(10 lectures)**

   Fermat's and Wilson's Theorem

4. **Number Theoretic Functions:** **(15 lectures)**

Sum and number of divisors, Mobius function, Mobius Inversion, greatest integer function, Euler's phi function

5. **Diophantine Equations:** **(10 lectures)**

   Linear Diophantine equations ax+by=c, the equation$x^2 + y^2 = z^2$, Fermat's Last Theorem.

References:

1. Adams & Goldstein, Introduction to Number Theory, Prentice Hall
2. Baker Alan, A concise introduction to the Theory of Numbers, Cambridge University Press
3. Burton David, Elementary Number Theory, 2012, Mc Graw Hill, 7th Edition.
4. Niven & Zuckerman, An Introduction to the Theory of Numbers, Wiley Publications.
5. Telang S.G. & Nadkarni M.D, Number Theory

Course Title: Combinatorics

Course Code: MAT-III.E-3

Marks: 100

Credits: 4

Course Pre Requisites: - Basic set theory, Basic Algebra, Concepts of sequences and Series.

Aim: - This paper is introduced to inculcate lateral thinking ability in students, to give them some basic techniques to solve combinatorial problems and make them realize that there may not be readymade solutions to all the problems.

Learning Outcome: - Students will be able to tackle some combinatorial problems and also can analyse given problem to find a way to solve it.

Unit I: - Counting principles **(20Lectures)**

Rules of sum and product, Permutation – Combination, Distributions of distinct/ identical objects, Stirling numbers of 1st and 2nd kind Stirling's formula., Pigeon hole Principle

Unit II: - Generating Functions **(15Lectures)**

Generating functions for combinations, Enumerators for permutations, distribution of distinct objects in to identical cells, Partitions of integers, relations. Exponential generating function

Unit III: - Recurrence Relations **(15Lectures)**

Linear recurrence relations with constant coefficients, Characteristic equation method, Solutions by technique of generating function, recurrence relations with two indices.

Unit IV: - The principle of inclusion and exclusion **(10Lectures)**

The general formula, derangements, Permutations with restrictions on relative positions, the rook polynomials, permutations with forbidden positions.

Text book: - Liu C.L., Introduction to Combinatorial Mathematics, McGraw-Hill Book Company.

References:

1. Berge C, Principles of Combinatorics, Academic Press
2. Brualdi R.A., Introductory Combinatorics, Pearson
3. Chuan-Chong Chen & Khee-Meng Koh, Principles and techniques in Combinatorics, World Scientific Publishing
4. Knuth, Graham, Patashnik, Concrete Mathematics: A Foundation for Computer Science, Addison Wesley
5. Kolman B, Discrete mathematical structures, Pearson Education
6. Liu C.L, Discrete mathematical structures, McGraw-Hill Book Company.
7. Stanley R., Enumerative Combinatorics Volume 1, Springer
8. Tucker Alan, Applied Combinatorics, Wiley Pvt. Ltd.

Course Title: NUMERICAL METHODS

Course Code: MAT-III.E-4

Marks: 100

Credits: 4

Course Objectives: This course covers the basic methods for finding the finite difference, solution of simultaneous equations and the techniques of Numerical Differentiation and Numerical Integration. It also deals with solution of Algebraic and Transcendental equations.

Learning outcome: The student will be able to solve numerically various equations.

Module I: Error Analysis **(7 lectures)**

Approximate numbers, significant figures, rounding off numbers, Error- Absolute, relative and percentage

Module II: Finite Differences **(7 lectures)**

Operators- Δ, ∇ and E (Definitions and some relations among them), finite difference tables, fundamental theorem on differences of a polynomial and examples.

Module III: Interpolation and Extrapolation **(7 lectures)**

Newton Gregory Forward and backward interpolation formulae (with deduction of formulae) and examples (for equal intervals)

For unequal intervals- Lagrange's Formula and Newton's divided difference formula (No proof) and examples

Module IV: Numerical Integration and differentiation (11 lectures)

Trapezoidal rule, Simpson's $1/3^{rd}$ and $3/8^{th}$ rules (with proof) and problems. Weddle's rule (no proof, only problems)

Numerical differentiation and examples

Module V: Numerical Solutions of Equations (7 lectures)

To find a real root of an algebraic or transcendental equation using Bisection method, regular falsi method, Newton Raphson method with geometrical significance and problems and method of iteration

Module VI: Curve fitting (7 lectures)

Method of least squares- fitting a line, second degree polynomial, exponential curve and examples

Module VII: Solution of System of Equations (7 lectures)

Gauss Elimination, Gauss- Seidal Iteration method, Iteration method

Module VIII: Solution of Differential Equations (7 lectures)

Euler's Method, Runge Kutta Method

References:

1. Atkinson K., An Introduction to Numerical Analysis, John Wiley & Sons
2. Chatterji P.N, Numerical Analysis
3. Comte S.D and Carl de Boor, Elementary Numerical analysis - An Algorithmic approach, McGraw Hill
4. Hildebrand F.B, Introduction to Numerical Analysis, McGraw Hill
5. Sastry S.S, Introductory Methods of Numerical Analysis, Prentice Hall India
6. Scarborough J.B, Numerical Mathematical Analysis, Oxford and IBH Publishing Company, New Delhi.

Course Title: LINEAR ALGEBRA

Course Code: MAT-IV.C-6

Marks: 100

Credits: 4

Course Objectives: This course aims to impart emphasis on Vector spaces.

Learning outcome: Students will be familiar with Vector Spaces, linear transformations and inner product spaces

Prerequisites: Basic Algebra

Unit 1: **(15 lectures)**

Vector space [Definition and examples], subspaces, sum and direct sum of subspaces. Linear span, linear dependence, independence and their properties. Finite dimensional vector Space Basis, dimension of a vector space. Dimension of sum of subspaces. Existence of complementary subspace of a finite dimensional vector space. Quotient space and its dimension.

Unit 2: **(15 lectures)**

Linear transformation, Kernel and Range of a Linear Transformation. Matrix representation of linear transformation, composition of linear maps, change of basis, similar matrices, Rank Nullity theorem.

Unit 3: **(15 lectures)**

Eigen values and Eigen vectors of a linear transformation and matrices. Eigen space, Algebraic and Geometric Multiplicity of an eigenvalue. Diagonalisabilty of an n x n matrix over IR

Unit 4: **(15 lectures)**

Inner products spaces. Cauchy- Schwarz inequality, Triangle inequality, orthogonal vectors, orthogonal complement, orthogonal sets and bases, Gram-Schmidt Process

References:

1. Anton H, Elementary Linear Algebra, Wiley Pvt. Ltd.
2. Hoffman K. & Kunze R., Linear Algebra , PHI
3. Kumaresan S., Linear Algebra: A Geometric Approach, PHI
4. Strang G., Linear Algebra and its Applications, Cengage Learning
5. Vasishtha A.R., Linear Algebra, Krishna Prakashan

Course Title: ADVANCED ANALYSIS

Course Code: MAT-IV-E-5

Marks: 100

Credits: 4

Course Objectives: To develop the understanding of point wise and uniform convergence of sequence and series of real valued functions.

To understand Power Series and Fourier Series

Learning outcome: The student will be able to understand series and sequences of real valued functions

Prerequisites: Basic Real Analysis, Mathematical Analysis

Module I: Sequences of Real valued Functions (20 lectures)

Pointwise and uniform convergence and examples, M_n test for uniform convergence and examples, Cauchy's criterion for uniform convergence and examples.

Properties of uniformly convergent sequence of functions: uniform convergence and continuity, uniform convergence and differentiability, uniform convergence and integrability and examples

(i)Weierstrass Approximation Theorem

(ii)C [a, b] is complete, where C [a, b] is a class of continuous functions on C [a, b]

Module II: Series of Real Valued Functions (20 lectures)

Revision of series of real numbers, Alternating Series, Leibnitz test, rearrangement of terms of series, Pointwise and uniform convergence and examples, Cauchy's criterion for uniform convergence, Weierstrass M-test and examples

Properties: (i) uniform convergence and continuity, (ii) uniform convergence and differentiability, (iii) uniform convergence and integrability and examples

Module III: Power Series (20 lectures)

Definition of Power Series and examples. Uniform convergence of Power Series and examples, Theorems on Power series, radius and interval of convergence

Theorem: Power series can be integrated and differentiated in its interval of convergence, examples

Trigonometric functions (sine and cosine), exponential functions and logarithmic functions and their properties.Binomial Series

References:

1. Bartle R.G, Sherberf D.R, Introduction to Real Analysis (Third Edition), Wiley
2. Berberian S.K., A First Course in Real Analysis, Springer
3. Bhatia R., Fourier Series, Hindustan Book Agency
4. Goldberg R.R, Methods of Real Analysis, Oxford and lbh
5. Kumaresan S & Kumar A, A Basic Course in Real Analysis, CRC Press
6. Malik S.C. and Arora, Mathematical Analysis, New Age

7. Pugh C.C., Real Mathematical Analysis,Springer
8. Rudin W., Principles of Mathematical Analysis, Tata McGraw Hill
9. Shanti Narayan, P.K.Mittal, A Course of Mathematical Analysis, S Chand
10. Somasundaram, Mathematical Analysis
11. Stein E.M & Shakarchi R., Fourier Analysis: An Introduction, Princeton University Press

Course Title: ALGEBRA-II

Course Code: MAT-IV.E-6

Marks: 100

Credits: 4

Course Objectives: To introduce to students further concepts of groups and rings in Algebra

Learning outcome: The student will gain additional knowledge of groups and rings

Prerequisites: Basic Algebra, Algebra I

Unit 1

Review of basics of groups, Group actions, orbits and stabilizers, class equation. Cauchy's Theorem, Sylow Theorems, structure theorem for finite abelian groups. (Statement and examples)

Unit 2

Review of basics of rings, Ring of Polynomials, divisibility in a ring, irreducible and prime elements, Eucledian domains, Principle Ideal domains, unique factorisation domains.

Unit 3

Irreducibility of polynomials in one variable with integer/ rational coefficients, Gauss' lemma, Eisenstein's criterion for irreducibility, cyclotonic polynomials, examples

References:

1. M.Artin, Algebra, Pearsons
2. S. Lang, Undergraduate Algebra,
3. J. Stillwell, Elements of Algebra,
4. Fraleigh J.B., A First Course in Abstract Algebra
5. Gallian J, Contemporary Abstract Algebra, Narosa, New Delhi
6. Gopalkrishnan N.S., University Algebra
7. Herstein I.N , Topics in Algebra,(2012) John Wiley & Sons., 2ndEdition

Course Title: Operation Research

Course Code: MAT-IV.E-7

Marks: 100

Credits: 4

Course Objectives: This course aims to teach linear programming

Learning outcome: Students will be able to solve linear programing problems

1. Linear Programming Problem **(5 lectures)**

Definition of standard form, formulation of LPP, convex set and their properties, extreme points. Graphical solution of LPP (Only two variables).

2. Simplex Method: **(25 lectures)**

Theorems related to simplex method .and problems .Cases pertaining to existence of multiple solutions, unbounded and no feasible solution.Big M method and two phase Simplex method

3. Transportation Problems: **(8 lectures)**

Mathematical formulation, condition for existence of feasible solution, rank of transportation matrix, Initial basic feasible solution by (i) NWC method (ii) Matrix-minima and (iii) VAM, Modi's method to find an optimal solution, balanced and unbalanced transportation problems.

4. Assignment Problems: **(7 lectures)**

Mathematical formulation, Hungarian methods to solve assignment problems, balanced & unbalanced assignments problems

5. Game Theory **(15 lectures)**

Optimal Solution of Two-Person Zero-Sum Games, Solution of Mixed Strategy Games, Converting Game theory into LPP

References:

1. Kanti Swarup, Gupta P.K, Man Mohan, Operations research, S Chand
2. Loomba, Linear Programming
3. Taha H, Operation Research, Pearson
4. Vajda, Game Theory

Course Title: Cryptography

Course Code: MAT-IV E-8

Marks: 100

Credits: 4

Course prerequsites: Algebra-1 and Number Theory-1

Course objectives: - To introduce some applications of algebra and number theory to students.

Learning Outcome: -Students will learnsome methods which are used in data storage and transfer.

Unit 1: Review of some topics of Number theory and algebra :- **(12Lectures)**

Divisibility and primes, Prime factorization, Euclidian algorithm, Fermat's little theorem, Congruence and ring of integers.

Groups of compositions, order of permutation, Fields, finite fields, ring of polynomials, factorization of polynomials, to be reviewed.

Unit 2: Classical Cryptosystems. **(8Lectures)**

Affine cryptosystem, Hill cryptosystem, Block Ciphers, Stream Ciphers, Linear feedback shift registers.

Unit 3: Public Key cryptosystem. **(16Lectures)**

One way functions, Trapdoor functions, RSA Public Key cryptosystem, Key exchange protocols, hash functions.

Unit 4: Private Key cryptosystem. **(8Lectures)**

Modern techniques and algorithms like DSE and AES.

Unit 5: Elliptic curve cryptosystem. **(16Lectures)**

Introduction to elliptic curves and its application to factorization and cryptography.

References:

1. N. Koblitz, a course in Number theory and Cryptography, Springer.
2. J Katze & Y Lindell, Introduction to modern cryptography, Springer.
3. C Paar & J Pelze, Understanding Cryptography: A textbook for students and practitioners, Springer.
4. W Trappe, Introduction to Cryptography with coding theory, Pearson.

Course Title: Functions of several variables

Course Code: MAT-V C7

Marks: 100

Credits: 4

Course Pre Requisites: Mathematical Analysis, Co-ordinate geometry.

Aim: - To introduce multivariate calculus, i.e. Continuity, Differentiation and Integration of functions of several variables, applications of differentiation and integration.

Learning outcome: - Students will be well prepared to understand vector valued functions, can visualize lines, curves and surfaces in $\mathbf{R}^3$.

Unit 1 :- **(15 lectures)**

Introduction: -Neighbourhood of a point in $\mathbf{R}^2$(in$\mathbf{R}^n$), Open sets in $\mathbf{R}^2$, Sequence in $\mathbf{R}^2$, limit point of a sequence, Limit of a function, Continuity of a function. Functions from $\mathbf{R}^2$ to **R,**Examples, and graphs in three dimensions.

Unit 2:- **(15 lectures)**

Directional derivatives, Partial Derivatives, their geometrical meaning, MVT, higher order partial derivatives, Equality of mixed partial derivatives, Taylor's theorem, Applications of partial derivatives, Maxima-Minima, Saddle Point, Lagrange multiplier method,

Unit 3:- **(15 lectures)**

Differentiability of functions of two variables, sufficient condition for Differentiability, Total derivative, chain rule, Jacobian. Implicit and Inverse function theorems.

Unit 4:- **(15 lectures)**

Integration. Line integral, fundamental theorem of Calculus, Double integral on rectangles & bounded regions, change of order, change of variables, calculating volumes and surface areas of simple geometrical objects.

References:

- S.R. Ghorpade & B.V. Limaye, A Course in Multivariable Calculus and Analysis, Springer
- S.C. Malik & S. Arora, Mathematical Analysis, Fourth Edition, New Age International
- G.B. Thomas Jr. and R.L. Finney, Calculus and Analytic Geometry, Pearson
- W.H. Fleming, Functions of Several Variables, Springer
- T. Apostol, Calculus Volume II, Wiley India

Course Title: Metric Spaces

Course Code: MAT-V E-9

Marks: 100

Credits: 4

Course Objectives: To introduce different kind of 'Distance' and analysis that follows.

Learning outcome: Students will start to understand abstract nature analysis, also will help them to appreciate Euclidian analysis.

Prerequisites: Basic Real Analysis.

Unit1] Idea of 'Distance', definition, examples of Metric Spaces. Basic terminologies – neighbourhood of a point, open ball, open set, closed set, interior point, exterior point, limit point, isolated point, cluster point, closure of a set, interior of a set, frontier (boundary) of a set, Dense set, nowhere dense set, bounded set, diameter of a set, distance between the sets, distance of a point from a set and Results involving these concepts. **(15 lectures)**

Unit2] Equivalence of metrics, geometry with different metrics, Subspace of a metric space, results on subspaces of metric space, sequences in a metric space, convergence of sequences, Cauchy sequence, concepts of complete metric space, completion of a metric space. **(15 lectures)**

Unit3] Connected subsets of a metric space, Separation of a set, connected components of metric space, Results regarding connectedness of a metric space. **(10 lectures)**

Unit4] Compact metric space, open cover, finite cover, sequential compactness, one point compactification, **(10 lectures)**

Unit5] Functions on metric space. Continuous functions (maps), equivalent definitions, invariance of compactness, completeness, connectedness of continuous images. Open maps-closed maps and their basic properties. **(10 lectures)**

References:-

1. E.T. Copson, Metric Spaces, Cambridge University Press
2. G.F. Simmons, Introduction to Topology and Modern Analysis, Mc Graw Hill
3. S. Shirali and H.L. Vasudeva, Metric Spaces, Springer
4. S. Kumaresan, Topology of Metric Spaces, Narosa

Course Title: Differential Equations-II

Course Code: MAT-V E10

Marks: 100

Credits: 4

Course Objectives: Some more techniques of solving differential equations. Introduction to PDE.

Learning outcome: Students enhance their thinking and problem solving abilities.

Prerequisites: Ordinary Differential equations.

Unit 1: Power Series Solutions of DE

Series solution of first order DE, Series solution of second order Linear DE at ordinary points

Regular singular points, Gauss Hyper geometric equation, Bessel's function

Legendre Polynomials **(20 lectures)**

Unit 2: Laplace Transforms

Definition and examples, Derivatives and integrals of Laplace Transforms

Applications to DE, Convolutions **(15 lectures)**

Unit 3: Systems of first order DE

Homogeneous Linear Systems with Constant coefficients **(10 lectures)**

Unit 4: Boundary value problems, Sturm-Liouville Theorems, linear differential equation of higher order. **(15 lectures)**

References:

- G.F. Simmons, Differential Equations with Application and Historical Notes, Mc Graw Hill.
- W.E. Boyce and R.C Di Prima, Elementary Differential Equations and Boundary value Problems, Ninth Edition, Wiley India
- M. Tenenbaum and H. Pollard, Ordinary Differential Equations, Dover

Course Title: Graph theory

Course Code: MAT-V E-11

Marks: 100

Credits: 4

Course Pre Requisites: Basic set theory, Principle of counting, Principles of Mathematical Induction

Course objective: To introduce the concept of discrete graphs, trees and some of their applications in real world problems.

Unit 1 Graphs (8 Lectures)

The Konigsberg 7 bridges problem and Euler's solution to it.

Definition of graph examples and types of graphs: complete, directed, bipartite, multi graph, etc, degree of a vertex, Adjacency matrix, incidence matrix, operations on graphs: subgraphs, union, intersection and Cartesian product, isomorphisms in graphs, special graphs: self-complimentary graphs, Petersen graphs, Herschel's Graph

Unit 2 Walks paths and cycles (12 Lectures)

Definition of walks, paths and cycle, distance and weighted distance, radius and diameter of a graph, eccentricity of a vertex. Euler walks, Hamiltonian cycles application: travelling salesman problem

Unit 3 Connectivity, cut-points, blocks, connectivity(8 Lectures)

Unit 4 Trees (12 Lectures)

Definition of tree, results on trees, spanning tree, application: minimum spanning trees and Kruskal's algorithm. Breadth First Search Algorithm and its use in the Chinese postman problem. Dijkstra's Algorithm for shortest path.

Unit 5 Coloring (10 Lectures)

Vertex coloring, chromatic number of a graph and simple relation, chromatic polynomial and its properties, edge colorings.

Unit 6 Planarity (10 Lectures)

Representations and crossing number of graphs, Euler's formula, maps and planar graphs. Proof of five color theorem for planar graphs

References:

1. W.D. Wallis, A Beginners Guide to Graph Theory, Birkhauser
2. Robin J. Wilson Introduction to Graph Theory, Longman Group Ltd.
3. J.A. Bondy, U.S.R Murthy, Graph Theory, Springer
4. D.B. West, Introduction to Graph Theory, second edition, Prentice Hall of India.
5. F Harary, Graph Theory, Narosa
6. V.K. Balakrisnan, Graph Theory (Schaum series), Mc Graw Hill India

Course Title: PEDAGOGY OF MATHEMATICS

Course Code: MAT-V E-12

Marks: 100

Credits: 4

Course Objectives: To make the students aware of the different methods used for the teaching of mathematics.

Learning outcome: Students will be able to teach mathematics to school level children better.

Unit 1: Meaning and History of Mathematics **(10 lectures)**

Meaning of Mathematics

Branches of Mathematics

Historical Development of Mathematics

Unit 2: Methodology of Teaching Methods **(40 lectures)**

Inductive - Deductive

Analytic- Synthetic

Heuristic/ Discovery

Project Method

Open Ended Approach

Investigative Approach

Problem Solving

Concept Attainment Model

(With applications in different topics in School level Mathematics syllabus)

Unit 3: Techniques of Teaching **(8 lectures)**

Assignments

Drill work

Remedial teaching

Accelerated teaching

Unit 4: Qualities of a good Mathematics Teacher **(2 lectures)**

References:

1. E.T Bell, Men of Mathematics, Touchstone
2. M. Ediger, Essays on teaching mathematics, Discovery Publishing Pvt.Ltd
3. R.G. Goel, Teaching of Mathematics, Lotus Press
4. A. James., Methods of teaching Mathematics, Neelkamal
5. Kline Morris, Mathematical Thought From Ancient to Modern Times, Oxford University Press
6. S. Krantz, How to teach Mathematics, American Mathematical Society
7. G. Polya, How to Solve It, Penguin UK
8. Sidhu Kulbir Singh., Teaching of Mathematics, Sterling Publishers Pvt. Ltd
9. J. Stillwell, Mathematics and its History, Springer
10. P.P Zubair., Teaching of Mathematics, Aph Publishing

Course Title: Vector Analysis

Course Code: MAT-VI C-8

Marks: 100

Credits: 4

Course Objectives: To introduce students to Vector representations of geometrical objects, analysis done on them and their applications in Physics.

Learning outcome: Students are introduced to one more representation of geometrical objects and extensions of the fundamental theorem of integral calculus.

Prerequisites: functions of several variables.

Unit 1: Revision of vectors :- Basic concept such as dot product, cross product, scalar triple product, vector triple product, geometrical understanding of all algebraic operations, orthogonal vectors, vector equations of geometrical objects, **(10 lectures)**

Unit 2: Vector valued functions (vector fields), scalar valued functions (scalar fields), concepts of 'curves', 'plane', 'surface' in $\mathbf{R}^3$ Idea of continuous, smooth and regular objects in $\mathbf{R}^3$, Gradient, Divergence and Curl of these functions, Physical interpretations. Irrotational and solenoidal vector fields. **(20 lectures)**

Unit 3: Line integral, surface integral and volume integral, (arc length, surface area, and volume of simple objects), Green's theorem, Stokes theorem, Gauss Theorem and Green's formulas. **(20 lectures)**

Unit 4: Theory of Curves in $\mathbf{R}^3$, Unit speed curve, Tangent, Normal, Bi-normal, Curvature, Torsion, Ferret-Serrate formulae, evolutes and involutes. (**10 lectures)**

References:

1 .H.F. Davis and A.D. Snider, Introduction to Vector Analysis, Sixth Edition, Allyn& Bacon

2. J.E. Marsden and A. Tromba, Vector Calculus, Sixth Edition, W.H. Freeman Publishers

3. E. Kreysig, Advanced Engineering Mathematics, Tenth Edition, Wiley Inida

4. M. Spiegel, Vector Analysis: Schaum's Outline Series, Mc Graw Hill

Course Title: COMPLEX ANALYSIS

Course Code: MAT-VI E-13

Marks: 100

Credits: 4

Course Objectives: Introduce students to complex numbers, complex functions and complex differentiation and integration.

Learning outcome: The student will know about complex numbers and complex functions.

Prerequisites: Basic Real Analysis, Mathematical Analysis, Functions of several Variables

Unit 1: Complex Numbers

Algebraic properties of complex numbers, modulus, Argand diagram, exponential form and polar coordinates, triangle inequality and metric properties, connectedness of regions. **(10 lectures)**

Unit 2: Analytic Functions

Complex valued functions on complex domain, limits and continuity of complex valued function on a complex domain, differentiability and analytic functions, algebra of analytic functions, Cauchy-Riemann equations, sufficient condition for analyticity, Harmonic Functions. **(10 lectures)**

Unit 3: Elementary Functions

Exponential, logarithmic function and its branches, trigonometric functions, hyperbolic functions, complex exponents and roots. **(10 lectures)**

Unit 4: Contour Integration

Contours and contour integrals, Cauchy Goursat's theorem, Simply connected domains, Cauchy's integral formula, higher derivatives of analytic functions, Liouville's theorem, fundamental theorem of algebra, maximum modulus principle. **(10 lectures)**

Unit 5: Series

Convergence of series, Taylor series, Laurent series. **(10 lectures)**

Unit 6: Residue Theory

Singularities of a function, poles and essential singularities, residues at a singular point and its computation, Cauchy residue theorem **(10 lectures)**

References:

1. R.V. Churchill and J.W. Brown, Complex variables and Applications, Eight Edition, Mc Graw Hill
2. L. V. Ahlfors, Complex Analysis, Mc Graw Hill
3. A.R. Shastri, Complex Analysis, Laxmi Publications
4. M. Spiegel and S. Lipschutz, Complex Variable: Schaum's Outline Series, Mc Graw Hill
5. J.B. Conway, Functions of a Complex Variable, Narosa
6. S. Ponnusamy, Complex Analysis, Narosa

7. S. Ponnusamy and H. Silverman , Complex variables with Applications, Birkhauser
8. T.W. Gamelin, Complex Analysis, Springer
9. E.M. Stein and R. Shakarchi, Complex Analysis, Princeton Lectures in Analysis

CourseTitle: NUMBER THEORY-II

Course Code: MAT-VI E-14

Marks: 100

Credits: 4

Course Objectives: To learn about Primitive Roots, Quadratic reciprocity and Fibonacci numbers

Learning outcome:The student will gain knowledge about different concepts in number theory.

Prerequisites: Number Theory I

Unit 1: Primitive Roots and Indices: - **(15 lectures)**

Review of congruence, Chinese remainder theorem Euler phi theorem and Euler theorem. The order of an integer modulo n, Characterization of positive integers n for which primitive roots mod-n exist, The theory of Indices.(Structure of the group of units of Z/nZ as a product of cyclic groups.)

Unit 2: The Quadratic Reciprocity Law **(15 lectures)**

Euler's criterion, Legendre Symbol and its Properties, Quadratic Reciprocity, Quadratic Congruences with Composite moduli

Unit 3: Representations of numbers as sums of squares. **(15 lectures)**

Fermat's two squares theorem, Lagrange's four squares theorem, and statement of Warings problem.

Unit 4: Continued Fractions **(15 lectures)**

Finite Continued fractions, Infinite continued fractions, Dirichlet's theorem on approximation of a real number by a rational number, Liouville's theorem.

References:

1. D. Burton, Elementary Number Theory, Seventh Edition, Mc Graw Hill
2. Baker, A Concise Introduction to the Theory of Numbers, Cambridge University Press

3. Niven, H.S. Zuckerman and H.L. Montgomery, An Introduction to the Theory of Numbers, Fifth Edition, Wiley India
4. W.W. Adams and L.J. Goldstein, introduction to Number Theory, Prentice Hall
5. S.G. Telang and M.D. Nadkarni, Number Theory

Course Title: Theory of Probability

Course Code: MAT-VI E-15

Marks: 100

Credits: 4

Course Objectives: To understand how mathematical tools are applied to develop tools in Statistics and learn to use those tools.

Learning outcome: Application of Combinatorics

Prerequisites: Statistical methods.

Unit 1 Revision of Probability theory, Set theory. **(5 lectures)**

Unit 2: Probability as a function from super set of a non-empty set to the interval [0, 1]. Axioms of Probability.

Probability distributions, Discrete and continuous distributions, Probability Mass function, density function, Distribution function, Central tendencies, Expected values, Variance, Standard Deviation, Moments, Moment generating function, characteristic function, conditional expectations and distribution, random vectors and joint probability distributions, functions of random vectors, change of variable. **(20 lectures)**

Unit 3: Uniform, binomial, Poisons, Geometric, Hyper-geometric, Normal, Chi-square, beta, gamma, Students t, F, distributions, their distribution functions, graphs, statistic, relations. **(25 lectures)**

Unit 4: Modes of convergence, Weak and Strong laws of large numbers, Central limit theorem **(10 lectures)**

References:

1. P. Billingsley, Probability and measure, 2nd edition, John Willy &sons (SEA) Pvt. Ltd. 1995
2. P.G. Hoel, S.C. Port & C.J. Stone, Introduction to Probability, Universal Book Stall, New Delhi, 1998.
3. J.S. Rosenthal, A first look at Rigorous Probability Theory, World Scientific, 2000.

4. M. Woodroofe, Probability with applications, McGraw-Hill Kogakusha Ltd. Tokyo, 1975.

Course Title: Computers for Mathematics

Course Code: MAT-VI E-16

Marks: 100

Credits: 4

Course prerequsites: Basic knowledge of computers, a basic course in ODE, Numerical analysis. Familiarity with computer programming will be helpful but not compulsory.

Course objectives: - To train students to use computers for mathematical typing, computing and plotting. Helping them understand theory using computational methods.

Learning Outcome: -Students will be able to use these free packages for writing and drawing mathematical papers. Also can understand some basic aspects of programming.

Unit 1.Introduction to LaTeX **(15 Lectures)**

Mathematical typing in MS Word 07/13

Short comings of Word, need of some other package of writing.

Document Editing using LaTeX: - Text formatting, Paragraph formatting

Fonts and colours, special characters, Tables, Page layout, importing graphics, footnotes, referencing

Beamer Presentations

Unit 2.Mathematical typesetting in LaTeX **(10Lectures)**

Mathematical environments and packages

Symbols, Greek letters and operators, Powers and indices, fractions, Roots, Sums, integrals and derivatives, Brackets, Matrices

Unit 3. **Python** Some basics of programming, algorithms, flowcharts, syntax, do s and don't s, Python programming. **(15 lectures)**

Unit 4. Scilab/ Matlab **(5Lectures)**

Introduction to Scilab, familiarizing with the Scilab, Scilab syntax, Variables, functions, plotting graphs

Unit 5. Geogebra **(3 lectures)**

Unit 6. Numerical methods using Scilab/ Python **(12Lectures)**

Finding roots of algebraic and transcendental equations, Interpolation, Numerical integration and differentiation, fitting of data, Numerical ODE, Solutions of simultaneous equations

References:

1. M.Alley, the Craft of Scientific Presentations, Springer (2003).
2. W.C. Booth, G.G. Colomb, and J.M. Williams, The Craft of Research (Chicago Guides to Writing, Editing, and Publishing) Univ. of Chicago Press, 2008.
3. George Graetzer, Math into LaTex, An introduction to LaTex and AMS-LaTex, Birkhauser, 1996.
4. Donald E. Knuth; Tracy E Larrabee, Paul M. Roberts: Mathematical writing, Mathematical Association of America, 1989.
5. S. Krantz: A Primer of Mathematical Writing: Being a Disquisition on Having Your Ideas Recorded, Typeset, Published, Read & Appreciated, American Mathematical Society, 1996.
6. S. Krantz: How to Teach Mathematics, American Mathematical Society, 1999.
7. Leslie Lamport: LaTex, a document preparing system, Addison-Wesley, 1994.
8. Jr. Strunk, William; E. B. White, The Elements of Style, Fourth Edition, Longman; 4th edition (1999).

Course Title: COMPUTATIONAL LINEAR ALGEBRA

Course Code: MAT-IV E-17

Max Marks: 100

Credits: 4

Course Objectives: To learn about the different computational techniques in linear algebra

Learning Outcome: The student will be able to apply the techniques learnt to solve various problems in linear algebra.

Unit 1:Review of Gaussian Elimination (8 lectures)

Unit 2: Orthogonality (10 lectures)

Orthogonal vectors and subspaces, projections and least squares, QR Factorizations

Unit 3: Positive Definite Matrices (20lectures)

Maxima, minima and saddle points, test for positive definiteness, singular value decompositions, Lagrange multipliers and Rayleigh quotients, finite element method

Unit 4: Matrix norm and Condition Number (22 lectures)

References:

1. G. Strang, Linear Algebra and its Applications

PHYSICS

Annexure I

Core Compulsory Papers for Major in Physics (CC)

Sr. No	Semester	Title of the Paper	Code
1	I	Introduction to Mathematical Physics	PHY-I.C-1
2	I	Mechanics-I	PHY-I.C-2
3	II	Heat and Thermodynamics	PHY-II.C-3
4	II	Electricity and Magnetism	PHY-II.C-4
5	III	Electromagnetic Theory-I	PHY-III.C-5
6	IV	Optics	PHY-IV.C-6
7	V	Electromagnetic Theory-II	PHY-V.C-7
8	VI	Atomic and Molecular Physics	PHY-VI.C-8

Core Elective Papers for Major in Physics (CE)

Sr. No	Semester	Title of the Paper	Code
1	III	Electronics-I (CCE)	PHY-III.CE-1
2	III	Astronomy and Astrophysics	PHY-III.CE-2
3	III	Modern Physics	PHY-III.CE-3
4	III	Solid State Devices	PHY-III.CE-4
5	IV	Oscillations, Waves and Sound (CCE)	PHY-IV.CE-5
6	IV	Properties of Matter and Acoustics	PHY-IV.CE-6
7	IV	Computational Physics	PHY-IV.CE-7

8	IV	Mechanics II	PHY-IV.CE-8
9	V	Quantum Mechanics (CCE)	PHY-V.CE-9
10	V	Statistical Physics	PHY-V.CE-10
11	V	Electronics-II	PHY-V.CE-11
12	V	Introduction to Nanoscience	PHY-V.CE-12
13	VI	Solid State Physics (CCE)	PHY-VI.CE-13
14	VI	Nuclear and Elementary Particle Physics	PHY-VI.CE-14
15	VI	Introduction to Special Theory of Relativity	PHY-VI.CE-15
16	VI	Introduction to Physical Oceanography	PHY-VI.CE-16

Note:

CCE- Core compulsory Electives

These are compulsory electives which a students must offer while selecting Elective course in respective semester.

Core Compulsory Papers for Minor in Physics (CM)

Sr. No.	Semester	Title of the Paper	Code
1	I	Mechanics, Properties of Matter and Sound	PHY-I.CM-1
2	II	Electricity, Magnetism and Electronics	PHY-II.CM-2
3	III	Elementary Modern Physics	PHY-III.CM-3
4	IV	Heat and Optics	PHY-IV.CM-4
5	V	Material Science	PHY-V.CM-5
6	VI	Atomic and Nuclear Physics	PHY-VI.CM-6

Interdisciplinary papers:

Sr. No.	Title of the Paper
1	History and Philosophy of Science
2	Technological Evolution through Physics
3	Energy Studies

Annexure II

Parvatibai Chowgule College of Arts and Science (Autonomous)

Margao, Goa

Syllabus for

Semester I and Semester II

for the undergraduate course

in

Physics

(2015-2016)

Core Compulsory papers for Major in Physics

Semester 1:

1. Introduction to Mathematical Physics
2. Mechanics-I

Semester II:

1. Heat and Thermodynamics
2. Electricity and Magnetism

Paper Title : Introduction to Mathematical Physics

Paper Code : PHY-I.C-1

Name of Faculty: Ashish Desai

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Course Objectives: To develop basic competence in certain areas of mathematics required for understanding several important topics in physics.

Learning outcome: After successful completion of this course, student will comprehend some of the important mathematical concepts and should be able to use these methods to solve several problems in Physics.

Theory:

1. **Vector Analysis** **[6]**
   Scalars and vectors, Basis vectors and components, Multiplication of Vectors. Equation of lines and planes. Using vectors to find distances. Reciprocal vectors. Differentiation and Integration of vectors.

   [Riley 6.1, 6.3-6.9, 8.1, 8.2]

2. **Infinite Series and Power Series** **[6]**
   Geometric Series and other infinite series. Convergent and Divergent Series. Testing series for convergence. Power series. Expanding functions in power series. Techniques for obtaining power series expansion.

   [Boas 1.1-1.6, 1.10-1.13]

3. **Complex Numbers** **[6]**
   Real and imaginary Parts of a complex number. Complex plane. Complex algebra. Euler's formula. Powers and roots of complex numbers. Exponential and trigonometric functions.

   [Boas 2.1-2.5, 2.9-2.11]

4. **Matrices** **[6]**
   Matrix Analysis and Notation, Matrix Operations, Properties of matrices. Transpose matrix. Complex Conjugate Matrix, Hermitian Matrix, Unit matrix, Diagonal matrix,

Adjoint and self-adjoint matrix, symmetric matrix, anti-symmetric matrix, unitary matrix, orthogonal matrix, trace of a matrix, inverse matrix.

[Harper 2.3, 2.4, 2.5 and 2.6]

5. **Partial Differentiation** **[7]**
   Definition of the partial derivative. Total differentials. Exact and inexact differentials. Theorems of partial differentiation. Chain rule. Thermodynamic relations. Differentiation of Integrals.

   [Riley 4.1-4.5, 4.10-4.11]

6. **Ordinary Differential Equation** **[8]**
   Introduction. Linear differential equation of the first order. Homogenous and inhomogeneous linear differential equation of the second order.

   [Boas 8.1-8.6 and Harper 5.1-5.2]

7. **Coordinate Systems** **[6]**
   Plane polar coordinates. Cylindrical and Spherical polar coordinates.

   [Harper 1.6.6, Riley 8.9]

Experiments: (Minimum Six)

1. Least count of Instruments (Vernier Caliper, Screw Gauge, Travelling Microscope and Spectrometer).
2. Error Analysis
3. Application of Error Analysis
4. Plotting of various algebraic and trigonometric functions using Excel.
5. Fitting of given data using Excel.
6. Interpretation of graphs.
7. Solving Integration, Ordinary Differential Equation and Matrices using Mathematica.
8. Tutorial
9. Tutorial

References:

1. K. F. Riley, M. P. Hobson and S. J. Bence, *Mathematical Methods for Physics and Engineering* (Cambridge University Press, 1998)
2. Mary L. Boas, *Mathematical Methods in Physical Sciences* (John Wiley and Sons, 3rd Edition)
3. Charlie Harper, *Introduction to Mathematical Physics*- (Prentice Hall)

Additional References:

1. B. D. Gupta, *Mathematical Physics* (Vikas Publishing House, 2004)

2. M. Spiegel, S. Lipschutz, D. Spellman, *Schaum's Outline of Vector Analysis*, (McGraw Hill Education, 2009)

Paper Title : **Mechanics I**

Paper Code : **PHY-II.C-2**

Name of Faculty : **Malati Dessai**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Course Objectives: This course provides an introduction to topics in mechanics, which are essential for advanced work in physics. An objective of this course is to train students to think about some of the physical phenomenon in mathematical terms.

Learning outcome: After successful completion of this course, Students will develop qualitative and quantitative understanding of Newtonian mechanics in one and two dimensions, its conservation laws, Gravitation fields and potentials and their applications to basic physical problems familiar from the everyday world.

Theory:

1. **Newton's Laws of Motion** **[10]**
   Brief description of classical view of Space and Time (vector operations). The concept of Mass and Force. Newton's First and Second Laws; Inertial frames. Equations of motion. Interpretation of Newtons third Law as Conservation of Momentum. Newton's Second Law in Cartesian coordinates and in two dimensional Polar coordinates. Applications of Newtons Laws: Atwood Machine, Free fall near surface of the earth, simple harmonic motion and time dependent force.

   [Taylor 1.1-1.7, Kleppner 2.4]

2. **Projectiles and Charged Particles** **[10]**
   Motion of projectile in air resistance/drag (function of velocity.) Linear Air Resistance. Horizontal and vertical motion with linear drag, Trajectory and Range in a Linear Medium. Quadratic Air Resistance. Horizontal motion with quadratic drag (ignoring gravity), Motion of a charged particle with a velocity perpendicular to the direction of a uniform constant (1) electric field, (2) magnetic field and (3) electric and magnetic field (crossed) in mutually perpendicular directions. Lorentz force.

   [Taylor 2.1 - 2.7, Symon 3.17]

3. **Momentum and Angular Momentum** **[7]**

Principle of conservation of momentum (Elastic and Inelastic collision), Analysis of Rocket motion. The Centre of Mass, Angular Momentum for a Single Particle. Kepler's second law as a consequence of conservation of angular momentum.

[Taylor 3.1-3.5]

4. **Work and Energy** **[10]**

Kinetic Energy and Work: Work energy theorem. Potential Energy and Conservative Forces. Force as a Gradient of Potential Energy, Time dependent potential energy (one dimension). Energy for Linear One-Dimensional Systems. Curvilinear one-dimensional systems. Energy of interaction of two particles in one dimension.

[Taylor 4.1-4.3, 4.5-4.7, 4.9]

5. **Gravitation Field and potentials** **[8]**

Newton's Law of Gravitation. Gravitational field. Gravitational potential energy. Equipotential surface. Gravitational potential and field due to a (1) thin spherical shell, (2) uniform hollow sphere and (3) thin circular plate.

[Brijlal 5.5-5.8, 5.10, 5.11]

Experiments: (Minimum Six)

1. Dimensions of different solid body
2. Moment of Inertia of a flywheel
3. Atwood Machine
4. Verification of Newton's Second Law using Air Track
5. Conservation of linear momentum using Air Track
6. Spring Mass System: Determining the Spring Constant
7. Simple Pendulum
8. Log Decrement
9. Determining "**g**" using time of flight method using Python

References:

1. John Taylor, *Classical Mechanics*, (University Science Books, 2004)
2. Kleppner and Kolenkow, *Introduction to Mechanics*,(Cambridge University Press, 2013)
3. K. R. Symon, *Mechanics* (Addison Wesley, 1971)
4. Brij Lal and N. Subrahmanyam, *Mechanics and Electrodynamics*, (S. Chand and Company LTD , 2005)

Additional References:

1. Kittle and Knight, Mechanics (Berkeley Physics Course, Vol. 1), (McGraw Hill Education, 2011)
2. D. S. Mathur, *Mechanics* (S. Chand & Co., 2005)
3. R. G. Takawale and P. S. Puranik, *Introduction to Classical Mechanics*, (Tata McGraw-Hill, 1997)
4. Javier E. Hasbun, *Classical Mechanics* (Jones and Bartlett India Pvt. Ltd. 2010)
5. Atam Arya, *Introduction to Newtonian Mechanics*, (Addison-Wesley, 1997))
6. R. G. Takawale and P. S. Puranik, *Introduction to Classical Mechanics* (Tata McGraw-Hill, 1997)
7. Javier E. Hasbun, *Classical Mechanics* (Jones and Bartlett India Pvt. Ltd. 2010)

Paper Title : **Heat and Thermodynamics**

Paper Code : **PHY-II.C-3**

Name of Faculty : **Yatin P. Desai**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Course Objectives : To acquaint students with fundamental concepts of Thermal Physics and explain the usefulness of these concepts for wide range of applications that include heat engines, refrigerators and air conditioners.

Learning outcome : At the end of this course students would understand the movement of heat (energy) and how energy instills movement. More precisely students would be able to relate the effects of changes in temperature, pressure and volume on physical systems at macroscopic scale by analyzing collective motion of their particles.

Theory:

1. **Principle of Thermometry [5]**
   Review of concept of heat and temperature, Thermometry, Types of thermometers, Centrigrade, Fahrenheit, Rankine Scales and relations between them, Platinum resistance thermometer, Thermocouple (thermoelectric) thermometers.

   [Ref. No. 1: 13.1 – 13.5, 13.15, 13.23]

2. **Laws of Thermodynamics [14]**
   Thermodynamic system, Thermodynamic variables, Thermodynamic equilibrium, and Thermodynamic processes, Zeroth law of thermodynamics, Concept of work and internal energy, First law of thermodynamics, Isothermal and adiabatic changes, Work done in isothermal and adiabatic changes, Relation between pressure, volume and temperature in adiabatic process, Reversible and irreversible processes, Carnot Heat engine, Carnot cycle for perfect gas, efficiency, Second law of thermodynamics (Kelvin – Planck Statement, Clausius Statement)

   [Ref. No. 1: 4.1, 4.4 – 4.7, 4.10.4, 4.11 - 4.13, 4.20 – 4.24, 4.28]

3. **Equations of State [6]**
   Equation of state, Andrew's experiment, Amagat's experiment, Van der Waal's equation of State, Critical constants, Reduced equation of state, Boyle temperature.

   [Ref. No. 2: 10.1 -10.6], [Ref. No. 1: 2.6, 2.14]

4. **Applications of First and Second Law of Thermodynamics [14]**
   Otto cycle and Otto engine, Diesel cycle and Diesel engine, Efficiencies, Introduction to refrigeration, Principle and coefficient of performance, Principle of air conditioning, comfort chart A.C. machine, factors affecting size and capacity of A.C. machines.

   [Ref. No. 2: 4.16 – 4.19], [Ref. No. 1: 4.26, 4.27, Chapter 17]

5. **Concept of Entropy [6]**
   Changes of entropy during reversible and irreversible process, Temperature – Entropy diagram, Temperature – Entropy diagram of Carnot's cycle, Physical significance of Entropy, Entropy of a perfect gas, Principle of increase of entropy, Third Law of Thermodynamics.

   [Ref. No. 2: 6.9, 6.12], [Ref. No. 1: 5.1 – 5.8]

Experiments: (Minimum Six)

1. Latent heat of ice
2. Calibration of Si diode as a thermometer.
3. Constant volume air thermometer.
4. Constant pressure air thermometer.
5. Thermal conductivity by Lee's method.
6. Thermal conductivity of copper.
7. Temperature coefficient of resistance of copper.
8. Temperature coefficient of resistance of Platinum thermometer using PT-100.

References:

1. Brijlal, Subramanyam N., Hemne P.S., Heat Thermodynamics and Statistical Physics, S. Chand (2007)
2. Saha M.N., Shrivastava B.N., Treatise on Heat, The Indian Press 5th Ed. (1965)

Additional References:

1. Roberts J. K., Miller A.R., Thermodynamics, E.L.B.S. (1960)
2. Zemansky M.W., Ditman R.H., Heat and Thermodynamics, McGraw Hill, 8th Ed. (5th reprint), 2013

Paper Title : **Electricity and Magnetism**

Paper Code : **PHY-II.C-4**

Name of Faculty : **Ananya Das**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Course Objectives : The objective of this course is to introduce fundamentals of electricity and magnetism to the students, which is an essential preparation for more advanced courses like Electromagnetic theory.

Learning Outcome : On successful completion of this course, the students will be able to:

- Comprehend basic concepts like: laws of electrostatics and magnetostatics and also related applications.
- Understand the interrelated concepts of Electricity and Magnetism.
- Understand the working of transient circuits and alternating current circuits.
- Correlate the theoretical basis of various concepts of electricity and magnetism while performing experiments.

Theory:

1: Electrostatics **[8L]**

Coulomb's law: Statement, Vector form of Coulomb's law for like and unlike charges,

Variation of force with distance (F.vs.r graph),

Concept of electric field and Electric Field Lines:

Electric field, Electric field due to (i) a Point Charge, (ii) an Electric Dipole, (iii) a Line of Charge and a Charged Disk,

Concept of electric flux: Gauss' Law of electrostatics (Conceptual explanation),

Applications of Gauss law: Coulomb's Law from Gauss' Law, Electric Field due to (i) an isolated uniformly charged sphere, (ii) an uniform distribution of charge throughout the sphere and (iii) an uniformly charged hollow cylinder,

Electric Field near (i) a charged infinite cylindrical conductor or a cable and (ii) a plane of sheet charge

Concept of Electric Potential: Electric Potential Energy, Equipotential Surfaces,

Calculating the Potential from the Field

Potential due to (i) a Point Charge, (ii) a Group of Point Charges and (iii) an Electric Dipole

Calculating the Field from the Potential

[Ref. No.1: 22.4, 23.2-23.7, 24.1-24.5, 25.1-25.7, 25.9] [Ref. No.2: 2.4(1-6)]

2 : Capacitors and Dielectrics **[5L]**

Capacitance: Calculation of capacitance of (i) a Parallel-Plate Capacitor, (ii) a Cylindrical Capacitor and (iii) a Spherical Capacitor; Energy stored in an electric field,

Capacitor with a Dielectric, Dielectrics: An Atomic View, Dielectrics and Gauss' Law,

Relation between three electric vectors (E, D and P)(Without derivation, qualitative discussion only)

[Ref. No.1: 26.1- 26.3, 26.5-26.8]

3 : Magnetostatics **[7L]**

Concept of magnetic field: Definition and properties of magnetic field

Biot–Savart's law and its applications: (i) a long straight wire and (ii) a current carrying circular loop (for a point on the axis only)

Ampere's circuital law and its applications: (i) Field of solenoid and (ii) Field of toroidal solenoid

Magnetic Field lines and Magnetic flux; Gauss' law for magnetism

[Ref. No.1: 29.1, 29.2, 30.1, 30.3, 30.4, 32.2][Ref. No.3:27.2, 27.3]

4: Self and Mutual Inductance **[6L]**

Self induction; Calculation of self inductance of (i) a long solenoid, (ii) long parallel wires and (iii) a coaxial cable

Mutual inductance, Coefficient of coupling; Calculation of mutual inductance between two coaxial solenoids, Mutual inductance of two coils in series

Energy stored in a magnetic field and Energy density of a magnetic field

[Ref. No.4: 5.1, 5.2, 5.8, 5.9] [Ref. No.1:31.8, 31.10, 31.11, 31.12]

5 : Magnetic Properties of Material **[4L]**

Magnetic Materials, Bohr magneton.

Magnetisation (M), Magnetic Intensity (H) and magnetic induction (B)

Magnetisation, Susceptibility and Magnetic permeability

Relation between B, M and H (without derivation, qualitative discussion only)

. Diamagnetic, paramagnetic and ferromagnetic. Explanation with the help of

susceptibility and permeability, Hysteresis

[Ref. No.3:28.8]

6 : Transient Circuits **[6L]**

Transient currents

Growth and Decay of current in an inductive (L-R) circuit, Physical meaning of time

constant

Charging and Discharging of a capacitor through resistor in C-R circuit, Physical

meaning of time constant

Charging and Discharging of a capacitor through resistor and inductor in L-C-R circuit:

Over damped, Critically damped and Under damped conditions of L-C-R circuit

[Ref. No.4:5.3, 5.4, 5.13, 5.14]

7: Alternating Current Circuits **[9L]**

Inductive and Capacitive reactance, Variation of inductive reactance and capacitance reactances with frequency

Introduction to vector or phasor diagrams method and its application to A.C. circuits(Series L-R, Series C-R, Series L-C-R and Parallel L-C-R)

Introduction to j-operator method and its application to A.C. circuits(Series L-C-R and Parallel L-C-R)

Physical significance of Series resonance, Parallel resonance, Quality factor and Bandwidth, Graphical representation of resonance

A.C. bridges: Maxwell’s inductive bridge, Maxwell's L/C bridge, de Sauty's capacitance bridge, Wien's frequency bridge.

[Ref. No.2:22.3, 22.4, 22.6, 22.7, 22.8, 22.9, 22.10, 22.13, 22.14]

[Ref. No.2: 22.19, 22.20, 22.21(b), 22.22]

[Ref. No.4:6.5, 6.6, 6.7(c), 6.9, 6.14, 6.20, 6.21, 6.22, 6.24]

Experiments: (Minimum Six)

1.Measurement of Dielectric constant of a liquid using two co-axial metal tubes.
2. Susceptibility measurement of a parallel plate capacitor in a dielectric medium
3. Step Response of RC circuit
4 .Transient response of L-C-R circuit using square wave generator and C.R.O.
5. Response of LR and CR circuits to A.C. - phasor diagrams
6. LCR Series and parallel resonance –Resonant frequency, Q value and Bandwidth
7. Determination of Mutual Inductance using LCR series resonance
8. de Sauty's bridge / Maxwells L/C bridge

References:

1. Halliday David, Resnik Robert and Walker Jearl, Fundamentals of Physics, John Wiley & Sons, Inc., 6th Edition (2003)
2. Vasudeva D. N., Fundamentals of Magnetism and Electricity, S. Chand & Company Ltd., 12th Revised Edition (1999)
3. Young Hugh D., Freedman Roger A. and Ford A. Lewis, Sears and Zemansky's University Physics with Modern Physics, Addison-Wesley Publishers, 13th Edition(PDF) (2012)
4. Fewkes J. H. and Yarwood John, Electricity, Magnetism and Atomic Physics, Volume I, Oxford University Press Ltd., 10th Impression (1991)

Additional References:

1. Purcell Edward M., Electricity and Magnetism-Berkeley Physics Course,Volume 2, McGraw-Hill Book Company (PDF)

Core Compulsory papers for Minor in Physics

Semester I:

1. Mechanics, Sound and Properties of Matter

Semester II:

2. Electricity, Magnetism and Electronics

Paper Title : Mechanics, Sound and Properties of Matter

Paper Code : PHY-I.CM-1

Name of Faculty: Malati Dessai and Ashish Desai

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Course Objectives: This course provides an introduction to topics in mechanics, sound and properties of matter. An objective of this course is to build up an understanding of fundamental physical principles which are required for most of other physical sciences.

Learning outcome: After successful completion of this course,

- Students will gain an introductory knowledge of Newtonian mechanics, its conservation laws and its applications to basic physical problems.
- They will have knowledge of waves, sound and ultrasonic waves and its application.
- Students will be able to comprehend the phenomenon of elasticity, surface tension, viscosity and their application.

1. **Elements of Newtonian Mechanics** **[5]**
   Newton's Laws of motion, equation of motion. Elementary problems in mechanics: Atwood machine and motion along a rough inclined plane and free fall.

   [Symon 1.4, 1.7]

2. **Motion of a particle in one dimension** **[10]**
   Momentum and energy conservation theorems. Discussion of the general problem of one dimensional motion. Applied force depending on time. Motion under damping force depending on velocity. Conservative force depending on position. Brief review of simple harmonic motion and potential energy curve. Body falling under gravity in a resistive medium proportional to velocity.
   [Symon 2.1 - 2.7]

3. **Gravitation Field and potentials:** **[6]**
   Newton's Law of Gravitation. Gravitation field and Gravitation potential energy, Gravitational potential and field due to a thin spherical shell.

   [Brij Lal 5.5-5.8]

4. **Sound** **[10]**

   Transverse vibrations in strings.Velocity of longitudinal waves in gases. Newton's formula for velocity of sound. Velocity in a homogeneous medium. Laplace’s correction. Kundt's tube-determination of velocity of sound in a gas and in solids. Intensity level and Bel and Decibel. Doppler Effect. Source and listener in relative motion (Normal incidence only). Production and detection of Ultrasonic waves and its applications.

   [Khanna 4.2, 5.3-5.5, 11.1, 11.3, 12.1-12.4, 19.6 and Subra. 11.23 11.25,11.27]

5. **Elasticity** **[8]**

   Modulii of elasticity, Poisson's ratio and relationship between them. Bending of beams-bending moment, flexural rigidity. Cantilever (rectangular bar). Depression of a beam supported at the ends and loaded at the center. A vibrating cantilever. Torsion in a string-couple per unit twist, Torsional Pendulum.

   [Mathur 8.8, 8.9, 8.12 -8.18, 8.22, 8.26, 8.29, 8.30]

6. **Surface Tension** **[3]**

   Brief review of molecular theory of surface tension. Relation between surface tension and surface energy. Angle of contact. Capillarity-rise of liquid in a capillary tube.

   [Mathur 14.1-14.4, 14.6, 14.14, 14.15 and 14.17]

7. **Viscosity** **[3]**

   Streamline flow, Turbulent flow, Critical velocity, Coefficient of viscosity, Poiseuille's formula for flow of liquid through a capillary tube.

   [Mathur 12.1, 12.2, 12.7, 12.11]

List of Experiments: (Minimum Six: Three from each section)

I. **Mechanics and Sound**

1. Dimensions of different solid body
2. Moment of Inertia of a flywheel
3. Spring Mass System: Determining the Spring Constant
4. Velocity of sound by Helmholtz Resonator

II. Properties of Matter

1. Young’s Modulus by Vibration
2. Young’s Modulus by Bending
3. Surface Tension by rise of a liquid in a capillary tube.
4. Coefficient of Viscosity by Poiseuille’s Method.

eferences:

1. K. R. Symon, *Mechanics (*Addison Wesley, 1971)
2. Brij Lal and N. Subrahmanyam, *Mechanics and Electrodynamics*, (S. Chand and Company LTD , 2005)
3. D. R. Khanna and R. S. Bedi ,*A Textbook of Sound* (Atma Ram and Sons, 1992)
4. N. Subrahmanyam and Brijlal, *Waves and Oscillation* (Vikas Publishing House 1994)
5. D. S. Mathur, *Elements of Properties of Matter* (S.Chand & Co. 2005)

Additional References:

1. John Taylor, Classical Mechanics (University Science Books, 2004)
2. Atam Arya, *Introduction to Newtonian Mechanics*, (Addison-Wesley, 1997)
3. Kittle and Knight, Mechanics (Berkeley Physics Course, Vol. 1), (McGraw Hill Education, 2011)
4. R. G. Takawale and P. S. Puranik, *Introduction to Classical Mechanics*, (Tata McGraw-Hill, 1997)
5. R. Murugeshan and Er. Kiruthiga Sivaprasath, *Properties of Matter and Acoustics* (S. Chand & Co., 2011)

Paper Title : Electricity, Magnetism and Electronics

Paper Code : PHY-II.CM-2

Name of Faculty: Ananya Das and Vaishali Gaonkar

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Course Objectives: The objective of this course is to introduce fundamentals of electricity, magnetism and basic electronics to the students, which are essential allied learning components for most of the subjects of Physical Sciences.

Learning Outcome: On successful completion of this course, the students will be able to:

- Comprehend basic concepts like: laws of electrostatics and magnetostatics, self and mutual inductions
- Understand the working of d.c. and a.c. circuits in terms of the role of passive components like capacitor and inductor present in the circuits.
- Understand the working and application of various electronic circuits like rectifier, voltage regulator, CE Amplifier, Op-Amps and Logic gates.
- Correlate the theoretical basis of various concepts of electricity, magnetism and electronics while performing experiments.

Theory:

I. Electricity and Magnetism [23L]

1: Laws of Electrostatics [5L]

Coulomb's law: Statement, Vector form of Coulomb's law for like and unlike charges, Variation force with distance (F v/s r graph)

Concept of electric field and Electric Field Lines

Concept of electric flux: Gauss's theorem in electrostatics (conceptual explanation)

Coulomb's Law from Gauss' Law

Concept of Electric Potential: Electric Potential Energy, Equipotential Surfaces

Calculating the Potential from the Field, Calculating the Field from the Potential

[Ref. No.1: 22.4, 23.2, 23.3, 24.1-24.5, 25.1-25.4, 25.9] [Ref. No.2: 2.4(1)]

2 : Laws of Magnetostatics [4L]

Concept of magnetic field, Definition and properties of magnetic field

Biot – Savart's law and its applications: (i) Long straight conductor and (ii) Current carrying circular loop (for a point on the axis only)

Ampere's circuital law and its application: Field of solenoid.

Magnetic Field lines and Magnetic flux, Gauss's law for magnetism

[Ref. No.1: 29.1, 29.2, 30.1, 30.3, 32.2][Ref. No.3:27.2, 27.3]

3: Self and Mutual Inductance **[5L]**

Self induction; Calculation of self inductance of (i) a long solenoid, (ii) long parallel wires and (iii) a coaxial cable

Mutual inductance, Coefficient of coupling; Mutual inductance of two coils in series

Energy stored in the magnetic field

[Ref. No.4: 5.1, 5.2, 5.8] [Ref. No.1:31.8, 31.10, 31.12]

4 : Transient Circuits and Alternating Current Circuits **[9L]**

Transient currents

Growth and Decay of current in an inductive (L-R) circuit, Physical meaning of time constant

Charging and Discharging of a capacitor through resistor in C-R circuit, Physical meaning of time constant

[Ref. No.4:5.3, 5.4]

Inductive and Capacitive reactance, Variation of inductive reactance, capacitance reactance with frequency.
Introduction to vector or phasor diagrams method and its application to A.C. circuits(Series L-R and Series C-R); Physical significance of Quality factor
A.C. bridges: Maxwell's Inductive bridge and de Sauty's Capacitance bridge
[Ref. No.2:22.3, 22.4, 22.6, 22.7, 22.8, 22.9, 22.10] [Ref. No.4: 6.20, 6.21, 6.22]

II. Electronics [22L]

5: Rectifiers and Regulators **[6L]**

Volt-ampere characteristics of Junction diode
Working of Half Wave and Full Wave Rectifiers without and with capacitive filters, Percentage regulation, Ripple factor and Rectification efficiency (only qualitative explanation with respect to HWR and FWR).

Zener diode characteristics and its use as a simple voltage regulator.
Thermistor characteristics and its use in A.C. voltage regulation.

[Ref. No. 1: 4.1-4.7 and Ref. No. 2: 6.1-6.4, 6.13-6.17]

6: Transistors **[8L]**

Basic configurations of transistors, Transistor's leads identification, Biasing of Transistor and working of Transistor as a switch

Transistor characteristic in CE and CB mode, Current gains and their interrelation, Leakage currents in transistor

Basic Amplifier Characteristics: Current gain, Voltage gain, Power gain, Input resistance, Output resistance

Classes of amplifier operations, DC load Line, Frequency response and Amplifier bandwidth

of CE Amplifier

[Ref. No.3: 8.1, 8.4, 8.7-8.12, 8.17, 8.18, 8.26] [Ref. No. 2: 7.1-7.7, 7.10, 8.7, 8.8]
[Ref.No.4 : 7.6]

7: Operation Amplifiers and Logic Gates **[8L]**

The Differential Amplifier;Op-Amp Characteristics: Input and Output impedance, Input bias

current, Input offset current, Input and Output offset voltages.

Op-Amp as Inverting and Non-Inverting amplifier.

[Ref. No.4:17.2, 18.4][Ref. No.5: 8.1-8.3] [Ref. No.6: 3.2]

Binary number system, Binary to Decimal and Decimal to Binary conversion.

Boolean Algebra, Basic logic gates: OR, AND, NOT, NOR, NAND, and EX-OR gates.

De Morgan's Theorems, NAND and NOR gates as universal building blocks in logic circuits.

[Ref. No.3: 26.3-26.6, 26.20, 26.12-26.17, 26.22]

Experiments: (Minimum Six: Three from each section)

I. Electricity and Magnetism

(1) Step Response of RC circuit Charging and discharging of a capacitor

(2) Response of LR and CR circuits to A.C. using phasor diagrams

(3) de Sauty's capacitance bridge

(4) Self inductance of a coil using Maxwell's inductive bridge

(5) Mutual inductance of two coils in series

II. Electronics

(1) Half wave and Full wave rectifier using Junction Diode, Load regulation characteristics.
(2) Zener Diode Regulation
(3) C.E. Amplifier: Gain v/s Load, Input and Output Impedance
(4) Op-Amp: Input and Output Impedance
(5) Inverting and Non-inverting Op-Amp
(6) Verification of De Morgan Law's and Boolean Identities (Construction using Gates)
(7) NAND and NOR gates as universal building blocks.

References:

I. Electricity and Magnetism

1. Halliday David, Resnik Robert and Walker Jearl, Fundamentals of Physics, John Wiley & Sons, Inc., 6th Edition (2003)
2. Vasudeva D. N., Fundamentals of Magnetism and Electricity, S. Chand & Company Ltd., 12th Revised Edition (1999)
3. Young Hugh D., Freedman Roger A. and Ford A. Lewis, Sears and Zemansky's University Physics with Modern Physics, Addison-Wesley Publishers, 13th Edition(PDF) (2012)
4. Fewkes J. H. and Yarwood John, Electricity, Magnetism and Atomic Physics, Volume I, Oxford University Press Ltd., 10th Impression (1991)
5. Purcell Edward M., Electricity and Magnetism-Berkeley Physics Course, Volume 2, Mcgraw-Hill Book Company(PDF)

II. Electronics

1. Bhargava N. N., Kulshreshtha D. C. and Gupta S. C., Basic Electronics and Linear Circuits, Tata McGraw Hill Education Private Ltd., 54th Reprint (2010)
2. Mottershed Allen, An Introduction to Electronics Devices and Circuits, Prentice-Hall of India Private Ltd., Eastern Economy Edition (2008)
3. Metha V. K. and Mehta Rohit, Principles of Electronics ,S. Chand & Company, Multicolour Revised Edition (2008)
4. Malvino A. P., Electronic Principles, Tata McGraw Hill Education Private Ltd., 5th Edition (1996)
5. Bapat Y. N., electronic Circuits and Systems, Tata McGraw-Hill Publishing company Limited New Delhi, First Reprint (1993).
6. Choudhury D. Roy, Jain Shail, Linear Integrated circuits, New Age International (P) Ltd., Twelfth Reprint, (1998).

Annexure III

List of Examiners

1. Dr. Swati Pawar, Dhempe College, Panaji
2. Dr. Satish Keluskar, PES College, Ponda
3. Mrs. Mandakini Rane, PES College, Ponda
4. Mr. Narayan Bandodkar, Govt. College of Arts, Science and Commerce, Quepem
5. Mr. Rajendra, Carmel College, Nuvem
6. Dr. Shirish Kamat, Govt. College of Arts, Science and Commerce, Quepem
7. Ms. Pearl Desouza, Carmel College Nuvem
8. Dr. Girish Kundaikar, PES College, Ponda
9. Dr. Efram Desa, Carmel College, Nuvem
10. Mr. Manoj Salgaonkar, St. Xavier College, Mapusa
11. Mr. Jason Joseph, Govt. College of Arts, Science and Commerce, Khandola
12. Mr. Benedict Soares, St. Xavier College, Mapusa

Annexure I

List of core and elective courses for the undergraduate program in Physics

Core Courses in Physics (Major)

Sr. No	**Semester**	**Title of the Paper**	**Code**
1	I	Introduction to Mathematical Physics	PHY-I.C-1
2	I	Mechanics-I	PHY-I.C-2
3	II	Heat and Thermodynamics	PHY-II.C-3
4	II	Electricity and Magnetism	PHY-II.C-4
5	III	Electromagnetic Theory-I	PHY-III.C-5
6	IV	Quantum Mechanics	PHY-IV.C-6
7	V	Electromagnetic Theory-II	PHY-V.C-7
8	VI	Atomic and Molecular Physics	PHY-VI.C-8

Elective Courses in Physics (Major)

Sr. No	**Semester**	**Title of the Paper**	**Code**
1	III	*Optics	PHY-III.CE-1
2	III	Modern Physics	PHY-III.CE-2
3	III	Oscillations, Waves and Sound	PHY-III.CE-3
4	III	Properties of Matter and Acoustics	PHY-III.CE-4
5	IV	*Electronics-I	PHY-IV.CE-5
6	IV	Solid State Devices	PHY-IV.CE-6
7	IV	Computational Physics	PHY-IV.CE-7
8	IV	Astronomy and Astrophysics/ Instrumentation	PHY-IV.CE-8
9	V	*Solid State Physics	PHY-V.CE-9
10	V	Thermodynamics and Statistical Mechanics	PHY-V.CE-10
11	V	Electronics-II	PHY-V.CE-11
12	V	Introduction to Physical Oceanography	PHY-V.CE-12
13	VI	*Mechanics II	PHY-VI.CE-13
14	VI	Nuclear and Elementary Particle Physics	PHY-VI.CE-14
15	VI	Introduction to Special Theory of Relativity	PHY-VI.CE-15
16	VI	Introduction to Material Science	PHY-VI.CE-16

***** Electives are compulsory

Core Courses in Physics (Minor)

Sr. No.	Semester	Title of the Paper	Code
1	I	Mechanics, Properties of Matter and Sound	PHY-I.CM-1
2	II	Electricity, Magnetism and Electronics	PHY-II.CM-2
3	III	Elementary Modern Physics	PHY-III.CM-3
4	IV	Heat and Optics	PHY-IV.CM-4
5	V	Solid State Physics	PHY-V.CM-5
6	VI	Atomic and Nuclear Physics	PHY-VI.CM-6

Annexure II

Syllabi for Semester-III and Semester-IV of the undergraduate program in Physics

Core and Elective Courses for students taking Physics as their Major subject.

Semester III:

1. Electromagnetic Theory-I
2. Optics
3. Modern Physics
4. Oscillation, Waves and Sound
5. Properties of Matter and Acoustics

Semester IV:

1. Quantum Mechanics
2. Electronics-I
3. Solid State Devices
4. Computational Physics
5. Astronomy and Astrophysics
6. Instrumentation

Courses for students taking Physics as their Minor subject.

Semester III

1. Elementary Modern Physics

Semester IV

1. Heat and Optics

Paper Title	**:**	**Electromagnetic Theory – I**
Paper Code	**:**	**PHY-III.C-5**
Name of Faculty	**:**	**Yatin P. Desai**
Marks	**:**	**75 (Theory) + 25 (Practical)**
Credits	**:**	**3 (Theory) + 1 (Practical)**
Contact Hours	**:**	**45 (Theory) + 30 (Practical)**

Course Objectives **:** To acquaint students with fundamental principles of Electrostatics part of the Electromagnetic Theory.

Learning Outcome **:** At the end of this course students would understand interaction between charges, the concept of electric field, electric potential in vacuum as well as in matter. Students would also learn techniques to solve electrostatic problems.

Pre-requisite: Electricity and Magnetism (PHY-II.C-4) and Introduction to Mathematical Physics (PHY-I.C-1)

Theory:

1. **Vector Analysis** **[8L]**

1.1. Vector Algebra: Vector Operations, Vector Algebra: Component form, Triple Products, Position, Displacement and Separation Vectors
[Ref. No. 1 pp. 1 – 8]

1.2. Differential Calculus: Ordinary Derivatives**,** Gradient**,** The Operator ∇**,** The Divergence and Curl**,** Product Rules**,** Second Derivatives
[Ref. No. 1 pp. 13 – 22]

1.3 Integral Calculus: Line, Surface and Volume Integrals, The fundamental Theorem for Divergences**,** The fundamental Theorem for Curls.
[Ref. No. 1 pp. 28, Ref. No. 2 pp. 20, Ref. No. 2 pp. 26]

1.4 Different Co-ordinate Systems: Cartesian Co-ordinate System, Cylindrical Co-ordinate System, Spherical Co-ordinate System, Some Useful Vector Identities with Proofs
[Ref. No. 2 pp. 36, Ref. No. 2 pp. 30-31]

2. **Electrostatics** **[15L]**

2.1. The Electric Field: Coulomb's Law, The Electric Field, Continuous Charge Distributions.

2.2. Divergence and Curl of Electrostatic Fields: Field Lines, Flux and Gauss's Law**,** The Divergence of E**,** Applications of Gauss's Law**,** The Curl of E.

2.3. Electric Potential: Introduction to Potential**,** Poisson's Equation and Laplace's Equation**,** Potential of a Localised Charged Distribution**,** Summary: Electrostatic Boundary Condition.

2.4. Work and Energy in Electrostatics: Work Done to Move a Charge**,** The Energy of a Point Charge Distribution**,** The Energy of a Continuous Charge Distribution**,** Comments on Electrostatic Energy.

2.5. Conductors: Basic Properties of Conductor, Induced Charges, Surface Charge and the Force on a Conductor,Capacitors.
[Ref. No. 1, pp. 58 – 103]

3. Techniques to Solve Electrostatic Problems **[8L]**
3.1. Poisson's Equation

3.2. Laplace's Equation: Laplace's Equation in One Dimension, Laplace's Equation in Two Dimensions, Laplace's Equation in Rectangular Co-ordinates, Solution to Laplace's Equation in Spherical Co-ordinates (Zonal Harmonics).

3.3. Conducting Sphere ina Uniform Electric Field

3.4. Electrostatic Images: Point Charge and Conducting Sphere**,** Line Charge and Line Images.
[Ref. No. 3 pp. 51 – 67]

4. Electrostatic Field in Matter **[8L]**
Polarization, Gauss's Law in a Dielectric, Electric Displacement Vector, Electric Susceptibility and Dielectric Constant, Boundary Conditions on the Field Vectors, Boundary Value Problems Involving Dielectric, Dielectric Sphere in a Uniform Electric Field
[Ref. No. 3 pp. 75 – 93]

5. Microscopic Theory of Dielectrics **[6L]**
Molecular field in a dielectric: ClausiusMossotti Relation, Polar and Non-Polar Molecules, Induced Dipoles,Langevin's Debye Formula, Permanent Polarization, Ferroelectricity.
[Ref. No. 3 pp. 101 – 109]

Experiments: (Minimum Six)

1. Vandegraff Generator.
2. Measurement of dielectric constant and susceptibility of liquid using parallel metal plates.
3. Measurement and Study of variation of dielectric constant of $BaTiO_3$ ferroelectric and determination of its Curie temperature.
4. E and D measurement for a parallel plate capacitor and calculation of dielectric constant.
5. Law of Capacitance using Dielectric Constant Measurement Kit.
6. Absolute capacity by ballistic galvanometer.
7. C_1/C_2 by De-Sauty's method using ballistic galvanometer.
8. Dipole Moment and Polarizability of Benzene.

References:

1. Griffiths D. J., Introduction to Electrodynamics, Prentice Hall of India, 3rd Ed. (2011)
2. Harper Charlie, Introduction to Mathematical Physics, Prentice Hall of India, 5th reprint, (1993)
3. Reitz J. R., Milford F. J., Christy R. W., Foundations of Electromagnetic Theory, Addison-Wesley Publishing Company, 3rd Ed., (1979)

Additional Reference:

1. Mukherji U., Electromagnetic Field Theory and Wave Propagation, Narosa Publishing House, (2008)

Paper Title : **Optics**

Paper Code : **PHY-III.CE-1**

Name of Faculty : **Ananya Das**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Course Objectives: The course aims to enable the students to develop understanding towards the different phenomena exhibited by light.

Learning Outcome: On completion of this course, the students will be able to:

- understand the image formation for various optical systems.
- differentiate between optical phenomena like Interference, Diffraction and Polarization.
- correlate the theoretical basis of various concepts of Geometrical Optics and Physical Optics while performing experiments.

Pre-requisite: Nil.

Theory:

Unit-I **[13 L]**

Geometrical Optics: (5 L)

Fundamentals of Reflection and Refraction: Refractive index and optical path, Fermat's Principle of least time, Derivation of the laws of reflection and refraction using Fermat's Principle.

Lenses: thin and thick lenses, Lens equation, Lens maker's formula, Cardinal points of an optical system, Combination of coaxially placed two thin lenses (equivalent lenses) (including derivation for focal length and cardinal points).

[Ref.1: Chapter.1: 1.6, 1.7; Ref.2: Chapter.1: 1.2, 1.3, 1.4; Ref.1: Chapter.4: 4.8, 4.9, 4.10, 4.11, 4.12, 4.15, 4.17; Chapter.5: 5.2, 5.2.1, 5.2.2, 5.2.3, 5.3, 5.10, Chapter.6: 6.1, 6.2]

Lens Aberrations: (4 L)

Introduction, Types of aberrations: monochromatic and chromatic aberration, Monochromatic aberration and its reduction: Spherical aberration, Types of chromatic aberration: Achromatism (lenses in contact and separated by finite distance).

[Ref.1: Chapter.9: 9.1, 9.2, 9.5, 9.5.1, 9.10, 9.11, 9.12, 9.13]

Optical Instruments: (4 L)

Objective and Eyepiece, Huygen's eyepiece, Ramsden's eyepiece, Telescopes, Refracting and Reflecting type of telescopes and Constant deviation Spectrometer.

[Ref.1: Chapter.10: 10.8, 10.10, 10.10.1, 10.11, 10.11.1,10.12, 10.15, 10.15.1, 10.16, 10.16.1, 10.17]

Unit-II **[10 L]**

Interference: (6L)

Introduction: Superposition of waves, Interference, Coherence, Conditions for Interference, Techniques of obtaining Interference, Young's Double Slit Experiment, Phase Change on reflection: Stoke's law.

[Ref.1: Chapter.14: 14.3, 14.4, 14.4.2, 14.4.4, 14.6, 14.7, 14.8 and Ref.2: Chapter6: 6.3]

Interference in Thin Films: Thin Film, Plane Parallel Film, Interference due to Transmitted light, Haidinger Fringes, Wedge-shaped Film, Newton's Rings.

[Ref.1: Chapter.15: 15.1, 15.2, 15.2.1 to 15.2.5, 15.3, 15.4, 15.5, 15.5.1 to 15.5.4, 15.6, 15.6.1 to 15.6.9]

Interferometry: (4L)

Michelson's Interferometer: Principle, Construction, Working, Circular Fringes, Localised Fringes, White Light Fringes, Application of Michelson's Interferometer: Measurement of Wavelength and Determination of the difference in the wavelength of two waves.

[Ref.1: Chapter.15: 15.7, 15.7.1 to 15.7.5, 15.8, 15.8.1, 15.8.2]

Unit-III **[12 L]**

Diffraction: (5L)

Difference between Interference and Diffraction, Types of diffraction: Fresenel Class and Fraunhoffer Class.

[Ref.1: Chapter.17: 17.6, 17.7 and Ref.2: Chapter7: 7.5, 7.6]

Diffraction of Light (Fresnel Class):

Division of cylindrical wave-front into Fresnel's half period strips, Diffraction at straight edge, Diffraction at a narrow wire.

[Ref.2: Chapter.7: 7.9, 7.10, 7.11]

Diffraction of Light (Fraunhoffer Class):(7L)

Diffraction at a single slit (Central maximum, Secondary maxima and Secondary minima), Diffraction at double slit, Distinction between single slit and double slit diffraction patterns, Missing orders in a double slit diffraction pattern, Diffraction at N slits(only conceptual), Determination of wavelength of a spectral line using Plane Transmission Grating. Resolving Power, Rayleigh's criterion, Resolving power of telescope and Resolving Power of Prism.

[Ref.1: Chapter.18: 18.2, 18.2.1, pg.431 to 433, 18.4, 18.4.1, 18.4.2, 18.4.3, 18.7, 18.7.1, 18.7.2, 18.7.6 and Chapter.19: 19.1, 19.2, 19.6, 19.7, 19.11]

Unit-IV **[10 L]**

Polarization:

Polarized Light, Natural Light, Production of Linearly Polarised Light, Anisotropic Crystal, Calcite Crystal, Huygens Theory of Double Refraction in Uniaxial crystal, Nicol prism- its fabrication, working and use, Effect of Polarizer on Natural Light, Effect of Analyser on Plane Polarized Light, Types of Polarized Light, Retardation plates - Quarter wave plate and Half wave plate, Production of Elliptically and Circularly Polarized Lights, Detection of plane, circularly, elliptically polarized lights, Analysis of polarized light, Optical activity, Specific rotation, Simple Polarimeter, Laurent's Half-Shade Polarimeter.

[Ref.1: Chapter.20: 20.3, 20.4, 20.5, 20.5.1 to 20.5.5, 20.7, 20.8, 20.8.1 to 20.8.3, 20.9, 20.9.1, 20.9.2, 20.6.1, 20.6.3, 20.15, 20.17.1, 20.17.2, 20.18, 20.18.1, 20.19, 20.19.1, 20.20, 20.24, 20.24.1, 20.25, 20.26]

Experiments: (Minimum six)

1) Cardinals points of Two lenses
2) Prism Spectrometer: Optical levelling, Angle of Prism
3) Dispersive power of prism
4) Newton's Rings
5) Single Slit Diffraction
6) Diffraction Gratings
7) Brewster's Law
8) Polarimeter
9) Lloyd's Mirror/Biprism (Demonstration)
10) Cylindrical Obstacle (Demonstration)

References:

1. Subhramanyam N., Lal Brij, Avadhanulu M. N., A Text book of Optics, S. Chand & Company Ltd., New Delhi, Firstmulticolour Edition (2006).
2. Singh S. P. and Agarwal J. P., Optics, PragatiPrakashan, 8th Edition (2001).

Additional References:

1. Mathur B. K., Principles of Optics, New Global Printing Press, Kanpur.
2. GhatakAjoy, Optics, Tata McGraw-Hill Publicashing Company Ltd. (1977)
3. Jenkins F. A. and White H. E., Fundamentals of Optics, Tata McGraw-Hill Publishing Company Ltd., (1981)

Paper Title : Modern Physics

Paper Code : PHY-III.CE-2

Name of Faculty: Ashish Desai

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Course Objective:
Modern Physics involves the study of radiation and matter at atomic levels and velocities close to the speed of light. This course will focus on the early development of the theory of atomic structure, wave particle duality, elementary nuclear physics and Lasers. Lectures will help you clarify concepts of modern physics through various conceptual questions and problems.

Learning Outcome:
After completion of this course, students will develop a comprehension of broad knowledge in modern physics. Students will also acquire the necessary skills for critical thinking and problem solving.

Pre-requisite: Nil.

Theory:

1. **Electrons, Nucleus and Atoms: [5L]**
   Determination of e/m for cathode rays. Thomson's model of the atom and qualitative discussion of alpha scattering experiment. Rutherford's model of the atom. Determining upper limit to nuclear dimension. Electron orbits. Failure of Classical Physics.
   [Rajam: Pages 33-36, 44-50; Beiser: 5.1, 5.3, 5.5-5.7]

2. **Brief review of Atomic models: [6L]**
   Atomic Spectra. Frank-Hertz experiment. The Bohr Atom: Quantization of energy. Bohr-Sommerfeld model. Nuclear motion and reduced mass. Bohr's Correspondence Principle.
   [**Beiser: 6.1-6.8]**

3. **Particle Properties of waves: [4L]**
   Conepts of Blackbody radiation.The Photoelectric effect. Compton Effect. Experimental verification of the Photoelectric effect.
   [Beiser: 3.1,3.2, 3.5; Muregeshan: 8.5]

4. **Wave Properties of Particles: [6L]**
   De Broglie's hypothesis. Electron Diffraction experiment of G. P. Thomson. Experiments with bullets, waves and electrons. The interference of electron waves. Watching the electrons. The uncertainty principle and its application.
   [Beiser 4.1-4.8; Feynman 1.1-1.8]

5. **Properties of the Nucleus:** **[3L]**
   Nuclear sizes. Nuclear spin. Binding energy, B.E versus A plot. Saturation of nuclear forces.
   [Beiser: 21.2, 21.4-21.6]

6. **Nuclear Forces and Models:** **[5L]**
   Main characteristics of Nuclear Forces. Meson theory of Nuclear forces. Yukawa potential. Brief discussion of the Liquid drop Model and Shell Model.
   [Beiser: 22.4-22.6]

7. **Radioactivity and Radioactive Decay:** **[8L]**
   The law of Radioactivity Decay. Mean lifetime. Half life and Decay constant. Successive radioactive transformation (A-B-C) type, Ideal transient and secular equilibrium. Radioactive series. Carbon dating. Artificial radioactivity. Brief qualitative discussion on apha decay, beta decay and gamma decay.
   [Patel: 2.3, 2.6-2.9, 2.11, 2.13; Beiser: 23.3, 23.6-23.10]

8. **Nuclear Fission and Nuclear Fusion:** **[4L]**
   Nuclear fission. The chain reaction. Transuranic elements. Thermonuclear energy
   [Beiser: 24.7-24.10]

9. **Lasers:** **[4L]**
   Attenuation of light in an optical media. Thermal Equilibrium. Interaction of light with matter. Einstein's A and B coefficients and their relations. Population inversion. Principal pumping schemes. Ruby Laser and He-Ne Laser. Applications of Laser.
   [Subrahmanyam: 22.1-22.8, 22.10, 22.14.1, 22.14.3, 22.19]

Experiments: (Minimum Six)

1. Determination of e/m of electrons using Thomson's method.
2. Measurement of k/e.
3. Measurement of diameter of Lycopodium powder.
4. To determine wavelength of Laser source by diffraction of single slit.
5. To determine wavelength of Laser source by diffraction of double slit.
6. Frank Hertz Experiment.
7. Photoelectric effect.
8. Geiger Muller Counter (Demonstration).

References:

1. Beiser, A. 1969, *Perspectives of Modern Physics*, McGraw-Hill Book Company, Singapore.
2. Feynman, R. 2012, *Feynman Lectures on Physics: Quantum Mechanics (Volume - 3)*, Pearson Education, India.
3. Kakani, S. 2011, *Modern Physics*, Viva Books private limited, New Delhi.
4. Murugeshan, R 2009, *Modern Physics,* S. Chand and Company limited, New Delhi.

5. Patel, S. 2011, *Nuclear Physics: An Introduction*, 2nd ed. New Age Inernational Limited, New Delhi.
6. Rajam, J. 2000, *Atomic Physics,* S. Chand and Company limited, New Delhi.
7. Subrahmanyam, N., Lal, B. and Avadhanulu, M. 2004, *A Textbook of Optics,* S. Chand and Company limited, New Delhi.

Additional References:

1. Ghatak 2012, *Optics*,Mcgraw Hill Education, India.
2. Richtmyer, F., Kennard, E., Cooper, J. 2001, *Introduction to Modern Physics*, 6th ed. McGraw-Hill Book Company, New Delhi.
3. Tipler, P. 2012, *Modern Physics*, WH Freeman, New York.

Paper Title : Oscillations, Waves and Sound

Paper Code : PHY-III.CE-3

Name of Faculty: Ashish Desai

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Prerequisite: Introduction to Mathematical Physics (PHY-I.C-1)

Course Objectives:Simple harmonic motion is one of the fundamental types of motion that exists in nature. The objective of this course is to cover the fundamental physical concepts of Simple harmonic motion, waves and sound.

Learning Outcome: After successful completion of this course, students will be able to

- Understand the behavior of oscillations and waves in nature
- Understand systems of single and multiple harmonic oscillators and appreciate the role of driving and damping harmonic systems.
- Demonstrate understanding of nature of sound waves and the Doppler Effect.

Theory:

1. **Undamped free oscillation** **[15L]**

   Different type of equilibria (Stable, unstable and neutral equilibrium). Periodic oscillations and potential well.
   [Mathur: 5.9]

   Differential equation for simple harmonic oscillator and its solutions. Energy of the harmonic oscillator.
   [Taylor: 5.1-5.2]

   Examples of simple harmonic oscillations: spring and mass system, simple and compound pendulum, torsional pendulum, bifilar oscillations, Helmholtz resonator.
   [Mathur: 7.7.1-7.7.5]

   Superposition of two simple harmonic motions of the same frequency along the same line. Superposition of two mutually perpendicular simple harmonic vibrations of the same frequency. Superposition of two mutually perpendicular simple harmonic vibrations and having time periods in the ratio 1:2. Uses of Lissajous' figures.
   [Subrahmanyam: 2.1, 2.2, 2.4, 2.6, 2.9]

2. **Damped Oscillations** **[8L]**

Introduction. Differential equation of damped harmonic oscillator and its solution, discussion of different cases (Strong, weak and Critical damping). Logarithmic decrement. Energy equation of damped oscillations. Power dissipation.Quality factor.

[Taylor: 5.4 and Mathur: 8.2-8.4]

3. **Driven Damped Oscillations** **[6L]**

Introduction, Differential equation of forced oscillation and its solution (transient and steady state). Resonance.Width of the resonance; the Q factor. The phase at resonance. Velocity resonance.

[Taylor: 5.5-5.6 and Mathur: 8.9]

4. **Waves and Sound** **[10L]**

Transverse vibrations in strings. Velocity of longitudinal waves in gases. Newton's formula for velocity of sound. Velocity in a homogeneous medium. Laplace’s correction. Kundt's tube-determination of velocity of sound in a gas and in solids. Intensity level and Bel and Decibel.

Production and detection of Ultrasonic waves and its applications

[Khanna 4.2, 5.3-5.5, 11.1, 11.3, 12.1-12.4, 19.6 and Subrah.: 11.23 11.25,11.27]

5. **Doppler Effect:** **[6L]**

Explanation of Doppler effect in sound. Observer in rest and source in motion. Source at rest and observer in motion. When both source and observer are in motion. Effect of wind velocity. Doppler effect in light. Applications of Doppler effect.

[Subrahmanyam: 8.1-8.6]

Experiments: (Minimum Six)

1. To determine the equivalent length of the Kater’s pendulum and the acceleration due to gravity using a resonance pendulum.
2. To determine the damping constant using Damped harmonic oscillator
3. To determine the velocity of Sound using Helmholtz resonator
4. To determine the value of acceleration due to gravity using a bar pendulum.
5. To determine the frequency of AC mains using Sonometer.
6. Bifilar suspension: Dependence of the time period on the geometry of non-parallel bifilar suspension.
7. Log Decrement.
8. Velocity of Sound using CRO.
9. Lissajous Figures (Demonstration).

References:

1. Khanna, D. and Bedi, R. 1992, *A Textbook of Sound*, Atma Ram and sons, Delhi.
2. Mathur, D. 2012, *Mechanics*, S. Chand, New Delhi.
3. Taylor, J. 2005, *Classical Mechanics*, University Science Books, USA
4. Subrahmanyam, N. and Lal, B. 1994, Waves and Oscillation, Vikas Publishing House, Noida

Additional References:

1. French, AP 2003, Vibration and Waves, CBS Publisher, India.
2. Halliday, D., Resnick, R. and Walker, J. 2003, Fundamentals of Physics, 6th edition, John Wiley and Sons, USA.
3. Pain, J. 2005, *The Physics of Vibration and Waves*, 6th Edition, Wiley.

Paper Title : **Properties of Matter and Acoustics**

Paper Code : **PHY-III.CE-4**

Name of Faculty : **MalatiDessai**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Course Objectives: This course provides an introduction to dynamics of rigid bodies and calculation of moment of inertia, properties of matter and acoustics of rooms. An objective of this course is to build up an understanding of fundamental physical principles which are required for most of other physical sciences.

Learning Outcome: After successful completion of this course,

- Students will gain an introductory knowledge of dynamics of rigid bodies, and its applications to basic physical problems.
- They will have knowledge of acoustics of rooms and musical scales.
- Students will be able to comprehend the phenomenon of elasticity, surface tension, viscosity and their application.

Pre-requisite: Nil.

Dynamics of Rigid bodies: **[11L]**

Rigid bodies, Rotational Kinetic energy, Moment of inertia and its physical significance, Angular acceleration, angular moment, law of conservation of momentum, Analogy between translatory and rotatory motion, Theorem of perpendicular axis, Theorem of parallel axis, Moment of inertia of thin uniform bar, Moment of Inertia of a bar about an axis passing through one end and perpendicular to its length, Moment of Inertia of a bar about an axis perpendicular to its at a distance 'a' from one end, Moment of inertia of rectangular lamina, Moment of inertia of solid uniform bar of rectangular cross section, Moment of inertia of ring, Moment of inertia of disc, ,Moment of inertia of Annular disc, Moment of inertia of hollow cylinder, Moment of inertia of solid sphere, ,Moment of inertia of hollow sphere, Moment of inertia of spherical shell, ,Moment of inertia of a uniform elliptical lamina, Moment of inertia of a uniform triangular lamina, Moment of inertia of a solid cone.

[Reference#1 : Section 3.1-3.25]

Properties of Matter Elasticity: **[12L]**

Modulii of elasticity, Poisson's ratio and relationship between them.Bending of beams-bending moment, flexural rigidity. Cantilever (rectangular bar). Depression of a beam supported at the ends and loaded at the center. A vibrating cantilever.Torsion in a string-couple per unit twist, Torsional Pendulum.

[Reference # 2, Section 8.8, 8.9, 8.12, 8.13, 8.14, 8.15, 8.16, 8.17, 8.18, 8.22, 8.26, 8.29, 8.30(a(i)), 8.32, 8.33(i)]

Surface Tension: **[6L]**

Brief review of molecular theory of surface tension.Relation between surface tension and surface energy. Excess pressure inside a spherical Liquid drop, difference of pressure across a curved surface,Angle of contact. Capillarity-rise of liquid in a capillary tube.

[Reference # 2, Section 14.1, 14.2, 14.3, 14.4 14.6, 14.8, 14.14, 14.15 and 14.17]
[Reference #1 section 8.7 -8.9]

Viscosity **[9L]**

Equation of continuity: Euler's equation for liquid flow, Bernoulli's theorem and its applications. Streamline flow, Turbulent flow, Critical velocity, Coefficient of viscosity, Poiseuille's formula for flow of liquid through a capillary tube. Criticism of Poiseuille's equation

[Reference # 2, Section 12.1 - 12.12 (12.8 upto equation b)]

Acoustics of Rooms and Musical Scales **[7L]**

Reverberation of Sound, Reverberation time, Absorption coefficient, Sabine's formula for reverberation time (discussions only) , Acoustic requirements of an auditorium. Musical interval, harmony, melody.Diatonic scale. Tempered scale. (only concepts)

[Reference # 3, Section: 23.1-23.17, Section:17.1-17.12]

Experiments: (Minimum Six)

1) Cantilever : Determination of Young's modulus by vertical vibrations of a cantilever.
2) Torsional Pendulum : Determination of Rigidity Modulus of the material of a wire.
3) Jagger's Method : Determination of Surface Tension
4) Viscosity of a liquid by Poiseuilles method
5) Bending of beams: determination of Young's modulus
6) Capillarity: determination of Surface tension
7) Flat Spiral Spring: determination of elastic constants by vertical and torsional oscillations of a loaded spring
8) Young's Modulus of Brass by Flexural Vibrations of Bar.
9) Rigidity Modulus of Brass.

References:

1) Properties of matter by Brij Lal N. Subrahmanyam, Eurasia Publishing House New Delhi (1999)
2) Elements of Properties of Matter, by D. S. Mathur, S. Chand and Company, New Delhi.
3) Text book of Sound. D. R. Khanna and R.S. Bedi, Atma Ram, New Delhi (1994).

Additional References:

1) Sound. F. G. Mee, Heinemann Ltd., London (1967)
2) Newman and Searle, General properties of Matter
3) C. J. Smith, Properties of Matter

Paper Title : **Quantum Mechanics**

Paper Code : **PHY-IV.C-6**

Name of Faculty : **Ashish Desai and Yatin Desai**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1(Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Course Objectives: The objective of this course is to provide an introduction to quantum mechanics and its application.

Learning Outcome: On successful completion of this course, the students will be able to

1. develop a knowledge of the origin of Quantum Physics.
2. understand the wavelike properties of matter and interpret experiments displaying it.
3. understand the concepts and principles of quantum mechanics.
4. solve the Schrödinger equation to obtain wave functions for some important types of potential in one dimension.

Pre-requisite: Nil

Theory:

1. Review of Particle-like Properties of Radiation: **[3L]**

Black body radiation and Plank's constant. Einstein's quantum theory of the Photoelectric effect. Compton effect. The dual nature of electromagnetic radiation.

[Singh: 1.1-1.3], [Eisberg: 2.1-2.5]

2. De Broglie's Postulate - Wavelike properties of Particles: **[12L]**

2.1. Dual nature of matter: Experiments with bullets, waves and electrons. The interference of electron waves. Watching the electrons.
[Feynman: 1.1-1.6]

2.2. Matter Waves: De Broglie's postulate. Davisson and Germer experiment. Electron diffraction experiment of G. P. Thomson. Review of the Bohr's postulate about stationary states in the light of De Broglie's concepts.
[Eisberg: 3.1], [Singh: 2.8]

2.3. Properties of Matter waves: Wave and group velocities. Relation between the group velocity and phase velocity. Velocity of De Broglie wave. Wave packet and its motion in one dimension.
[Singh: 2.3-2.5, 2.9]

2.4. The Philosophy of Quantum Theory: Copenhagen interpretation of Bohr and Heisenberg; points of view of Einstein and De Broglie.
[Eisberg: 3.6]

3. Heisenberg's Uncertainty Principle: **[5L]**

Uncertainty principle. Elementary proof of Heisenberg's uncertainty relation between position and momentum. Elementary proof of Heisenberg's uncertainty relation between energy and time. Illustration of Heisenberg's uncertainty principle with thought-experiments. Consequences of the uncertainty relation.

[Singh: 3.1-3.5]

4. Schrödinger's Theory of Quantum Mechanics: **[10L]**

- **4.1 Max Born's Interpretation of the wave function**: Wavefunction. Complex character of the wave function. Wave function as computational devices. Probability density. Acceptable wave function. Normalisation of wave function.
  [Beiser: 4.2], [Eisberg: 5.3]
- **4.2 Schrödinger's Wave Equation:** One dimensional time-dependent Schrödinger's wave equation. One Dimensional Time-Independent Schrödinger's Wave Equation. Operators in quantum mechanics: position, momentum, kinetic energy, Hamiltonian, total energy, angular momentum. Eigen function, eigen value and eigen value equation. Expectation values. Postulates of quantum mechanics.
  [Singh: 4.1 – 4.6]

5. **Applications of Schrödinger's Steady state equation:** **[15L]**

- 5.1 Free particle.
- 5.2 One dimensional infinite rectangular potential well (Particle in a one dimensional box). Concept of parity, parity operator and its eigen values.
- 5.3 Particle in a three dimensional rigid box. Degree of degeneracy.
- 5.4 One dimensional step potential of finite height (Energy less than step height and energy greater than step height)
- 5.5 One dimensional potential barrier. Tunnel effect. Tunnel diode. Qualitative discussion of alpha decay,
- 5.6 One dimensional finite rectangular potential well (placed symmetric to origin). Parity and parity operators,
- 5.7 One dimensional harmonic oscillator (Algebraic method using raising and lowering operators and analytical method.)
  [Singh: 5.2], [Eisberg: 6.2 – 6.9], [Griffiths: 2.3]

Experiments:

1. Stefan's law
2. Photo-electric effect
3. Tunnel Diode I-V Characteristics: Tunnel Effect
4. Tutorial based on De Broglie's hypothesis and Dual nature of radiation/ matter
5. Tutorial based on Concepts of Wave Packets: Group Velocity and Phase Velocity
6. Tutorial based on Concepts of Uncertainty Principle
7. Tutorial based on Concepts of Wave function: Normalisation, Probability distribution and Expectation Values
8. Tutorial based on Quantum mechanical Operators
9. Tutorial-I based on Application of One dimensional Time-Independent Schrodinger's Wave Equation
10. Tutorial-II based on Application of One dimensional Time-Independent Schrodinger's Wave Equation

References:

1. Beiser, A. 1969, *Perspectives of Modern Physics*, McGraw-Hill Book Company, Singapore.
2. Eisberg, R. And Resnick, R. 2010, *Quantum Physics of Atoms, Molecules, Solids, Nuclei and particles*, 2nd Edition, Wiley India Pvt Ltd.
3. Feynman, R. 2012, *Feynman Lectures on Physics: Quantum Mechanics (Volume - 3)*, Pearson Education, India.
4. Griffiths, D. 2015, *Introduction to Quantum Mechanics*, Pearson Education, India.
5. Singh, K. And Singh, S. 2013, *Elements of Quantum Mechanics*, S. Chand, New Delhi.

Additional References:

1. Flugge, S. 2008, *Practical Quantum Mechanics*, Springer (SIE).
2. Rajasekar, S. and Veluswamy, R. 2014, *Quantum Mechanics I: The Fundamentals*, CRC Press, New York.
3. Richtmyer, F., Kennard, E., Cooper, J. 2001, *Introduction to Modern Physics*, 6th ed. Tata McGraw-Hill Book Company, New Delhi.
4. Verma, H. 2012, *Quantum Physics*, TBS, Calicut.
5. Wichmann, E. 2010, *Quantum Physics: Berkeley Physics Course Vol 4*, Tata McGraw-Hill Book Company, New Delhi.

Paper Title : **Electronics-I**

Paper Code : **PHY-IV.CE-5**

Name of Faculty : **Malati Dessai**

Marks : **75 (Theory) + 25 (Practical)**

Credits :**3 (Theory) + 1 (Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Course Objectives: The general goal of this course is to allow the students to understand the fundamentals of semiconductor behavior and the operation of basic semiconductor devices. This course lays the foundations for the understanding of more advanced semiconductor devices such as those covered in more advanced courses.

Learning Outcome: In this course, students will study basic circuit laws; semiconductor based analog circuits from a fundamental point of view. It extends this knowledge to descriptions of bipolar transistors and its applications. A discussion of feedback leads to the study of operational amplifier and sinusoidal oscillators.

Pre-requisite: Nil

Theory:

1. **Basic concepts and resistor circuits** **[8L]**
   Basics of current and voltages in a circuit, Constant voltage and Constant current source, Conversion of voltage source into current source, Maximum power transfer theorem, Kirchoff's Current and voltage Law, Thevenin's theorem and Norton's theorem,Techniques for solving circuit problems.
   [Reference #1 section1.1, 1.2.1.3, 1.2.3, Reference #2 section 1.8-1.16]

2. **Semiconductor Diodes** **[10L]**
   Semiconductor materials- intrinsic and extrinsic types, Ideal Diode, Terminal characteristics of diodes: p-n junction under open circuit condition, p-n junction under forward bias and reverse bias conditions, Diode I-V characteristic and load line for a simple diode circuit,Diodeapplications:Voltage dropper, Diode limiter, Variable diode clipper, Diode clamp, Rectification-working of Half wave and Full wave – calculation of efficiency, nature of rectifier output, comparison of rectifiers, Power supply filters (capacitor filter)
   [Reference #1 section 3.1.3, 3.1.4, 3.2.1-3.2.4, Reference #2 section 5.8-5.18,6.7-6.21]

3. **Bipolar Junction Transistors (BJTs)** **[10L]**
   Physical structure and operation modes, Transistor action, Transistor as an amplifier, Basic BJT amplifier configuration: common emitter, common base and common collector connections and their characteristics, comparison of transistor connections, Transistor as an amplifier in C-E mode, Active region operation of transistor, D.C. analysis of transistor circuits, performance of transistor amplifier, cut off and saturation points, power rating of

transistor.Biasing the BJT: fixed bias, emitter feedback bias, collector feedback bias and voltage divider bias.
[Reference #2 section 8.1- 8.23, 9.1-9.12, Reference #1 section 4.1-4.4]

4. **Sinusoidal oscillators** **[8L]**
Positive and negative feedback,Voltage and current feedback, series and shunt feedback, Effect of negative feedback on gain, frequency response, input and output resistance and distortion, Positive feedback, Barkhausen criterion for oscillations, Phase shift oscillator, Wein bridge oscillator, Hartley oscillator and Colpitts oscillator.
[Reference #2 section13.1-13.13 ,14.1-14.14, Reference #1 section 7.3-7.3.4.1]

5. **Operation Amplifier (Op-amps)** **[9L]**
Ideal Op-amp, operation of differential amplifier, differential and common mode signals, common mode rejection ratio (CMRR), d.c. analysis of differential amplifier , parameters of differential amplifier due to mismatch of transistors,bandwidth of an Op-amp, Slew rate limiting, Frequency response, Practical op-amp circuits: inverting amplifier, non –inverting amplifier, integrator, differentiator.
[Reference #2 section 25.1-25.5,25.9,25.11,25.15,25.19,25.21,25.23,25.35,25.37, Reference #1 section 6.1,6.3,6.4]

Experiments: (Minimum Six)

1. Half wave rectifier using Junction Diode
2. Full wave rectifier using Junction Diode
3. Bridge rectifier with capacitor filter- Ripple factor using CRO.
4. C.E. Amplifier: Gain v/s Load
5. C.E. Amplifier :Input and Output Impedance
6. C.E. Amplifier. Fequency response. Calculation of Gain Bandwidth product
7. OP-Amp: Characteristics Input and Output impedance
8. OP-Amp: Inverting and Non-inverting amplifier
9. Colpitts Oscillator
10. Wein's Bridge Oscillator

References:
1) Dennis L. Eggleston, Basic Electronics for Scientists and Engineers, CAMBRIDGE UNIVERSITY PRESS, First edition, 2011
2) V.K.Mehta,Rohit Mehta, Principles of Electronics,S. Chand and co. Ltd.

Additional References:
1) KalSaantiram, Basic Electronics: Devices, Circuits and IT fundamentals
2) Malvino, Electronic Principles, the McGraw- Hill companies
3) Mottershead Allen, <u>Electronics Devices and Circuits An Introduction</u>, Prentice-Hall of India Pvt. Ltd., New Delhi, 23rd Printing, (2000)

Paper Title : **Solid State Devices**

Paper Code : **PHY-IV.CE-6**

Name of Faculty : **Ananya Das**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1(Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Course Objectives: The objectives are to provide a clear explanation of the operation of most commonly used solid state devices.

Learning Outcome: On successful completion of this course, the students will be able to understand the performance and usages of most of the solid statedevices.

Pre-requisite: Nil

Theory:

1. Basic Semiconductor and pn-Junction Theory: **[10 L]**

The Atom, Electron Orbit and Energy Levels, Energy Bands, Conduction in Solids, Conventional Current and Electron Flow, Bonding Forces between Atoms, Classification of Solids, Intrinsic Semiconductor, Conduction of Electrons and Holes, *p*-Type and *n*-Type Semiconductors, Effect of Heat and Light, Drift Current and Diffusion Current, The *pn*-Junction, Reverse-biased Junction, Forward-biased Junction, Temperature Effect, Mobility and Conductivity, Hall Effect and Hall Coefficient.

[Ref.1: Chapter 1 and Ref.2: Chapter 1: 1.8 and1.9]

2. Special Diodes: **[6 L]**

Zener Diode, Use of Zener Diode as voltage regulator and as Peak Clipper, Meter Protection, Tunneling Effect, Tunnel Diode, Tunnel Diode as Oscillator, Varactor, PIN Diode, Schottky Diode, Step Recovery Diode.

[Ref.3: Chapter 15]

3. Optoelectronic Devices: **[8 L]**

Light Units, Photomultiplier tube, Photoconductive Cell, Photovoltaic Cell, Photodiode, Solar Cell, Phototransistor, PhotoFET, Spectral response of Human eye, Light Emitting Diode(LED), Liquid Crystal Display(LCD), Optoelectronic Couplers, Laser Diode, Light Dependent Resistor (LDR).

[Ref.1: Chapter 19: 19-1 to 19-7, 19-9, 19-11, 19-12 and Ref.3: 16.1 to 16.3]

4. Breakdown Devices: **[12 L]**

Silicon Controlled Rectifier(SCR), SCR Characteristic and Parameters, Simple applications of SCR: HWR, Battery-charging regulator and Temperature Controller, Silicon Controlled Switch (SCS), Gate Turn Off switch (GTO), Light Activated SCR (LASCR), Shockley Diode, The TRIAC and DIAC, Typical Diac-Triac Phase control circuit, The Unijunction Transistor(UJT), UJT Characteristics, UJT Parameter and Specification, UJT Relaxation Oscillator, UJT Control of SCR, Programmable Unijunction Transistor.

[Ref.1: Chapter 18: 18-1, 18-2, 18-4, 18-6 to 18-11; Ref.4: Chapter 21: 21.6 to 21.10 and Ref.5: Chapter 28: 28-4]

5. Field Effect Transistors: **[9 L]**

Advantage and Disadvantage of The FET, Basic Construction of JFET, Characteristics curves of The JFET, Principle of operation of The JFET, Effect of V_{DS} on Channel Conductivity, Channel Ohmic Region and Pinch-Off Rergion, Characteristic Parameters of The FET, Effect of Temperature on FET Parameters, The MOSFET, The Depletion MOSFET, The Enhancement MOSFET, The difference between JFETs and MOSFETs, Dual Gate MOSFET, FET used in Phase-Shift Oscillator Circuit, Applications of FET in its Channel Ohmic Region, FET as a VVR in Voltage controlled Attenuator and in an Automatic Gain Controlled Circuit, Field-Effect Diode and its use as CRD, Power MOSFETs.

[Ref.5: Chapter 21: 21-1 to 21-8, Chapter 22: 22-1 to 22-5, 22-9, 22-10;
Ref.1: Chapter 8: 8-9]

Experiments: **(Minimum six)**

1. Energy Gap of a Semiconductor
2. Energy Gap of a LED.
3. Zener Diode Characteristics and Voltage regulation
4. LDR Characteristics
5. LED VI Characteristics
6. Phototransistor
7. SCR characteristics and gate controlled ac half wave rectifier
8. UJT Characteristics and its use in relaxation oscillator
9. FET Characteristics
10. Solar Cell.
11. SCR, DiacTriac Characteristics.

References:

1. Bell David A., Electronics Devices and Circuits, Prentice-Hall of India Pvt. Ltd., New Delhi, 3rd Edition (2000).
2. Singh Kamal and Singh S. P., Solid State Devices and Electronics, S. Chand & Company Ltd., New Delhi, 1st Edition (2007).
3. Theraja B. L., Basic Electronics (Solid State), S. Chand and Company Ltd., New Delhi, 1st Multicolour Edition (2005).

4. Boylestad Robert and Nashelsky Louis, Electronic Devices and Circuit Theory, Prentice-Hall of India Pvt. Ltd., New Delhi, 6th Edition (2000).
5. Mottershead Allen, Electronics Devices and Circuits An Introduction, Prentice-Hall of India Pvt. Ltd., New Delhi, 23rd Printing, (2000).

Paper Title : Computational Physics
Paper Code : PHY-IV.CE-7
Name of Faculty : Ananya Das
Marks : 75 (Theory) + 25 (Practical)
Credits : 3 (Theory) + 1 (Practical)
Contact Hours : 45 (Theory) + 30 (Practical)

Course Objectives: The course aims to enable the students to solve problems in Physicswhich involves numerical methods by using FORTRAN as aprogramming language.

Learning Outcome: On completion of this course, the students will be able to:

- Understand various numerical methods
- Use FORTRAN language for numerical calculations
- Understand various concepts of Physics using numerical methods using FORTRAN as a programming language.

Pre-requisite: Nil

Theory:

1. Concepts of programming: [5 L]
Definition and Properties of algorithms, Algorithm development, Flow charts- symbols and simple flowcharts.

2. FORTRAN Programming [20 L]
Evolution of Fortran.
Simple Fortran Programs:
Writing a Program, Input statements, Some Fortran program examples.
Numerical Constants and Variables:
Constants, Scalar Variables, Declaring Variable Names, Implicit Declaration, Named Constants.
Arithmetic Expressions:
Arithmetic Operators and Modes of Expression, Integer Expressions, Real Expressions, Precedence of Operations in Expressions, Assignment Statements, Defining Variables, Some problems due to rounding of real numbers, mixed mode expressions, Intrinsic functions, Examples of Use of Functions.
Input-Output Statements:
List-directed input statements, List-directed output statements.
Conditional Statements:
Relational Operators, The block IF construct, Example programs Using IF structure.
Implementing Loops in Program:
The block DO loop, count control DO loop, Rules to be followed in writing DO loops.
Logical expressions and More Control statements:

Introduction, Logical constants, variables and expressions, precedence rules for logical operators, Some examples of use of Logical expressions, The case statements.
Functions and subroutines:
Introduction, function subprogram, syntax rules for function subprograms, Generic functions, Subroutines, Internal Procedures.

Defining and Manipulating Arrays:
Arrays Variables, Use of multiple subscripts, Do type notation for Input/Output Statements, Initializing arrays, Terminology used for multidimensional arrays, use of arrays in DO loops, whole array operations.
[Ref.1: Chapter-1 to Chapter-10]

3. Computational Physics: [20 L]
Errors in Computation:
Inherent errors in storing, Numbers due to finite bit representation to use in Computer, Truncation error, round off errors (Explain with the help of examples)
Iterative methods:
Discussion of algorithm and flowcharts and writing FORTRAN programs for finding single root of equation using bi-section method, Newton-Raphson method.
Least Square Curve fitting:
Discussion of algorithm and flowcharts and writing FORTRAN program for straight line fit with example in physics.
Numerical Integration:
Discussion of algorithm and flowcharts and writing FORTRAN program for trapezoidal rule and Simpson's 1/3rd rule.
Solution of Differential equations:
Discussion of algorithm and flowcharts and writing FORTRAN program for Euler's method for finding solution of differential equation.

(*Derivation of formula is not expected for all the above numerical methods*)
[Ref.2: Chapters - 2, 3, 6, 8 and 9]

Experiments:
Following programs may be discussed thoroughly in theory lectures and implemented in the practicals.

1. Sum of digits of an integer
2. To find factorial of a number
3. Checking and printing of prime numbers
4. Generation of Fibonacci numbers
5. To find sin(X), cos(X) using series method

6. Sorting of Numerical data - ascending, descending.
7. Matrix operations – addition, subtraction, multiplication
8. Graphics- line, circle, arc, bar, ellipse.
9. Root of equation-Bisection method, Newton Raphson method
10. Numerical integration- Trapezoidal, Simpson's 1/3rd rule.
11. Least square curve fitting- data for ohm's law.
12. Freely falling body and motion of falling body including air drag. (using Euler's method)
13. Electric field due to a point charge
14. Charging and Discharging of Capacitor in RC circuit/Growth and Decay of current in RL Circuit.

References:

1. Rajaraman V., Computer Programming in Fortran 90 and 95, Prentice-Hall of India, New Delhi, 2nd Edition (1987).
2. Rajaraman V., Computer Oriented Numerical Methods, Prentice-Hall of India, New Delhi, 2nd Printing (1999).

Additional References:

Verma P. K. and Ahluwalia and Sharma K. C., Computational Physics, New Age International Publishers, India, (1999).

Paper Title : **Astronomy and Astrophysics**

Paper Code : **PHY-IV.CE-8**

Name of Faculty : Reshma Raut Dessai

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1(Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Course objectives: The objective of this course is to develop an understanding of the scale, constituents, and physics of stellar astronomy. A descriptive course includes the methods of astronomy and astrophysics, the motions of celestial objects and the evolution of galaxies.

Learning outcome: On completion of this course, the students will get necessary foundation in astronomy and astrophysics that will prepare them for the advanced study in Astronomy.

Pre-requisite: .

Theory:

1. **Introduction to Astronomy** **[3L]**
   Introduction of astronomy and astrophysics. Importance and scope of astronomy. Methods of astronomy and astrophysics.The scientific method.
   [Abhyankar 1.1 - 1.5]

2. **Celestial coordinates** **[7L]**
   Spherical coordinates. Celestial sphere. Altazimuth system. Finding right ascension and declination of a star. Equatorial, ecliptic and galactic system of co-ordinates. Conversion of coordinates. Sky charts and their importance.
   [Abhyankar 2.1 – 2.8]

3. **Astronomical Scales and measurements** **[8L]**
   Units of measurement in astronomy. Measuring distances within solar system. Measuring distances in Universe: Parallax method. Standard Candle method**.** Cepheid variable method**.** RedShift.
   [Abhyankar 4.1 – 4.3]

4. **Stellar structure , Birth and Death of stars** **[8L]**
   Basic Properties of a Star: Star brightness, colour, magnitude. Effective temp of a star. Size, mass, and luminosity. Internal Structure of a star: The Hydrostatic Equilibrium. star formation and Proto stars. The Main Sequence (HR Diagrams). White Dwarf.Supernova.Neutron Stars and Black Holes.
   [Abhyankar 3.2, 9.1,9.2] [Maoz 4.1-4.5] [Choudhuri 3.2.1, 3.2.4, 3.6, 4.7]

5. **Galaxies** **[6L]**
   Galaxy formation and Evolution.Radio galaxies.Seyfert galaxies.Types of galaxies.Hubble tunning fork model for galaxy classification.Elliptical galaxies.Spiral galaxy.Lenticular galaxies.Irregular galaxies.Distance, luminosity, size and mass of galaxies.
   [Schneider 3.1, 3.2, 3.3] [Abhyankar 17.1,17.2]

6. **Milky way** **[5L]**
   Mass and size of the Milkyway Galaxy. Interstellar Medium and its composition. Structure of Milkway Galaxy from optical and radio observations. Star count. Distribution of stars in the solar neighbourhood. Motion of Stars within the Galaxy.
   [Choudhuri 6.1] [Abhyankar 14.1, 14.2,14.6,15.1]

7. **Telescopes and astronomy in different bands of electromagnetic radiation** **[8L]**
   Types of telescopes. Optical telescopes.Radio telescopes. Infrared and Ultraviolet telescopes. X-ray telescopes. Design and construction of an optical telescope. Schmidt telescopes. Optical astronomy.Infrared astronomy.Ultraviolet astronomy.Radio astronomy.X-ray astronomy and gamma ray astronomy.
   [Abhyankar 19.1 - 19.5] [Choudhuri 1.7]

Experiments: (Minimum Six)

1. Measurement of the solar constant.
2. Resolving power of telescope.
3. Study of scattering of light (Diameter of Lycopodium powder).
4. To obtain proper motion of Barnard's star using Aladin.
5. Draw constellation map of a) Orion b) Auriga c)Taurus d)Ursa Major (Big Dipper) marking of pole star.
6. To determine the elements in sun using Fraunhofer spectra.
7. To estimate Astronomical Unit using venus transit data by parallax method.
8. Data analysis technique using virtual observatory.
9. Determine the period of revolution of sun using virtual laboratory.

References:

1. K.D. Abhyankar, *Astrophysics: Stars and Galaxies* (University Press, 2001).
2. D. Maoz, *Astrophysics in a Nutshell AKA basic astrophysics* (Princeton University Press 2007).
3. Peter Schneider, *Extragalactic Astronomy and Cosmology an introduction* (Springer 2006).
4. A. R. Choudhuri, *Astrophysics for Physicists* (Cambridge University Press 2010).

Additional References:

1. Seed Backman, *Foundations in Astronomy and Astrophysics* (Cengage Learning 2013)
2. M.Sandage and J.Kristian, *Galaxies and the Universe* (University of Chicago Press).
3. Gordon Walker, *Astronomical Observations - an Optical Perspective* (Cambridge University press).

Paper Title : Instrumentation

Paper Code : PHY-IV.CE-8

Name of Faculty: Ananya Das and Yatin P. Desai

Marks: 75 (Theory) + 25 (Practical)

Credit: 3 (Theory) + 1(Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Course Objectives: The objective of this course is to understand basic concepts related to the various types of measuring instruments and measuring techniques.

Learning Outcome: On completion of this course, the students will get necessary knowledge of errors associated with instruments and basic principles involved in measuring instruments like Ammeter, Voltmeter, Ohmmeter and Multimeters.Students get familiar with working and use of CROs and Signal Generators. Students understand working and usage of the various types of transducers.

Pre-requiste: Nil

Theory:

1. **Fundamentals of Measurement: [6 L]**
   Introduction, Performance Characteristics, Static Characteristics, Errors in Measurements, Types of Static Error, Sources of Error, Dynamic Characteristics, Standard, Electrical Standards.
   [Ref.1: Chapter 1.2 to 1.7, 1.9, 1.10]

2. **Indicators and Display Devices: [5 L]**
   Types of Instrument, Basic Meter Movement: PMMC Movement and Practical PMMC Movement, Classification of Displays, Use of LED and LCD as Display Devices, Segmental Displays using LEDs.
   [Ref.1: Chapter 2.1, 2.2, 2.8, 2.10, 2.11, 2.12.3]

3. **Measuring Instruments: [12 L]**
   DC Ammeter, Multirange Ammeter, Universal Shunt, Requirements of a Shunt, Extending of Ammeter Ranges. Basic Meter as a DC Voltmeter, DC Voltmeter, MultirangeVoltmeter, Extending Voltmeter Ranges, Loading, Transistor Voltmeter(TVM), FET DC Voltmeter. AC Voltmeter using Rectifiers, Multirange AC Voltmeter, AC current measurements using AC Voltmeter and a series Resistor. Ohmmeter: Series type and Shunt type, Multimeter.
   Digital voltmeter: Ramp Technique, Digital Multimeters and Frequency meter (with help of Block Diagrams), Q meter.
   [Ref.1: Chapter 3.1 to 3.5, 4.2 to 4.7,4.12 to 4.15, 4.21, 4.22, 4.25, 5.2, 6.2,6.3,10.7 and Ref.2: Chapter 22: 22-9]

4. Oscilloscope: **[6 L]**

Basic Principle, Block Diagram of Oscilloscope, Simple CRO, Vertical Amplifier, Horizontal Deflecting System, sweep generator, Delay line.

[Ref.1: Chapter 7.2.1, 7.4, 7.5, 7.5.1, 7.6, 7.7.1, 7.10]

5. Signal Generator: **[4L]**

Standard Signal Generator, AF Sine and Square Wave Generator, Function Generator.

[Ref.1: Chapter 8.4, 8.5, 8.7, 8.8]

6. Transducers: **[12 L]**

Introduction, Electrical Transducer, Selecting a Transducer, Strain Gauges, Resistance Wire Gauge, Types of Strain Gauges(Wire), Foil Strain Gauge, Semiconductor Strain Gauge, Inductive Transducer, Differential Output Transducers, Linear Variable Differential Transducers (LVDT), Capacitive Transducer, PiezoElectric Transducer, Semiconductor Diode Temperature Sensor, Temperature Transducers: Resistance Temperature Detectors, Thermistors, Thermocouples.

[Ref.3: Chapter 36.1 to 36.3, 36.12 to 36.15] [Ref.1: Chapter 13.1 to 13.3, 13.6, 13.6.1 to 13.6.4, 13.9, 13.9.1, 13.9.2, 13.10, 13.11, 13.13, 13.15, 13.20.7]

Experiments: **(Minimum six)**

1. Use of CRO and Function Generator (AC/DC voltage measurement, frequency measurement).
2. To measure displacement (linear and angular) using potentiometer/variable inductor/variable capacitor.
3. Construction and design of analog two ranges Voltmeter.
4. Construction and design of analog two ranges Ohmmeter.
5. Crystal Oscillator: Determination of velocity of ultrasonic waves in a liquid medium.
6. Study of strain Gauges
7. Study of LVDT (including calibration) and its use in any one application.
8. Calibration of Thermocouple
9. Thermistor as a temperature sensor.

References:

1. Kalsi H S, Electronics Instrumentation, Tata McGraw Hill Education Pvt. Ltd. New Delhi, 3rd Edition (2010).
2. Mottershead Allen, Electronics Devices and Circuits An Introduction, Prentice-Hall of India Pvt. Ltd., New Delhi, 23rd Printing, (2000).
3. Theraja B. L., Basic Electronics (Solid State), S. Chand and Company Ltd., New Delhi, 1st Multicolour Edition (2005).

Additional References:

1. Boylestad Robert and Nashelsky Louis, Electronic Devices and Circuit Theory, Prentice-Hall of India Pvt. Ltd., New Delhi, 6th Edition (2000).

Paper Title : Elementary Modern Physics

Paper Code : PHY-III.CM-3

Name of Faculty: Ashish Desai

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Course Objective:

The course will focus on the two major theories, which were developed in the beginning of the 20^{th} century, the special theory of relativity and the quantum mechanics. Lectures will help the students in clarifying the concepts of modern physics through various conceptual questions and problems.

Learning Outcome:

Upon completion of this course students will develop a better understanding of fundamental concepts and theories of modern physics required for advanced courses in physics and other physical sciences. Students will also be able to analyze and solve basic problems in modern physics.

Theory:

1. **Special Theory of Relativity: [8L]**
   Postulates of special theory of relativity. The Michelson-Morley experiment. The Galilean transformation. The Lorentz transformation. The Lorentz-Fitzgerald contraction. Time dilation. Simultaneity.
   [Beiser 1.2-1.8]

2. **Relativistic Mechanics: [6L]**
   Velocity addition. The relativity of mass. Mass and energy
   [Beiser 2.1-2.5]

3. **Particle Properties of waves: [5L]**
   Concepts of Black Body Radiation. The Photoelectric effect. Compton effect, Experimental verification of the Photoelectric effect.
   [Beiser 3.1-3.2, 3.5]

4. **Wave Properties of Particles: [9L]**
   De Broglie's hypothesis. Wave function. Wave and group velocities. Davisson-Germer Experiment. Experiments with bullets, waves and electrons. The interference of electron waves. Watching the electrons. The uncertainty principle and its application.
   [Beiser 4.1-4.8, Feynman 1.1-1.8]

5. **Schrodinger's Wave Equation**: **[8L]**
Derivation of the wave equation on a stretched string. Schrodinger's Equation: Time-dependent form. Probability current. Expectation values and operators. Schrodinger's equation: Steady state form. Eigenvalues and Eigenfunctions.
[Beiser 7.1-7.9]

6. **Application of Quantum Mechanics** **[9L]**
6.1 Free particle.
6.2 Particle in a one-dimensional infinite square well potential.
6.3 One dimensional step potential of finite height (Energy less than step height and energy greater than step height)
6.4 One dimensional potential barrier. Qualitative discussion of alpha decay.
[Eisberg: 6.2-6.6, 6.8]

Experiments: (Minimum Six)

1. Measurement of diameter of Lycopodium powder
2. Fraunhoffer diffraction over double slit
3. Frank Hertz Experiment
4. Photoelectric effect.
5. Determination of Boltzmann's constant using transistor.
6. Determination of e/m of electrons using Thomson's method.
7. Michelson Interferometer.

References:

1. Beiser, A 1969, *Perspectives of Modern Physics*, McGraw-Hill Book Company, Singapore.
2. Eisberg, R. And Resnick, R. 2010, *Quantum Physics of Atoms, Molecules, Solids, Nuclei and particles*, 2nd Edition, Wiley India Pvt Ltd.
3. Feynman, RP 2012, *Feynman Lectures on Physics: Quantum Mechanics (Volume - 3)*, Pearson Education, India.

Additional References:

1. Griffiths, D 2015, *Introduction to Quantum Mechanics*, Pearson Education, India.
2. Singh, K. 2013, *Elements of Quantum Mechanics*, S. Chand and Company, New Delhi.
3. Resnick, R. 2010, *Introduction to Special Relativity*, Wiley India Pvt Ltd, India.
4. Verma, HC 2012, *Quantum Physics*, TBS, Calicut.
5. Wichmann E 2010, *Quantum Physics: Berkeley Physics Course Vol 4*, Mcgraw Hill Education, India.

Paper Title : Heat and Optics

Paper Code : PHY-IV.CM-4

Name of Faculty: Yatin P. Desai and Ananya Das

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Contact Hours: 45 (Theory) + 30 (Practical)

Course Objectives: The objective of this course is to understand basics of Heat and Optics.

Learning Outcome: On completion of this course, the students will get necessary foundation in Heat and Optics that will prepare them for the advanced study in Thermodynamics and Optics.

Theory:

Section-I : Heat

Unit 1: Equations of State **[5L]**

Equation of state, Andrew's experiment, Amagat's experiment, Van der Waal's equation of State, Critical constants, Reduced equation of state, Boyle temperature.

[Saha& Srivastava: 10.1 -10.6, Brij.&Subr.: 2.6, 2.14]

Unit 2: Laws of Thermodynamics **[12L]**

Thermodynamic system, Thermodynamic variables, Thermodynamic equilibrium, and Thermodynamic processes, Zeroth law of thermodynamics, Concept of work and internal energy, First law of thermodynamics, Isothermal and adiabatic changes, Work done in isothermal and adiabatic changes, Relation between pressure, volume and temperature in adiabatic process, Reversible and irreversible processes, Carnot Heat engine, Carnot cycle for perfect gas, efficiency, Second law of thermodynamics (Kelvin – Planck Statement, Clausius Statement).

[Brij.&Subr.: 4.1, 4.4 – 4.7, 4.10.4, 4.11 - 4.13, 4.20 – 4.24, 4.28]

Unit 3: Principle of Thermometry **[5L]**

Review of concept of heat and temperature, Thermometry, Types of thermometers, Centrigrade, Fahrenheit, Rankine Scales and relations between them, Platinum resistance thermometer, Thermocouple (thermoelectric) thermometers.

[Saha& Srivastava: 13.1 – 13.5, 13.15, 13.23]

Section-II: Optics

Unit-1 **[6L]**

Lenses: thin and thick lenses, Lens equation, Lens maker's formula, Cardinal points of an optical system, Combination of coaxially placed two thin lenses (equivalent lenses) (including derivation for focal length and cardinal points).

[Ref.1: 4.8, 4.9, 4.10, 4.11, 4.12, 4.15, 5.2, 5.2.1, 5.2.2, 5.2.3, 5.3, 4.17, 5.10, 6.1, 6.2]

Lens Aberrations: Introduction, Types of Aberrations: Monochromatic and Chromatic aberration, Methods to minimize Spherical and Chromatic Aberrations (only concept, without derivation)

[Ref.1: 9.1, 9.2, 9.5, 9.5.1, 9.10 , 9.11, 9.12, 9.13]

Optical Instruments:

Objective and Eyepiece, Huygen's eyepiece, Ramsden's eyepiece and Constant deviation Spectrometer.

[Ref.1: 10.8, 10.10, 10.10.1, 10.11, 10.11.1, 10.12, 10.17]

Unit-2 **[6L]**

Interference:

Introduction: Superposition of waves, Interference, Coherence, Conditions for Interference, Techniques of obtaining Interference, Phase Change on reflection: Stoke's law.

[Ref.1: 14.3, 14.4, 14.4.2, 14.4.4, 14.6, 14.7, 14.8 and Ref.2: 6.3]

Interference in Thin Films: Thin Film, Plane Parallel Film, Interference due to Transmitted light, Haidinger Fringes, Wedge-shaped Film, Newton's Rings.

[Ref.1: 15.1, 15.2, 15.2.1 to 15.2.5, 15.3, 15.4, 15.5, 15.5.1 to 15.5.4, 15.6, 15.6.1 to 15.6.9]

Unit-3 **[6L]**

Diffraction:

Difference between Interference and Diffraction, Types of diffraction: Fresenel Class and Fraunhoffer Class.

[Ref.1: 17.6, 17.7 and Ref.2: 7.5, 7.6]

Diffraction of Light (Fresnel Class):

Division of cylindrical wave-front into Fresnel's half period strips(concept), Diffraction at Straight edge.

[Ref.2: 7.9, 7.10]

Diffraction of Light (Fraunhoffer Class):

Diffraction at a single slit (Central maximum, Secondary maxima and Secondary minima), Diffraction at double slit(Concept, no derivation), Distinction between single slit and double slit diffraction patterns, Missing orders in a double slit diffraction pattern, Resolving Power, Rayleigh's criterion, Resolving power of telescope.

[Ref.1: 18.2, 18.2.1, pg.431 to 433, 18.4, 18.4.1, 18.4.2, 18.4.3, 19.1, 19.2, 19.6, 19.7]

Unit-4 **[5L]**

Polarization:

Polarized Light, Natural Light, Production of Linearly Polarised Light, Anisotropic Crystal, Calcite Crystal, Huygens Theory of Double Refraction in Uniaxial crystal, Nicol prism- its fabrication, working and use, Optical activity, Specific rotation, Simple Polarimeter.

[Ref.1: 20.3, 20.4, 20.5, 20.5.1, 20.5.2, 20.7, 20.8, 20.8.1 to 20.8.3, 20.9, 20.9.1, 20.9.2, 20.6.1, 20.24, 20.25, 20.26]

Experiments: (Minimum six)

I. Heat: (Minimum Three)

1. Calibration of Si diode as a Thermometer
2. Constant Volume Air Thermometer
3. Thermal conductivity by Lee's method
4. Temperature coefficient of resistance of Copper

II. Optics: (Minimum Three)

1. Newton's Rings
2. Brewster's Law
3. Cardinal points
4. Spectrometer: Dispersive Power of prism

References:

I. Heat:

1. Saha M.N., Shrivastava B.N., *Treatise on Heat*, The Indian Press 5th Ed. (1965).
2. Brijlal, Subramanyam N., Hemne P.S., *Heat Thermodynamics and Statistical Physics*, S. Chand (2007).

II. Optics:

3. Subhramanyam N., Lal Brij, Avadhanulu M. N., A Text book of Optics, S. Chand & Company Ltd., New Delhi, First multicolour Edition (2006).
4. Singh S. P. and Agarwal J. P., Optics, PragatiPrakashan, 8th Edition (2001).

Additional References:

1. Roberts J. K., Miller A.R., *Thermodynamics*, E.L.B.S. (1960).
2. Zemansky M.W., Ditman R.H., *Heat and Thermodynamics*, McGraw Hill, 8th Ed. (5th reprint), 2013
3. Ghatak Ajoy, Optics, Tata McGraw-Hill Publishing Company Ltd. (1977)
4. Jenkins F. A. and White H. E., Fundamentals of Optics, Tata McGraw-Hill Publishing Company Ltd., (1981)

Annexure III

Pattern of Question paper for Semester End Examination

Q1 12 Marks	Q2 18 Marks	Q3 18 Marks	Q4 24 Marks	Max marks	Total marks
Any 3 OF 4 **3×3= 9 Marks**	**Any 2 OF 3** **2×6=12 Marks**	**Any 2 OF 3** **2×6=12 Marks**	**Any 1 OF 2** **12 Marks**	**45**	**72**

Note: The Question no. 4of the approved Question Paper pattern may be divided into sub questions with combinations of **6+6** or **6+3+3** or**5+4+3** or**4+4+4** or **3+3+3+3** marks.

Annexure I

Core Courses in Physics (Major)

Sr. No	Semester	Title of the Paper	Code
1	I	Introduction to Mathematical Physics	PHY-I.C-1
2	I	Mechanics-I	PHY-I.C-2
3	II	Heat and Thermodynamics	PHY-II.C-3
4	II	Electricity and Magnetism	PHY-II.C-4
5	III	Electromagnetic Theory-I	PHY-III.C-5
6	IV	Quantum Mechanics	PHY-IV.C-6
7	V	Electromagnetic Theory-II	PHY-V.C-7
8	VI	Atomic and Molecular Physics	PHY-VI.C-8

Elective Courses in Physics (Major)

Sr. No.	Semester	Title of the Paper	Code
1	III	*Optics	PHY-III.CE-1
2	III	Modern Physics	PHY-III.CE-2
3	III	Oscillations, Waves and Sound	PHY-III.CE-3
4	III	Properties of Matter and Acoustics	PHY-III.CE-4
5	IV	*Electronics-I	PHY-IV.CE-5
6	IV	Solid State Devices	PHY-IV.CE-6
7	IV	Computational Physics	PHY-IV.CE-7
8	IV	Instrumentation	PHY-IV.CE-8
9	V	*Solid State Physics	PHY-V.CE-9
10	V	Thermodynamics and Statistical Mechanics	PHY-V.CE-10
11	V	Electronics-II	PHY-V.CE-11
12	V	Mathematical Physics	PHY-V.CE-12
13	VI	*Mechanics II	PHY-VI.CE-13
14	VI	Nuclear and Elementary Particle Physics	PHY-VI.CE-14
15	VI	Introduction to Special Theory of Relativity	PHY-VI.CE-15
16	VI	Introduction to Material Science	PHY-VI.CE-16
17	VI	Introduction to Astronomy and Astrophysics	PHY-VI.CE-17

*****BoS Physics recomends these elective courses to be taken by students as a prerequisite to the M.Sc. (Physics) Program.

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Core Courses in Physics (Minor)

Sr. No.	Semester	Title of the Paper	Code
1	I	Mechanics, Properties of Matter and Sound	PHY-I.MI-1
2	II	Electricity, Magnetism and Electronics	PHY-II.MI-2
3	III	Elementary Modern Physics	PHY-III.MI-3
4	IV	Heat and Optics	PHY-IV.MI-4
5	V	Statistical Physics and Solid State Physics	PHY-V.MI-5
6	VI	Atomic and Nuclear Physics	PHY-VI.MI-6

Note: Courses listed above are of 3 credits of Theory (45 Contact Hours) and 1 credit of Practical (15 sessions, each session of 2 Contact Hours).

Annexure II

ParvatibaiChowgule College of Arts and Science (Autonomous)
Margao, Goa

Syllabus for

Semester-V and Semester-VI

of the undergraduate degree courses

in

Physics

(2017-2018)

Core and Elective Courses for students taking Physics as their Major subject.

Semester V

1. Electromagnetic Theory-II
2. Solid State Physics
3. Thermodynamics and Statistical Mechanics
4. Electronics-II
5. Mathematical Physics

Semester VI

1. Atomic and Molecular Physics
2. Mechanics II
3. Nuclear and Elementary Particle Physics
4. Introduction to Special Theory of Relativity
5. Introduction to Material Science
6. Introduction to Astronomy and Astrophysics

Paper Title: Electromagnetic Theory – II

Paper Code: PHY-V.C-7

Marks: 75 (Theory) + 25 (Practical)

Credits: 3 (Theory) + 1 (Practical)

Contact Hours: 45 (Theory) + 30 (Practical)

Course Objectives: To acquaint students with fundamental principles of Magnetostatics part of the Electromagnetic Theory.

Learning Outcome: At the end of this course, students would be able:

a) to calculate magnetic field using Biot-Savart law and Ampere's law.
b) understand the link between electrostatics and magnetostatics using Maxwell's equations.
c) learn about the propagation of electromagnetic waves.

Pre-requisite: Electromagnetic Theory – I (PHY-III.C-5)

Theory:

1. Magnetostatics **[12L]**

Lorentz force law: Magnetic fields, Magnetic forces, Currents, Biot-Savart law: Steady currents, Magnetic fields of a steady current, Divergence and Curl of **B**: Straight-line currents, divergence and curl of **B**, applications of Ampere's law, comparison of magnetostatics and electrostatics, Magnetic vector Potential: Vector potential, magnetostatic boundary conditions, multipole expansion of the vector potential.
[Griffiths: 5.1: 5.1.1 – 5.1.3, 5.2: 5.2.1 – 5.2.2, 5.3: 5.3.1 – 5.3.4, 5.4: 5.4.1 – 5.4.3]

2. Magnetic Fields in Matter **[14L]**

Magnetization: Diamagnets, paramagnets and ferromagnets, torques and forces on magnetic dipoles, effect of a magnetic field on atomic orbits, magnetization, the field of a magnetized object: Bound currents, physical interpretation of bound currents, magnetic field inside matter, The auxiliary field H: Ampere's law in magnetized materials, a deceptive parallel, boundary conditions, Linear and nonlinear media: Magnetic susceptibility and permeability, Energy in magnetic fields.
[Griffiths: 6.1: 6.1.1 – 6.1.4, 6.2: 6.2.1 – 6.2.3, 6.3: 6.3.1 – 6.3.3, 6.4: 6.4.1 – 6.4.2, 7.2.4]

3. Microscopic Theory of Magnetism **[5L]**

Molecular field inside matter, origin of diamagnetism, origin of paramagnetism, theory of ferromagnetism, ferromagnetic domains, ferrites
[Reitz: 10.1 – 10.2]

4. Maxwell's Equations **[4L]**

Generalization of Ampere's law, displacement current, Maxwell's equations and their ampirical basis, electromagnetic energy, Poynting theorem.

[Reitz: 16.1 – 16.3]

5. Propagation of Electromagnetic Waves **[10L]**

The wave equation, plane monochromatic waves in non-conducting media, polarization, plane monochromatic waves in conducting media, reflection and refraction at the boundary of two non-conducting media: normal incidence and oblique incidence, Brewster's angle, critical angle.

[Reitz: 16.4, 17.1, 17.2, 17.4, 18.1, 18.2]

Experiments: (Minimum Six)

1. Hysteresis by magnetometer.
2. B-H curve in a hard magnetic material and in a soft ferrite.
3. Core losses and copper losses in a transformer.
4. Measurement of mutual inductance using ballistic galvanometer.
5. Calibration of lock-in-amplifier and determination of mutual inductance.
6. Determination of magnetic susceptibility of $FeCl_3$ by Quincke's method.
7. M/C using ballistic galvanometer

References:

1. Griffiths D. J., 2011, *Introduction to Electrodynamics,* 3rd Ed. , Prentice Hall of India.

2. Reitz J. R., Milford F. J., Christy R. W., 1979, *Foundations of Electromagnetic Theory*, 3rd Ed., Addison-Wesley Publishing Company.

Additional Reference:

1. Mukherji U., 2008, *Electromagnetic Field Theory and Wave Propagation*, Narosa Publishing House.

Paper Title : Solid State Physics

Paper Code : PHY-V.CE-9

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Course Objective: To give the students a firm understanding of the basics of Solid State Physics. The course broadly deals with the topics related to structural aspects and the various physical properties of crystalline solids.

Learning Outcome: After completion of this course, students will develop a comprehensive broad knowledge in topic such as: Bondings in Solids, Crystal Physics, Electrical properties of solids, Origin of energy band structure in solids and Magnetic properties of materials.

Pre-requisites: Modern Physics and Quantum Mechanics

Theory:

1. Bonding in Solids: [5 L]

Introduction, Bonding in Solids, Cohesive energy, Ionic bonding, Calculation of Cohesive energy of ionic solids, Covalent bonding, Metallic bonding, Hydrogen bonding, Van der Waals (Molecular) bonding.

[Palanisamy: 1.1, 1.2, 1.3, 1.4, 1.4.1, 1.5 - 1.5.2, 1.6 - 1.9]

2. Crystal Structure: [12 L]

Introduction, Space Lattice, Unit cell, Lattice Parameter of unit cell, Bravais lattices, Crystal Symmetry, Stacking sequences in metallic crystal structure, SC, BCC, FCC and HCP structures, Crystal structures- NaCl, diamond, CsCl, ZnS, Directions in crystals, Planes in crystals- Miller indices, Distances of Separation between Successive (*hkl*) Planes.

[Palanisamy: 2.1, 2.2 - 2.2.3, 2.3 - 2.3.4, 3.1, 3.2, 3.3 -3.3.2, 3.4]

3. Diffraction of X-rays by Crystals: [5 L]

Introduction, Bragg's law, Production of X-rays, Determination of lattice parameters and X-ray Diffraction methods: Laue method and Debye Scherrer method.

[Palanisamy: 4.9 - 4.9.3, 4.10 - 4.10.2]

4. Electron Theory of Metals: [18 L]

Introduction, Classical free electron theory, Quantum theory of free electrons, Fermi distribution function, Density of energy states, Sources of electrical resistance, Electrons in a periodic potentials, Energy bands in Solids.

[Palanisamy: 6.1, 6.2 - 6.2.2, 6.3, 6.3.1, 6.4, 6.5, 6.6, 6.7-6.7.5, 6.8]

5. Magnetic Properties: [5 L]

Introduction, Classification of magnetic materials, The quantum numbers, Origin of magnetic moment, Ferromagnetism, Ferromagnetic domains, Hysteresis, Hard and soft materials.

[Palanisamy: 8.1, 8.2, 8.3, 8.4, 8.7, 8.7.3, 8.7.5, 8.7.6]

Experiments: (Minimum Six)

1. Energy band gap of a semiconductor
2. Energy band gap of LEDs
3. To determine value of Planck's constant using LEDs of at least 4 different colours.
4. Fermi energy of Copper
5. Measurement of Hysteresis loss using CRO
6. Calculation of lattice constant by of Copper – X-ray diffraction pattern is given and student calculates: d-spacing, miller indices and lattice constant
7. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four-probe method (room temperature to 150 ^{o}C) and to determine its band gap

References:

1. Palanisamy P. K., 2004, *Solid State Physics,* Scitech Publications (India) Pvt. Ltd.
2. Pillai S. O., 1999, *Solid State Physics*, 3rd Edition, New Age International (P) Ltd, Publisher.
3. Kittel C., 2004, *Introduction to Solid State Physics*, 8th Edition,John Wiley and Sons.
4. Dekker A. J., 1998, *Solid State Physics*, Macmillan India Ltd. Publisher.

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Paper Title **: Thermodynamics and Statistical Mechanics**

Paper Code **: PHY-V.CE-10**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Contact Hours **: 45 (Theory) + 30 (Practical)**

Pre-requisite: PHY-II.C-3

Course Objectives: Topics covered include Power cycles, conversion of heat into useful work, phase transitions, classical and quantum distribution.

Learning Outcome: After completion of this course students will be able to understand applications of thermodynamics and statistical mechanics such as description of system involving many particles.

Theory

1. **Thermodynamic Potentials** **[4 L]**
   The Helmholtz function and Gibbs function, Thermodynamic Potentials, Maxwell Relations.
   [Ref#5 Section 7.1-7.3]

2. **Production of low temperature.** **[18 L]**
   Cooling by evaporation. Vapour compression machines. Refrigerators based on Vapour absorption. Cooling by sudden adiabatic expansion of compressed gases. Efficiency and performance of Refrigerating machines. Enthalpy and heat flow. Joule Kelvin effect. Expression for joule Kelvin coefficient and inversion temperature. Van der Waals' gas. Principles of regenerative and cascade cooling. Liquifaction of hydrogen and helium. Production of temperatures below 4 K. Properties of He I and He II. Cooling by Adiabatic Demagnetisation of paramagnetic substances.
   [Ref#1 Section 7.3,7.4,7.7,7.9,7.10-7.18 Ref#2 section 12.1-12.10]

3. **Probability** **[11 L]**
   Random Events, Probability, Probability and Frequency, Some basic rules of Probability theory, Continuous random variables, Mean value of discrete and continuous variables, Variance: Dispersion, Probability Distribution, Binomial distribution: Mean value and fluctuation, Stirling's Approximation, Poisson Distribution: Mean value and Standard deviation, Gaussian Distribution: Standard deviation, Random Walk.
   [Ref#1 Section 9.1-9.10 Ref# 2 pp 5-16]

4. **Statistical Thermodynamics** **[12L]**

   Phase space, Macrostate and Microstate, Maxwell Boltzman Statistics. Molecular speeds: mean, most probable and rms speeds. Experimental verification of Maxwell Boltzman statistics. Statistical interpretation of Entropy, Quantum statistics: Bose Einstein and Fermi Dirac distribution law.

   [Ref#1 Section 11.4-11.6, 10.15, 10.21, 12.5-12.8 Ref# 4 15.1-15.6, 16.1, 16.5]

Experiments: (Minimum Six)

1. Specific heat of Graphite
2. Study the temperature dependence of resistivity.
3. OPAMP as a bridge amplifier and its application in temperature measurement
4. Determination of Boltzmann constant
5. Tutorial on Maxwell Equation and Free enrgy
6. Tutorial on Probability
7. Tutorial on Probability
8. Tutorial on Statistical Thermodynamics
9. Tutorial on Statistical Thermodynamics

References:

1. Brijlal, Subrahmanyam N., 2008, *Heat thermodynamics and Statistical Physics*, S Chand Company Ltd.
2. Laud B., 2003, *Introduction to Statistical Mechanics*, New Age International.
3. Saha M. and Shrivastava B., 1965, *Treatise on heat*, The Indian Press.
4. Beiser A., 1995, *Perspectives of modern physics,* 5th edition, McGraw hill.
5. Sears F. and Salinger G., 1998, *Thermodynamics, Kinetic Theory and Statistical Thermodynamics*, 3rd Edition, Narosa.

Additional References:

1. Garg S., Bansal R.and Ghosh C., 1993, *Thermal Physics*, Tata McGraw Hill.
2. Zemansky M. and Ditman R., 1997, Heat *and Thermodynamics*, McGraw Hill.
3. Reif F., 1965, *Fundamentals of Statistical and Thermal Physics*, Mc Graw Hill

Paper Title **: Electronics-II**

Paper Code **: PHY-V.CE-11**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Contact Hours **: 45 (Theory) + 30 (Practical)**

Pre-requisite: PHY-IV.CE-5

Course Objectives: This course aims at introducing students to analog and digital circuits.

Learning Outcome: After completion of this course, students will understand the analysis of AC circuits and will be able to apply these techniques in designing circuits.

Theory

1. **AC Models (BJT)** **[4 L]**
   Base-Biased amplifier, Emitter-Biased amplifier, Small signal operation, analyzing an amplifier.
   [Ref.# 1 Article 9.1 to 9.7]

2. **Transistor Multivibrators** **[4 L]**
   Transistor as a switch, switching times, Multivibrators – Astable, Monostable, Bistable and Schmitt Trigger.
   [Ref.# 3 Article 18.1 to 18.5]

3. **FET's and MOSFET's** **[9 L]**
   Basic structure of the JFET, Principles of operation, Characteristic curves and parameters, Common source amplifiers, Common gate amplifier,
   MOSFET: Depletion Mode and Enhancement mode, Dual-Gate MOSFET.
   FET Phase shift oscillator, FET as VVR and its applications in Attenuator, AGC and Voltmeter circuits.
   [Ref.# 1 Article 13.1 to 13.9, 14.1 to 14.5]

4. **OPAMP Applications** **[4 L]**
   Active diode circuits, Comparator, Window comparator, Schmitt Trigger, Waveform generator –Square wave, Triangular and Ramp Generator and monostable.
   [Ref. #1 Article 22.7, 22.8]

5. **Timers** **[4 L]**
   The 555 Timer, Basic concept, 555 block diagram, Monostable, Astable, Bistable, Schmitt Trigger and Voltage controlled oscillator (VCO) using 555 timer.
   [Ref.# 1 Article 23.7, 23.8]

6. **Monolithic Linear Regulators** **[3 L]**

Basic type of IC regulator, Load and line regulation, LM7800 series,Current Boosters,LM-317 or LM7812 as a voltage regulator.

[Ref#4 24.4,24.5]

7. **Digital Circuits** **[8 L]**

Binary number system, Binary to Decimal and Decimal to Binary conversion, Basic logic gates, AND, OR, NOT (realization using Diodes and Transistor), NAND, NOR as universal building blocks in logic circuits, EX-OR and Ex-NOR gates.

Boolean Algebra:De Morgan's Law's, Boolean Laws, NAND and NOR gates, Sum of Products methods and Product of Sum methods of representation of logical functions. Half adder and Full adder,

Data Processing Circuits: Multiplexer and Demultiplexer, Encoders and decoders.

[Ref. # 2 Article5.1 to 5.8.1, 6.1, and 6.2]

8. **Sequential Circuits** **[9 L]**

Basic RS FF, Clocked RS FF, JK FF, D-type and T-type FF, Master Slave Concept.

Shift Registers: Serial-in-Serial-Out, Serial-in-Parallel-out, Parallel-in-Serial-out, Parallel-in-Parallel-out Shift registers (upto 4 bits)

Counters: Applications of FF's in counters, binary ripple counter, Modulus of counter (3,5) BCD Decade Counter, Cascade BCD Decade counters.

[Ref.# 2 Article7.1 to7.9, 8.1, 8.2, 8.4]

Experiments (Minimum Six):

1. Astable Multivibrator
2. Monostable Multivibrator
3. Bistable Multivibrator
4. Schmitt Trigger
5. F.E.T Characteristics
6. Op-Amp As A Bridge Amplifier And Its Application In Temperature Measurement
7. IC Lm 317 Voltage Regulator
8. IC 555 Timer As Astable Multivibrator And Its Use As Voltage Controlled Oscillator
9. IC 555 Timer As Monostable Multivibrator
10. Digital Multiplexer
11. Verification Of De Morgan’s Theorems And Boolean Identities
12. Nand And Nor Gates As Universal Building Blocks
13. Binary Addition –Half Adder And Full Adder Using Gates

References :

1. Malvino A., 1996, *Electronic Principles*, 5th edition, Tata McGraw Hill.
2. Jain R. P. 2003, *Digital Electronics*, 3rd edition, Tata McGraw Hill.
3. Mottershed A. 1997, *Electronics Devices and Circuits an Introduction*, PHI
4. Malvino A. and Bates D.J., 2007, *Electronic Principles*, 7th edition, Tata McGraw Hill

Additional References:

1. Malvino A. and Leach D. 1986, *Digital Principles and Applications,* 4th edition Tata McGraw Hill.
2. Millman J. and Halkias C., 1972, *Intergrated Electronics*, Tata McGraw Hill.
3. Millman J. and Halkais C., 1967, *Electronic Devices and Circuits,* Mc Graw Hill.
4. Mehta V.K., 2003, *Principles of Electronics,* 8th edition, S.Chand & Company.

Paper Title: Mathematical Physics

Paper Code: PHY-V.CE-12

Marks: 75 (Theory) + 25 (Practical)

Credits: 3 (Theory) + 1 (Practical)

Contact Hours: 45 (Theory) + 30 (Practical)

Course Objectives: To acquaint students with mathematical skills which are required to study various concepts of Physics.

Learning Outcome: At the end of this course, students would be able to apply mathematical techniques such as: calculus of residues, solutions of Legendre, Bessel and Hermite equations, Fourier transforms of different functions in solving various Physics problems.

Pre-requisite: Introduction to Mathematical Physics (PHY-I.C-1)
Theory:

1. **Functions of a Complex Variables** **[8 L]**

Introduction, complex variables and representations: algebraic operations, Argand diagram: vector representation, complex conjugate, Euler's formula, De Moivre's theorem, the n^{th} root or power of a complex number, analytic functions of a complex variable: the derivative of f(z) and analyticity, harmonic functions, contour integrals, Cauchy's integral theorem, Cauchy's integral formula.
[Harper: 3.1, 3.2: 3.2.1 – 3.2.6, 3.3: 3.3.1 – 3.3.5]

2. **Calculus of Residues** **[8 L]**

Zeroes, isolated singular points, evaluation of residues: m^{th} order pole, simple pole, the Cauchy residue theorem, the Cauchy principal value, evaluation of some definite integrals.
[Harper: 4.1 – 4.3: 4.3.1 – 4.3.2, 4.4 – 4.6: 4.6.1-4.6.4]

3. **Partial Differential Equations and Special Functions of Mathematical Physics** **[14 L]**

Introduction,Some important partial differential equations in physics, an illustration of the method of direct integration, method of seperation of variables, the Hermite polynomials: basic equations of motion in mechanics, one-dimensional linear harmonic oscillator, solution of Hermite's differential equation, Legendre and associate Legendre polynomials: spherical harmonics, the azimuthal equation, Legendre polynomials, Bessel function: introduction: solution of Bessel's equation, analysis of various solutions of Bessel's equation, characteristics of Bessel functions.
[Harper: 6.1 – 6.5: 6.5.1 – 6.5.3, 6.5.8]

4. Fourier Series **[7 L]**

Introduction: The Fourier cosine and sine series, change of interval, Fourier integral, complex form of Fourier series, generalized Fourier series and Dirac-delta function, summation of the Fourier series.

[Harper: 7.1 – 7.3]

5. Fourier Transforms **[8 L]**

Introduction, theory of Fourier transforms: formal development of the complex Fourier transform, cosine and sine transforms, multiple-dimensional Fourier transforms, the transforms of derivatives, the convolution theorem, Parseval's relation, the wave packet in quantum mechanics: origin of the problem - quantization of energy, the development of a new quantum theory, a wave equation for particles - the wave packet.

[Harper: 8.1 – 8.3]

Experiments: (Minimum Six)

1. Generating and plotting Legendre Polynomials.
2. Generating and plotting Bessel function.
3. Generating and plotting Hermite Polynomials.
4. Using spherical polar co-ordinates obtain an expression for divergence and curl of a vector function, operate gradient and Laplacean operator on a scalar function.
5. Using cylindrical co-ordinates obtain an expression for divergence and curl of a vector function, operate gradient and Laplacean operator on a scalar function.
6. Fourier series: programme to sum: $\sum_{n=1}^{\infty}(0.2)^n$, and to evaluate Fourier co-efficients of a given periodic functions.
7. Compute the n^{th} roots of unity for n = 2, 3, and 4.

References:

1. Harper, C., 1993, *Introduction to Mathematical Physics*, 5^{th} Ed. , Prentice Hall of India,.
2. Arfken G., 2005, *Mathematical Methods for Physicists*, Elsevier.
3. Spiegel, M.R., 2004, *Fourier Analysis*, Tata McGraw-Hill.

Additional References:

1. Riley K. F., Hobson M. P., Bence S. J., 1998, *Mathematical Methods for Physics and Engineering*, Cambridge University Press
2. Boas M. L., 2013, *Mathematical Methods in Physical Sciences*, John Wiley and Sons, 3^{rd} Ed.
3. Lipschutz S., 1974, *Schaum Outline of Theory and Problems of Complex Variables*, Mc Graw Hill.

Paper Title **: Atomic and Molecular Physics**

Paper Code **: PHY-VI.C-8**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Contact Hours **: 45 (Theory) + 30 (Practical)**

Pre-requisite: Quantum Mechanics (PHY-IV.C-6)

Course Objectives: Atomic and molecular physics is the study of dynamics and interactions of the basic building blocks of matter. The objective of this course is to study the behaviour of the electrons that surround the atomic nucleus which will help students to understand the dynamics atoms and molecules.

Learning outcome: After successful completion of this course, student will be able to understand the atomic structure, and dynamics of atoms and molecules. They will also gain insight to the physics of atomic and molecular spectral lines.

Theory:

1. **Quantum Theory of the Hydrogen Atom**: **[6 L]**
   Schrodinger's equation for the H-atom. Separation of variables, Eigen values, Quantum numbers and Magnetic moment. Angular momentum, Electron Probability density.
   [Beiser 9.1-9.9]

2. **Many Electron Atoms:** **[7 L]**
   Electron Spin.. Pauli Exclusion Principle and classification of elements in periodic table. Symmetric and Antisymmetric wave functions. Electron configuration. Hund's rule. Total angular momentum. L-S coupling. J-J coupling.
   [Beiser 10.1, 10.3- 10.9]

3. **Atoms in a Magnetic Field:** **[7 L]**
   Effects of magnetic field on an atom. Larmor Precession. The Stern-Gerlach experiment. Spin Orbit Coupling. The Normal Zeeman effect, Lande 'g' factor. Zeeman pattern in a weak field (Anomalous Zeeman effect).
   [Eisberg 8.1-8.4, 10.6]

4. **Atomic Spectra:** **[4 L]**
   Origin of Spectral lines. Selection rules (derivation from transition probabilities). Alkali metal type spectra. Principal, Sharp, Diffused and Fundamental series, fine structure in alkali spectra.
   [Beiser 11.1-11.2, Mcgervey 9.1]

5. **X-ray Spectra:** **[4L]**
   Characteristic spectrum. Moseley's law. Explanation of X-ray spectra on the basis of quantum mechanics. Energy levels and characteristic X-ray lines. X-ray absorption spectra. Fluorescence and Auger effect.
   [Richtmayer: 7.6, 7.7, 16.1-16.3, 16.5]

6. **Spectra of Diatomic Molecules:** **[10L]**
   Rotational energy levels. Rotational spectra. Vibrational energy levels. Vibration - Rotation spectra. Fortrat Parabolas and explanation of band structure on its basis. Electronic spectra.
   [Beiser 14.1, 14.3, 14.5, 14.7, 14.8 and Rajam 11.2]

7. **Raman Effect:** **[7L]**
   Quantum theory of Raman effect. Classical theory of Raman effect. Pure rotational Raman spectra. Vibrational Raman spectra. Rotational fine structure. Experimental set up for Raman effect.
   [Banwell 4.1-4.3]

Experiments: (Minimum Six)

1. Absorption spectra of $KMnO_4$
2. X-ray Emission (characteristic lines of copper target)- Calculation of wavelength and Energy.
3. Resolving Sodium D-lines using grating.
4. Resolving Mercury lines using prism.
5. Determination of wavelength of Sodium light using Lloyd's Mirror.
6. Determination of wavelength of Sodium light using a cylindrical obstacle.
7. Double Refraction

References:

1. Beiser, A. 1969, *Perspectives of Modern Physics*, McGraw-Hill Book Company, Singapore.
2. Eisberg, R. And Resnick, R. 2010, *Quantum Physics of Atoms, Molecules, Solids, Nuclei and particles*, 2nd Edition, Wiley India Pvt Ltd.
3. Mcgervey, J. 1983, *Introduction to Modern Physics*, Academic Press, USA.
4. Richtmyer, F., Kennard, E., Cooper, J. 2001, *Introduction to Modern Physics*, 6th ed. Tata McGraw-Hill Book Company, New Delhi.
5. Rajam, J. 2000, *Atomic Physics*, S. Chand and Company limited, New Delhi.
6. Banwell, C. 1994, *Fundamentals for Molecular Spectroscopy*, 4th Edition, McGraw-Hill Higher Education.

Additional References:

1. White, H. 1934, *Introduction to Atomic Spectra*, McGraw-Hill Inc., USA.

Paper Title : **Mechanics – II**

Paper Code : **PHY-VI.CE-13**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Course Objectives: To acquaint students with a higher level Mechanics which includes advanced concepts through topics like central force problems, mechanics in non inertial frames, motion of rigid bodies, collision theory and Langrangian formulation.

Learning Outcome: At the end of this course students will be able to comprehend and relate advanced concepts in Mechanics.

Pre-requisite **:** Mechanics – I

Theory

1. **Two-Body Central-Force Problems** **[9 L]**
   CM and Relative Coordinates; Reduced Mass, The Equations of Motion, The Equivalent One-Dimensional Problem, The Equation of Orbits, The Unbounded Kepler Orbits, Changes of Orbits
   [Ref. No. 1 pp. 293 – 315]

2. **Mechanics in Non-inertial Frames** **[9 L]**
   Acceleration without Rotation, The Tides, The Angular Velocity Vector, Time Derivatives in a Rotating Frame, Newton's Second Law in Rotating Frame, The Centrifugal Force, The Coriolis Force, Free Fall, Projectile motion and the Foucault Pendulum.
   [Ref. No. 1, pp. 327 – 358]

3. **Rotational Motion of Rigid Bodies** **[10 L]**
   Properties of the Center of Mass, Rotation about a Fixed Axis, Rotation about Any Axis, the Inertia Tensor, Principal Axis of Inertia, Finding the Principal Axis; the Eigenvalue Equations, Precession of a Top due to a Weak Torque, Euler's Equations, Euler's Equations with Zero Torque, Euler Angles, Motion of Spinning Top
   [Ref. No. 1 pp. 367 – 403]

4. **Collision Theory** **[7 L]**
   The Scattering Angle and Impact Parameter, The Collision Cross Section, Generalizations of the Cross Section, Differential Scattering Cross Section and its Calculations Rutherford Scattering
   [Ref. No. 1 pp. 557 – 582]

5. **Lagrange's Equations** **[10 L]**
   Constraints, Generalised coordinates, D'Alembert's Principle. Lagrange's Equations, A general expression for kinetic energy, Symmetries and laws of conservation. Cyclic or ignorable coordinates
   [Ref. No. 1 pp. 237 – 275 and Ref. No. 2 Section 8.1-8.7]

List of Experiments: (Minimum Six)

1. Study of Compound Pendulum as a Reversible Pendulum: Kater's Pendulum
2. Measurement of Moment of Inertia of Uniform Rigid Bodies: Bifilar Suspension
3. Principle of conservation of linear momentum using linear air track
4.Value of "g" by Rod pendulum
5.To Study the different oscillation modes of the coupled pendulum
6.To determine the moment of inertia of Gyroscope disc
7. Equation of Orbit (bounded orbit) simulation experiment
8. Equation of Orbit (unbounded orbit) simulation experiment

References:

1. Taylor J. R., 2005, *Classical Mechanics*, University Science Books.
2. Takwale R. G., and Puranik P. S., 1992, *Introduction to Classical Mechanics*, Tata Mc-Graw Hill

Additional Reference:

1. Symon K. R., 1971, *Mechanics*, Addison Wesley

Paper Title : **Nuclear and Elementary Particle Physics**

Paper Code : **PHY-VI.CE-14**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Pre-requisite : **Quantum Mechanics (PHY-IV.C-6)**

Course objectives: The objective of this course is to introduce students to the fundamental principles and concepts governing nuclear and particle physics.

Learning outcome: After successful completion of this course, student will be able to understand the fundamental principles governing the basic properties of nuclei, nuclear structure and particle physics. Students will also be able to solve elementary problems, relating theoretical predictions and measurement results, in nuclear and particle physics.

Theory:

1. **Constituents and properties of the Nucleus:** **[4 L]**
   Measurement of Nuclear Radius. Nuclear spin. Magnetic dipole moment. Electric Quadrapole moment. Parity. Binding energies and a plot of B/A against A.
   [Patel: 4.1.3, 4.1.5, 1.2.4, 5.2]

2. **Nuclear forces:** **[3 L]**
   Main characteristics of Nuclear Forces. Meson theory of Nuclear forces, Estimation of the mass of a meson using Heisenberg's Uncertainty Principle, Yukawa potential.
   [Patel: 8.6]

3. **The Q Equation**: **[4 L]**
   Types of Nuclear Reaction, The Balance of mass and energy in Nuclear reaction, The Q Equation.
   [Patel: 3.2, 3.3, 3.4]

4. **Radioactive decay:** **[8 L]**
   Alpha decay: Velocity and energy of alpha particles, Geiger-Nuttal law, alpha spectra and fine structure, short range and long range alpha particles, disintegration energy, Gamow's theory of alpha decay. (Qualitative treatment)

   Beta Decay: Types of Beta decay, Energies of (Beta -decay, The continuous beta particle spectrum & difficulties in understanding it, Pauli's neutrino hypothesis.

   Gamma Decay : Origin of gamma decay, Internal Conversion, Nuclear isomerism.
   [Patel : 2.3, 4.2.1-4.2.3, 4.3.1- 4.3.3, 4.4.1, 4.4.3, 4.4.4]

5. **Liquid drop model of a nucleus**: **[6 L]**
Analogy between liquid drop & a nucleus. Wiezsacker's semi empirical mass formula. Mass Parabolas: Prediction of stability against beta decay for members of a isobaric family, Stability against spontaneous fission, Bohr – Wheeler theory for nuclear fission.
[Patel: 5.3, 5.4, 5.5]

6. **Nuclear Energy:** **[6 L]**
Neutron induced fission, Asymmetrical fission, Energy released in the fission of U-235. Fission chain reaction, Principle of a nuclear reactor, Neutron cycle in a thermal nuclear reactor (The four factor formula), Principle of a breeder reactor.
[Patel: 6.1-6.5, 6.7-6.9]

7. **Nuclear Shell Model**: **[6 L]**
Experimental evidences that lead to shell model, Main assumption of the single particle shell model, Jensen-Mayer Scheme (No derivation), Predictions of the shell model.
[Patel: 7.1-7.3, 7.7, 7.8]

8. **Elementary Particle Physics:** **[8 L]**
Theory of the electron. Antiparticles. Types and properties of Mesons. Systematics of Elementary Particles. Strangeness Number. Isotopic Spin. Symmetries and Conservation Principles. Theory of Elementary Particles.
[Beiser: 25.1-25.11]

Experiments:

1. Study of the characteristics of a GM tube and determination of its operating voltage, plateau length / slope etc
2. Study of nuclear counting statistics
3. Measurement of short half-life
4. Tutorial on Properties of the Nucleus
5. Tutorial on Q value
6. Tutorial on Radioactive decay
7. Tutorial on Liquid drop model
8. Tutorial on Nuclear fission

References:

1. Patel, S. 2011, *Nuclear Physics: An Introduction*, 2nd Edition. New Age Inernational Limited, New Delhi.
2. Beiser, A. 1969, *Perspectives of Modern Physics,* McGraw-Hill Book Company, Singapore.

Additional References:

1. Krane, K. 1987, *Introductory Nuclear Physics*, 3rd Edition. Wiley, New Jersey.
2. Kaplan, I. 1956, *Nuclear Physics,* 3rd Edition, Addison-Wesley, Boston.

Paper Title : Introduction to Special Theory of Relativity

Paper Code : PHY-VI.CE-15

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Pre-requisite: Electromagnetic Theory –I (PHY-III.C-5) and Electromagnetic Theory-II (PHY-V.C-7)

Course Objectives: The objective of this course is to introduce students to Special Theory of Relativity.

Learning Outcome: In this course, students will learn the true nature of Non-Relativistic and Relativistic mechanics.

Theory

1. Experimental Background: [10 L]

Galilean Transformation, Newtonian relativity, Electromagnetism and Newtonian relativity, Michelson Morley experiment, Lorentz-Fitzgerald contraction hypothesis, Ether Drag hypothesis, Attempts to modify electrodynamics, postulates of the theory of special Relativity. Einstein and origin of relativity theory.

[Ref#1 Article 1.1 to 1.10]

2. Relativistic Kinematics [9 L]

Relativity of simultaneity, Derivation of Lorentz transformation equations, some consequences of Lorentz transformation equations, Relativistic addition of velocities, relativistic transformation of velocities and Doppler effect in Relativity .

[Ref#1 Article 2.1to 2.8]

3. Relativistic Mechanics [8 L]

Mechanics and Relativity, Redefining momentum, Relativistic momentum, Relativistic mass, Equivalence of mass and energy. The transformation properties of Momentum, Energy, Mass and Force.

[Ref#1 Article 3.1to 3.7]

4. Relativity and Electromagnetism [10 L]

Interdependance of electric and magnetic fields, Transformation for E and B, Field of a uniformaly moving point charge, Forces and fields near a current carrying wire, Forces between moving charges,The invariance of Maxwells equations, Limitations of special relativity.

[Ref#1 Article 4.1to 4.8]

5. The Geometric Representation of Space –Time and Twin Paradox [8 L]

Space-Time Diagrams, Simultaneity, Contraction and Dilation, The time Order and Space Separation of events, The route dependance of proper time, space time diagram of the twin paradox, The experimental test.

[Ref#1 Article A1-A3 and B-1 to B-5]

Experiments: (Minimum Six)

1. Michelson Interferometer
2. Tutorial on Relativistic Kinematics
3. Tutorial on Relativistic Kinematics
4. Tutorial on Relativistic Mechanics
5. Tutorial on Relativistic Mechanics
6. Tutorial on Relativity and Electromagnetism
7. Tutorial on Relativity and Electromagnetism

References:

1. Resnick R., 1965, *Introduction to Special Relativity*, John Wiley.

Additional References:

1. Ghatak A., 2009, *Special Theory of Relativity,* Anshan Ltd

2. French A. P., 1968, *Special Relativity*, Chapman & Hall.

Paper Title: Introduction to Materials Science

Paper Code: PHY-VI.CE-16

Marks: 75 (Theory) + 25 (Practical)

Credits: 3 (Theory) + 1 (Practical)

Contact Hours: 45 (Theory) + 30 (Practical)

Course Objectives: To acquaint students with fundamentals of materials science and study the properties and applications of materials.

Learning Outcome: At the end of this course, students would be able to investigate the relationship that exists between the structures and properties of materials.

Pre-requisite: Quantum Mechanics (PHY-IV.C-6), Solid State physics (PHY-V.CE-9).

Theory:

1. Structure of Crystalline Solids **[14L]**

Introduction, metallic crystal structures: the face centered cubic crystal structure, the body centered cubic crystal structure, the hexagonal close-packed crystal structure, density computations, atomic arrangements, linear and planar densities, close-packed crystal structures, polymorphism and allotropy, ceramic crystal structures: radius ratio rules, AX-type crystal structures, A_MX_P-type crystal structures, $A_MB_NX_P$-type crystal structures, crystal structures from close packing of anions, ceramic density computations, silicate ceramics, carbon, polymer structures: polymer crystallinity, polymer crystals, x-ray diffraction: determination of crystal structures.

[Callister: 4.1 – 4.20]

2. Imperfections in Solids **[8 L]**

Introduction, point defects: vacancies and self-interstitials, impurities in solids, specification of composition, imperfections in ceramics, miscellaneous imperfections: dislocations-linear defects, interfacial defects, bulk or volume defects, atomic vibrations, defects in polymers, microscopic examination: microscopic techniques, grain size determination.

[Callister: 5.1 – 5.13]

3. Diffusion **[6 L]**

Introduction, diffusion mechanisms, steady-state diffusion, nonsteady-state diffusion, factors that influence diffusion, diffusion in ionic materials, diffusion in polymeric materials.

[Callister: 6.1 – 6.8]

4. Applications and Properties of Ceramics **[9 L]**

Introduction, types and applications of ceramics: glasses, Glass-ceramics, clay products, refractories, abrasives, cements, advanced ceramics, mechanical properties: brittle fracture of ceramics, stress-strain behavior, mechanism of plastic deformations, miscellaneous mechanical considerations, glass properties, heat treatment of glasses, heat treatment of glass ceramics.

[Callister: 12.1 – 12.8, 12.10 – 12.16]

5. Structures of Polymers: **[8 L]**

Introduction, hydrocarbon molecules, polymer molecules, the chemistry of polymer molecules, molecular weight, molecular shape, molecular structure, molecular configurations, thermoplastic and thermosetting polymers, copolymers.

[Callister: 13.1 –13.10]

Experiments: (Minimum Six)

1. Grain size estimation using XRD.
2. Determination of density of materials.
3. Analysis of surface morphology using SEM/TEM
4. Determination of compressibility of liquids using crystal oscillator.
5. To study the corrosion of metals with the help of galvanic cells.
6. Thermal diffusivity of brass.
7. Thermal conductivity of a poor conductor.
8. Specific heat of graphite.

References:

1. Callister W. D., 2015, *Materials Science and Engineering*, John Wiley and Sons, 2nd Ed.

2. West A. R.., 2014, *Solid State Chemistry and its Applications*, John Wiley and Sons.

Additional Reference:

1. Kittel C., 2015, *Introduction to Solid State Physics*, John Wiley and Sons, 8th Edition.

Paper Title : Introduction to Astronomy and Astrophysics

Paper Code : PHY-VI.CE-17

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Course Objectives: The course aims to introduce the students to the Exciting World of Extra-galactic Universe.

Learning Outcome: On completion of this course the students will be able to understand

a) the various Extra-galactic objects.
b) the construction, working and mounting of modern telescopes.
c) Co-ordinate system of Celestial Objects.
d) types of stars and their life cycle.

Theory:

1. Fundamentals of Astronomy: [9 L]

Introduction: Components of the Universe; Stars, Planets, Asteroids, Meteors, Comets, Galaxies. Solar System: Age, Origin Basic measurements: Planetary orbits, distances, physical size, mass, density, temperature, rotation period determination, Kepler's laws, black body radiation and curves, Doppler effect.

[Ref#1: chapter1: 1.1-1.5, chapter 3: 3.1- 3.4]

2. Astronomical Instruments: [10 L]

Optical telescopes, mounts, light gathering power, magnification, resolution. Spectroscopes, CCD camera, photometer, filters Radio telescopes, interferometry UV, IR, X-ray and Gamma ray telescopes. Modern telescopes: HST, Chandra.

[Ref#1: chapter19: 19.1-19.5, chapter20: 20.1-20.5]

3. Star and Star Systems [10 L]

Stars life cycle, Neutron stars, black holes, white dwarf, Chandrasekhar limit. Spectral classification of stars, O,B,A,F,G,K,M. Sytem of stars: Binaries / Cepheids / RR Lyrae, HR diagram, sun and solar system.

[Ref#1: chapter5: 5.1-5.7, chapter12: 12.3, 12.4]

4. Galaxies, Dark Matter and Dark Energy [7 L]

Galaxies, classification of galaxies, Hubble's tuning fork diagram, Open and Globular clusters, ISM.

[Ref#1: chapter16: 16.4, chapter 17: 17.1-17.4]

5. Observational Astronomy **[9 L]**

Co-ordinate system, Celestial hemisphere, Concept of time, Magnitudes: apparent and absolute, constellations. Star dial, Observation of Sun, Eclipses, Moon, planets, meteor showers, transits, occultation's.

[Ref#1: chapter2; 2.1-2., Ref#2; chapter1: 1.1-1.4]

Experiments: (Minimum six)

1. Resolving power of telescope.
2. Study of scattering of light (Diameter of Lycopodium powder).
3. Study of Diffraction using plane grating.
4. To find radius of curvature of a convex lens using optical lever.
5. Measurement of the solar constant.
6. To obtain proper motion of Barnard's star using Aladin.
7. Draw constellation map of a) Orion b) Auriga c) Taurus d) Ursa Major (Big Dipper) marking of pole star.
8. To determine the elements in sun using Fraunhofer spectra.
9. To estimate Astronomical Unit using Venus transit data by parallax method.
10. Data analysis technique using virtual observatory.
11. Determine the period of revolution of sun using virtual laboratory.

Reference

1. Abhyankar K.D., 2001, *Astrophysics - Stars and Galaxies*, Tata McGraw Hill Pub.
2. Shu F., 1981, *Physical Universe-An Introduction to Astronomy*, University Science Books, U.S.
3. Roy A.E. and Clarke D., 1989, *Astronomy structure of the Universe*, Adam Hilger Pub.
4. Glasstone S., 1965, *Source book on the Space Sciences*, Van Nostrand Reinhold Inc.,U.S
5. Bhatia V. B., 2001, *Textbook of Astronomy and Astrophysics with Elements of Cosmology*, Narosa Pub.
6. Narlikar J.V., 1976, *Structure of the Universe*, Oxford Paperbacks.
7. Badyanath and Basu., 2010, *An Introduction to Astrophysics*, 2nd Edition, Prentice Hall India Learning Private Limited

Courses for students taking Physics as their Minor subject.

Semester V

1. Statistical Physics and Solid State Physics

Semester VI

1. Atomic and Nuclear Physics

Paper Title : **Statistical Physics and Solid State Physics**

Paper Code : **PHY-V.MI-5**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Course Objective: To give the students a firm understanding of the basics of Statistical Physics and Solid State Physics. The course broadly deals with the statistical distribution of particles, structural aspects and electrical properties of crystalline solids, and concept of energy bands in solids.

Learning Outcome: After completion of this course, students will develop a comprehensive broad knowledge in Maxwell-Boltzmann Statistics, Fermi-Dirac Statistics, Bose-Einstein Statistics, Bondings in Solids, Crystal Physics, Electrical properties of solids and Origin of energy band structure in solids.

Theory:

I. Statistical Physics: **[15L]**

Introduction-basic concepts-phase space, microstate, macrostate, thermodynamic Probability, Maxwell-Boltzmann statistics- basic postulates, distribution function, Maxwell Boltzmann energy distribution function for an ideal gas, Applications of Maxwell-Boltzmann Distribution law: Total Internal energy and specific heat at constant volume of an ideal gas, Bose Einstein statistics- postulates, Bose-Einstein distribution law, Fermi-Dirac statistics, Fermi-Dirac distribution law

[Lal, 10.1-10.4, 9.7, 9.8, 11.1-11.4, 12.1,12.2,12.4, 12.5,12.8]

II. Solid State Physics

1. Bonding in Solids: **[3 L]**

Introduction, Bonding in Solids, Ionic bonding, Covalent bonding, Metallic bonding, Hydrogen bonding, Van der Waals (Molecular) bonding.

[Palanisamy: 1.1, 1.2, 1.4, 1.6 - 1.9]

2. Crystal Structure: **[9 L]**

Introduction, Space Lattice, Unit cell, Lattice Parameter of unit cell, Bravais lattices, Crystal Symmetry, Stacking sequences in metallic crystal structure, SC, BCC, FCC and HCP structures, Directions in crystals, Planes in crystals- Miller indices.

[Palanisamy: 2.1, 2.2 - 2.2.3, 2.3 - 2.3.3, 3.1, 3.2, 3.3 -3.3.2]

3. Electron Theory of Metals: **[18 L]**

Introduction, Classical free electron theory, Quantum theory of free electrons, Fermi distribution function, Density of energy states, Sources of electrical resistance, Electrons in a periodic potentials, Energy bands in Solids.

[Palanisamy: 6.1, 6.2 - 6.2.2, 6.3, 6.3.1, 6.4, 6.5, 6.6, 6.7-6.7.5, 6.8]

Experiments: (Minimum Six)

1. Energy band gap of a semiconductor
2. Energy band gap of LEDs
3. To determine value of Planck's constant using LEDs of at least 4 different colours.
4. Fermi energy of Copper
5. Measurement of Hysteresis loss using CRO
6. Determination of Boltzmann Constant
7. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four-probe method (room temperature to 150 oC) and to determine its band gap

References:

1. Palanisamy P. K., 2004, *Solid State Physics,* Scitech Publications (India) Pvt. Ltd.
2. Pillai S. O., 1999, *Solid State Physics*, 3rd Edition, New Age International (P) Ltd, Publisher.
3. Kittel C., 2004, *Introduction to Solid State Physics*, 8th Edition,John Wiley and Sons.
4. Dekker A. J., 1998, *Solid State Physics*, Macmillan India Ltd. Publisher.
5. Lal B., Subrahmanyam N. And Hemne P. S., 2012, *Heat Thermodynamics and Statis*tical *Physics*, S. Chand & Company Ltd.
6. Beiser, A 1969, *Perspectives of Modern Physics,* McGraw-Hill Book Company, Singapore.

Paper Title **: Atomic and Nuclear Physics**

Paper Code **: PHY-VI.MI-6**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Contact Hours **: 45 (Theory) + 30 (Practical)**

Course Objectives: The objective of this course is to introduce students to the fundamental aspects of atomic and nuclear physics.

Learning outcome: After successful completion of this course, student will be able to understand the fundamental principles governing the basic properties of atoms, atomic spectra, nucleus and radioactive decay.

Theory:

1. **Quantum Theory of the Hydrogen Atom**: **[6 L]**
   Schrodinger's equation for the H-atom. Separation of variables, Eigen values, Quantum numbers and Magnetic moment. Angular momentum, Electron Probability density.
   [Beiser 9.1-9.9]

2. **Many Electron Atoms:** **[7 L]**
   Electron Spin.. Pauli Exclusion Principle and classification of elements in periodic table. Symmetric and Antisymmetric wave functions. Electron configuration. Hund's rule. Total angular momentum. L-S coupling. J-J coupling.
   [Beiser 10.1, 10.3- 10.9]

3. **Atoms in a Magnetic Field:** **[7 L]**
   Effects of magnetic field on an atom. Larmor Precession. The Stern-Gerlach experiment.
   Spin Orbit Coupling. The Normal Zeeman effect, Lande 'g' factor, Zeeman pattern in a weak field (Anomalous Zeeman effect).
   [Eisberg 8.1-8.4, 10.6]

4. **Atomic Spectra:** **[4 L]**
   Origin of Spectral lines. Selection rules (derivation from transition probabilities), Alkali metal type spectra, Principal, Sharp, Diffused and Fundamental series, fine structure in alkali spectra **[Beiser 11.1-11.2, Mcgervey 9.1]**

5. **Properties of the Nucleus:** **[3 L]**
   Nuclear sizes. Nuclear spin. Binding energy, B.E versus A plot. Saturation of nuclear forces.
   [Beiser: 21.2, 21.4-21.6]

6. **Nuclear Forces and Models:** **[5 L]**
   Main characteristics of Nuclear Forces. Meson theory of Nuclear forces. Yukawa potential. Brief discussion of the Liquid drop Model and Shell Model.
   [Beiser: 22.4-22.6]

7. **Radioactivity and Radioactive Decay:** **[9 L]**
   The law of Radioactivity Decay. Mean lifetime. Half life and Decay constant. Successive radioactive transformation (A-B-C) type, Ideal transient and secular equilibrium. Radioactive series. Carbon dating. Artificial radioactivity. Brief qualitative discussion on apha decay, beta decay and gamma decay.
   [Patel: 2.3, 2.6-2.9, 2.11, 2.13; Beiser: 23.3, 23.6-23.10]

8. **Nuclear Fission and Nuclear Fusion:** **[4 L]**
   Nuclear fission. The chain reaction. Transuranic elements. Thermonuclear energy
   [Beiser: 24.7-24.10]

Experiments: (Minimum Six)

I. Atomic Physics

1. X-ray Emission (characteristic lines of copper target)- Calculation of wavelength and Energy.
2. Prism Spectrometer: Optical levelling, Angle of Prism
3. Single Slit Diffraction
4. Diffraction Gratings

II. Nuclear Physics

1. Geiger Muller Counter
2. Tutorial on Properties of the nucleus
3. Tutorial on Nuclear Forces and Models
4. Tutorial on Radioactivity

References:

1. Beiser, A. 1969, *Perspectives of Modern Physics*, McGraw-Hill Book Company, Singapore.
2. Eisberg, R. And Resnick, R. 2010, *Quantum Physics of Atoms, Molecules, Solids, Nuclei and particles*, 2^{nd} Edition, Wiley India Pvt Ltd.
3. Mcgervey, J. 1983, *Introduction to Modern Physics,* Academic Press, USA.
4. Patel, S. 2011, *Nuclear Physics: An Introduction*, 2^{nd} Edition. New Age Inernational Limited, New Delhi.

Additional References:

1. Richtmyer, F., Kennard, E., Cooper, J. 2001, *Introduction to Modern Physics*, 6th ed. Tata McGraw-Hill Book Company, New Delhi.
2. Krane, K. 1987, *Introductory Nuclear Physics,* 3rd Edition. Wiley, New Jersey.
3. Kaplan, I. 1956, *Nuclear Physics,* 3rd Edition, Addison-Wesley, Boston.

Annexure I

COURSE STRUCTURE

DEPARTMENT OF PHYSICS

SEMESTER	CORE		ELECTIVE				
I	PHY-I.C-1 Introduction to Mathematical Physics	PHY-I.C-2 Mechanics-I	-------	-------	-------	-------	-------
II	PHY-II.C-3 Heat and Thermodynamics	PHY-II.C-4 Electricity and Magnetism	-------	-------	-------	-------	-------
III	PHY-III.C-5 Electromagnetic Theory-I	-------	PHY-E1 *Optics	PHY-E2 Modern Physics	PHY-E3 Oscillations, Waves and Sound	PHY-E17 Introduction to Astronomy and Astrophysics	-------
IV	PHY-IV.C-6 Quantum Mechanics	-------	PHY-E5 *Electronics-I	PHY-E6 Solid State Devices	PHY-E4 Properties of Matter and Acoustics	PHY-E7 Computational Physics	-------
V	PHY-V.C-7 Electromagnetic Theory-II	-------	PHY-E9 *Solid State Physics	PHY-E10 Thermodynamics and Statistical Mechanics	PHY-E11 Electronics-II	PHY-E12 Mathematical Physics	-------
VI	PHY-VI.C-8 Atomic and Molecular Physics	-------	PHY-E13 *Mechanics II	PHY-E14 Nuclear and Elementary Particle Physics	PHY-E15 Introduction to Special Theory of Relativity	PHY-E16 Introduction to Material Science	PHY-E8 Instru mentati on

* BoS Physics recommends these elective courses to be taken by students as a prerequisite to the M.Sc. (Physics) Program.

Interdisciplinary courses	**CODE**
Elementary Physics – I	PHY-I1
Elementary Physics – II	PHY-I2
The Physics of Energy and Energy Sources-I	PHY-I3
The Physics of Energy and Energy Sources-II	PHY-I4

Annexure II

Course Title **: Introduction to Mathematical Physics**

Course Code **: PHY-I.C-1**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Course Objectives: To develop basic competence in certain areas of mathematics required for understanding several important topics in physics.

Learning outcome: After successful completion of this course, student will comprehend some of the important mathematical concepts and should be able to use these methods to solve several problems in Physics.

Theory:

1. **Vector Analysis** **[6 h]**
   Scalars and vectors, Basis vectors and components, Multiplication of Vectors. Equation of lines and planes. Using vectors to find distances. Reciprocal vectors. Differentiation and Integration of vectors.
   [Riley 7.1, 7.3-7.9, Boas 6.4, 6.8]

2. **Infinite Series and Power Series** **[6 h]**
   Geometric Series and other infinite series. Convergent and Divergent Series. Testing series for convergence. Power series. Expanding functions in power series. Techniques for obtaining power series expansion.
   [Boas 1.1-1.7, 1.10-1.13]

3. **Complex Numbers** **[6 h]**
   Real and imaginary Parts of a complex number. Complex plane. Complex algebra. Euler's formula. Powers and roots of complex numbers. Exponential and trigonometric functions.
   [Boas 2.1-2.5, 2.9-2.11]

4. **Matrices** **[6 h]**
   Matrix Analysis and Notation, Matrix Operations, Properties of matrices. Transpose matrix. Complex Conjugate Matrix, Hermitian Matrix, Unit matrix, Diagonal matrix, Adjoint and self-adjoint matrix, symmetric matrix, anti-symmetric matrix, unitary matrix, orthogonal matrix, trace of a matrix, inverse matrix.
   [Harper 2.3, 2.4, 2.5 and 2.6]

5. **Partial Differentiation** **[7 h]**
   Definition of the partial derivative. Total differentials. Exact and inexact differentials. Theorems of partial differentiation. Chain rule. Thermodynamic relations. Differentiation of Integrals.
   [Riley 4.1-4.5, 4.10-4.11]

6. **Ordinary Differential Equation** **[8 h]**
   Introduction. Linear differential equation of the first order. Homogenous and inhomogeneous linear differential equation of the second order.
   [Boas 8.1-8.6 and Harper 5.1-5.2]

7. **Coordinate Systems** **[6 h]**
   Plane polar coordinates. Cylindrical and Spherical polar coordinates.
   [Harper 1.6.6, Riley 8.9]

Experiments: (Minimum Six)

1. Least count of Instruments (Vernier Caliper, Screw Gauge, Travelling Microscope and Spectrometer).
2. Introduction Error Analysis: Propagation of Errors
3. Statistical Analysis of Random measurement
4. Application of Error Analysis
5. Least square fitting
6. Plotting of various algebraic and trigonometric functions using Excel.
7. Curve fitting using Excel.
8. Interpretation of graphs.
9. Solving Integration, Ordinary Differential Equation and Matrices using Mathematica.
10. Tutorial
11. Tutorial

References:

1. K. F. Riley, M. P. Hobson and S. J. Bence, *Mathematical Methods for Physics and Engineering* (Cambridge University Press, 1998)
2. Mary L. Boas, *Mathematical Methods in Physical Sciences* (John Wiley and Sons, 3rd Edition)
3. Charlie Harper, *Introduction to Mathematical Physics*- (Prentice Hall)

Additional References:

1. B. D. Gupta, *Mathematical Physics* (Vikas Publishing House, 2004)
2. M. Spiegel, S. Lipschutz, D. Spellman, *Schaum's Outline of Vector Analysis*, (McGraw Hill Education, 2009)

Course Title : **Heat and Thermodynamics**

Course Code : **PHY-II.C-3**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Course Objectives **:** To acquaint students with fundamental concepts of Thermal Physics and explain the usefulness of these concepts for wide range of applications that include heat engines, refrigerators and air conditioners.

Learning outcome **:** At the end of this course students would understand the movement of heat (energy) and how energy instills movement. More precisely students would be able to relate the effects of changes in temperature, pressure and volume on physical systems at macroscopic scale by analyzing collective motion of their particles.

Theory:

1. **Principle of Thermometry** **[6 h]**
   Review of concept of heat and temperature, Thermometry, Types of thermometers, Centrigrade, Fahrenheit, Rankine Scales and relations between them, Platinum resistance thermometer, Thermocouple (thermoelectric) thermometers.
   [Ref. No. 1: 13.1 – 13.5, 13.15, 13.23]

2. **Laws of Thermodynamics** **[12 h]**
   Thermodynamic system, Thermodynamic variables, Thermodynamic equilibrium, and Thermodynamic processes, Zeroth law of thermodynamics, Concept of work and internal energy, First law of thermodynamics, Isothermal and adiabatic changes, Work done in isothermal and adiabatic changes, Relation between pressure, volume and temperature in adiabatic process, Reversible and irreversible processes, Carnot Heat engine, Carnot cycle for perfect gas, efficiency, Second law of thermodynamics (Kelvin – Planck Statement, Clausius Statement)
   [Ref. No. 1: 4.1, 4.4 – 4.7, 4.10.4, 4.11 - 4.13, 4.20 – 4.24, 4.28]

3. **Equations of State** **[9 h]**
   Equation of state, Andrew's experiment, Amagat's experiment, Van der Waal's equation of State, Critical constants, Reduced equation of state, Boyle temperature. Joule's Law for a perfect gas, expression for Joule's coefficient, Joule Thomson effect, Joule Thomson porous plug experiment, Joule-Kelvin effect-temperature of inversion.

   [Ref. No. 2: 10.1 -10.6], [Ref. No. 1: 2.6, 2.14, 2.17-2.21]

4. **Applications of First and Second Law of Thermodynamics** **[12 h]**
   Otto cycle and Otto engine, Diesel cycle and Diesel engine, Efficiencies, Introduction to refrigeration, Principle and coefficient of performance, Principle of air conditioning, comfort chart A.C. machine, factors affecting size and capacity of A.C. machines.
   [Ref. No. 2: 4.16 – 4.19], [Ref. No. 1: 4.26, 4.27, Chapter 17]

5. **Concept of Entropy** **[6 h]**
   Changes of entropy during reversible and irreversible process, Temperature – Entropy diagram, Temperature – Entropy diagram of Carnot's cycle, Physical significance of Entropy, Entropy of a perfect gas, Principle of increase of entropy, Third Law of Thermodynamics.
   [Ref. No. 2: 6.9, 6.12], [Ref. No. 1: 5.1 – 5.8]

Experiments: (Minimum Six)

1. Latent heat of ice
2. Calibration of Si diode as a thermometer.
3. Constant volume air thermometer.
4. Constant pressure air thermometer.
5. Thermal conductivity by Lee's method.
6. Thermal conductivity of copper.
7. Temperature coefficient of resistance of copper.
8. Temperature coefficient of resistance of Platinum thermometer using PT-100.
9. Callender-Griffith Bridge.

References:

1. Brijlal, Subramanyam N., Hemne P.S., <u>Heat Thermodynamics and Statistical Physics</u>, S. Chand (2007)

2. Saha M.N., Shrivastava B.N., <u>Treatise on Heat</u>, The Indian Press 5th Ed. (1965)

Additional References:

1. Roberts J. K., Miller A.R., <u>Thermodynamics</u>, E.L.B.S. (1960)

2. Zemansky M.W., Ditman R.H., <u>Heat and Thermodynamics</u>, McGraw Hill, 8th Ed. (5th reprint), 2013

Course Title : **Electricity and Magnetism**

Course Code : **PHY-II.C-4**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Course Objectives: The objective of this course is to introduce fundamentals of electricity and magnetism to the students, which is an essential preparation for more advanced courses like Electromagnetic theory.

Learning Outcome: On successful completion of this course, the students will be able to:

- Comprehend basic concepts like: laws of electrostatics and magnetostatics and also related applications.
- Understand the interrelated concepts of Electricity and Magnetism.
- Understand the working of transient circuits and alternating current circuits.
- Correlate the theoretical basis of various concepts of electricity and magnetism while performing experiments.

Theory:

1: Electrostatics **[10 h]**

Coulomb's law: Statement, Vector form of Coulomb's law for like and unlike charges, Variation of force with distance (F.vs.r graph), Concept of electric field and Electric Field Lines: Electric field, Electric field due to (i) a Point Charge, (ii) an Electric Dipole, (iii) a Line of Charge and a Charged Disk, Concept of electric flux: Gauss' Law of electrostatics (Conceptual explanation), Applications of Gauss law: Coulomb's Law from Gauss' Law, Electric Field due to (i) an isolated uniformly charged sphere, (ii) an uniform distribution of charge throughout the sphere and (iii) an uniformly charged hollow cylinder, Electric Field near (i) a charged infinite cylindrical conductor or a cable and (ii) a plane of sheet charge Concept of Electric Potential: Electric Potential Energy, Equipotential Surfaces, Calculating the Potential from the Field Potential due to (i) a Point Charge, (ii) a Group of Point Charges and (iii) an Electric Dipole Calculating the Field from the Potential.
[Ref. No.1: 22.4, 23.2-23.7, 24.1-24.5, 25.1-25.7, 25.9] [Ref. No.2: 2.4(1-6)]

2 : Capacitors and Dielectrics **[5 h]**

Capacitance: Calculation of capacitance of (i) a Parallel-Plate Capacitor, (ii) a Cylindrical Capacitor and (iii) a Spherical Capacitor; Energy stored in an electric field, Capacitor with a Dielectric, Dielectrics: An Atomic View, Dielectrics and Gauss' Law, Relation between three electric vectors (E, D and P)(Without derivation, qualitative discussion only)
[Ref. No.1: 26.1- 26.3, 26.5-26.8]

3: Magnetostatics **[9 h]**

Concept of magnetic field: Definition and properties of magnetic field Biot–Savart’s law and its applications: (i) a long straight wire and (ii) a current carrying circular loop (for a point on the axis only) Ampere’s circuital law and its applications: (i) Field of solenoid and (ii) Field of toroidal solenoid Magnetic Field lines and Magnetic flux; Gauss’ law for magnetism [Ref. No.1: 29.1, 29.2, 30.1, 30.3, 30.4, 32.2][Ref. No.3:27.2, 27.3]

4: Self and Mutual Inductance **[6 h]**

Self induction; Calculation of self inductance of (i) a long solenoid, (ii) long parallel wires and (iii) a coaxial cable Mutual inductance, Coefficient of coupling; Calculation of mutual inductance between two coaxial solenoids, Mutual inductance of two coils in series Energy stored in a magnetic field and Energy density of a magnetic field

[Ref. No.4: 5.1, 5.2, 5.8, 5.9] [Ref. No.1:31.8, 31.10, 31.11, 31.12]

5: Transient Circuits **[6 h]**

Transient currents: Growth and Decay of current in an inductive (L-R) circuit, Physical meaning of time constant Charging and Discharging of a capacitor through resistor in C-R circuit, Physical meaning of time constant Charging and Discharging of a capacitor through resistor and inductor in L-C-R circuit: Over damped, Critically damped and Under damped conditions of L-C-R circuit.

[Ref. No.4:5.3, 5.4, 5.13, 5.14]

6: Alternating Current Circuits **[9 h]**

Inductive and Capacitive reactance, Variation of inductive reactance and capacitance reactances with frequency. Introduction to vector or phasor diagrams method and its application to A.C. circuits(Series L-R, Series C-R, Series L-C-R and Parallel L-C-R) Introduction to j-operator method and its application to A.C. circuits(Series L-C-R and Parallel L-C-R). Physical significance of Series resonance, Parallel resonance, Quality factor and Bandwidth, Graphical representation of resonance. A.C. bridges: Maxwell’s inductive bridge, Maxwell's L/C bridge, de Sauty's capacitance bridge, Wien's frequency bridge.

[Ref. No.2:22.3, 22.4, 22.6, 22.7, 22.8, 22.9, 22.10, 22.13, 22.14]

[Ref. No.2: 22.19, 22.20, 22.21(b), 22.22]

[Ref. No.4:6.5, 6.6, 6.7(c), 6.9, 6.14, 6.20, 6.21, 6.22, 6.24]

Experiments: (Minimum Six)

1. Measurement of Dielectric constant of a liquid using two co-axial metal tubes.
2. Susceptibility measurement of a parallel plate capacitor in a dielectric medium
3. Step Response of RC circuit
4. Transient response of L-C-R circuit using square wave generator and C.R.O.
5. Response of LR and CR circuits to A.C. - phasor diagrams
6. LCR Series and parallel resonance –Resonant frequency, Q value and Bandwidth
7. Determination of Mutual Inductance using LCR series resonance
8. de Sauty’s bridge / Maxwells L/C bridge

References:

1. Halliday David, Resnik Robert and Walker Jearl, Fundamentals of Physics, John Wiley & Sons, Inc., 6th Edition (2003)
2. Vasudeva D. N., Fundamentals of Magnetism and Electricity, S. Chand & Company Ltd., 12th Revised Edition (1999)
3. Young Hugh D., Freedman Roger A. and Ford A. Lewis, Sears and Zemansky's University Physics with Modern Physics, Addison-Wesley Publishers, 13th Edition(PDF) (2012)
4. Fewkes J. H. and Yarwood John, Electricity, Magnetism and Atomic Physics, Volume I, Oxford University Press Ltd., 10th Impression (1991)

Additional References:

1. Purcell Edward M., Electricity and Magnetism-Berkeley Physics Course,Volume 2, McGraw-Hill Book Company (PDF)

Course Title **: Modern Physics**

Course Code **: PHY-E2**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Course Objective:

Modern Physics involves the study of radiation and matter at atomic levels and velocities close to the speed of light. This course will focus on the early development of the theory of atomic structure, wave particle duality, mass spectrographs, accelerators and Lasers. Lectures will help you clarify concepts of modern physics through various conceptual questions and problems.

Learning Outcome:

After completion of this course, students will develop a comprehension of broad knowledge in modern physics. Students will also acquire the necessary skills for critical thinking and problem solving.

Pre-requisite: Nil.

Theory:

1. **Electrons, Nucleus and Atoms:** **[5 h]**
   Determination of e/m for cathode rays. Thomson's model of the atom and qualitative discussion of alpha scattering experiment. Rutherford's model of the atom. Determining upper limit to nuclear dimension. Electron orbits. Failure of Classical Physics.
   [Rajam: Pages 33-36, 44-50, Beiser: 5.1, 5.3, 5.5-5.7]

2. **Brief review of Atomic models:** **[6 h]**
   Atomic Spectra. Frank-Hertz experiment. The Bohr Atom: Quantization of energy. Bohr-Sommerfeld model. Nuclear motion and reduced mass.Bohr's Correspondence Principle.
   [**Beiser: 6.1, 6.3-6.8]**

3. **Particle Properties of waves:** **[4 h]**
   Concepts of Blackbody radiation.The Photoelectric effect.Compton Effect.Experimental verification of the Photoelectric effect.
   [Singh: 1.1-1.3, Beiser: 3.1,3.2, 3.5, Muregeshan: 8.5]

4. **De Broglie's Postulate - Wavelike properties of Particles:** **[12 h]**
   a. **Dual nature of matter:** Experiments with bullets, waves and electrons. The interference of electron waves. Watching the electrons.
   [Feynman: 1.1-1.6]

b. **Matter Waves**: De Broglie's postulate. Davisson and Germer experiment. Electron diffraction experiment of G. P. Thomson. Review of the Bohr's postulate about stationary states in the light of De Broglie's concepts.
   [Eisberg: 3.1], [Singh: 2.8]

c. **Properties of Matter waves:** Wave and group velocities. Relation between the group velocity and phase velocity. Velocity of De Broglie wave. Wave packet and its motion in one dimension.
   [Singh: 2.3-2.5, 2.9]

5. **Heisenberg's Uncertainty Principle: [5 h]**
   Uncertainty principle. Elementary proof of Heisenberg's uncertainty relation between position and momentum. Elementary proof of Heisenberg's uncertainty relation between energy and time. Illustration of Heisenberg's uncertainty principle with thought-experiments. Consequences of the uncertainty relation.

   [Singh: 3.1-3.5]

6. **Measurement of Mass and accelerators [6 h]**
   Measurement of Mass: Thomson's positive ray analysis, Dempster's Mass spectrometer, Bainbridge Mass spectrograph.

   Linear accelerator and Cyclotron.

   [**Rajam: pg. 227-233, 240-244, Muregeshan: 30.3, 30.4]**

7. **Lasers: [7 h]**
   Attenuation of light in an optical media. Thermal Equilibrium. Interaction of light with matter. Einstein's A and B coefficients and their relations. Population inversion. Principal pumping schemes. Ruby Laser, He-Ne Laser and Semiconductor laser. Applications of Laser.
   Optical fibres: Optical fibre, Total internal reflection, Propagation of light through optical fibre, Losses in optical fibre.
   [Subrahmanyam: 22.1-22.11,22.15, 22.16.1, 22.16.3, 22.7, 24.1-24.4, 24.15]

Experiments: (Minimum Six)

1. Determination of e/m of electrons using Thomson's method.
2. Measurement of k/e.
3. Measurement of diameter of Lycopodium powder.
4. To determine wavelength of Laser source by diffraction of single slit.
5. To determine wavelength of Laser source by diffraction of double slit.
6. Frank Hertz Experiment.
7. Photoelectric effect.

References:

1. Beiser, A. 1969, *Perspectives of Modern Physics*, McGraw-Hill Book Company, Singapore.
2. Feynman, R. 2012, *Feynman Lectures on Physics: Quantum Mechanics (Volume - 3)*, Pearson Education, India.
3. Murugeshan, R 2009, *Modern Physics*, S. Chand and Company limited, New Delhi.
4. Rajam, J. 2000, *Atomic Physics*, S. Chand and Company limited, New Delhi.
5. Subrahmanyam, N., Lal, B. and Avadhanulu, M. 2004, *A Textbook of Optics*, S. Chand and Company limited, New Delhi.
6. Singh, K. And Singh, S. 2013, *Elements of Quantum Mechanics*, S. Chand, New Delhi.

Additional References:

1. Ghatak 2012, *Optics*,Mcgraw Hill Education, India.
2. Richtmyer, F., Kennard, E., Cooper, J. 2001, *Introduction to Modern Physics*, 6th ed. McGraw-Hill Book Company, New Delhi.
3. Tipler, P. 2012, *Modern Physics*, WH Freeman, New York.

Course Title : **Quantum Mechanics**

Course Code : **PHY-IV.C-6**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1(Practical)**

Course Objectives: The objective of this course is to provide an introduction to quantum mechanics and its application.

Learning Outcome: On successful completion of this course, the students will be able to:

1. understand the concepts and principles of quantum mechanics.
2. solve the Schrödinger equation to obtain wave functions for some important types of potential in one dimension.
3. develop an understanding of why both analytic and numerical solutions are important in quantum mechanics and have acquired experience in using both types of methods on quantum mechanical problems.
4. use numerical tools and software to solve the Schrodinger equation for more complicated cases.

Pre-requisite: Nil

Theory:

1. **Schrödinger's Theory of Quantum Mechanics:** **[12 h]**
   Plausibility argument leading to Schrödinger equation, Born interpretation of wave functions, Operators in quantum mechanics: position, momentum, kinetic energy and Hamiltonian, Expectation values, The time independent Schrödinger equation, Required properties of Eigen functions, Energy quantization in the Schrödinger theory. Postulates of quantum mechanics.

   [Eisberg: 5.1- 5.8][Singh: 4.6]

2. **Applications of Schrödinger's Steady state equation:** **[18 h]**
   2.1 Free particle.

   2.2 One dimensional infinite rectangular potential well (Particle in a one dimensional box). Stationary states, Concept of parity, parity operator and its eigen values.
   2.3 Particle in a three dimensional rigid box. Degree of degeneracy.
   2.4 One dimensional step potential of finite height (Energy less than step height and energy greater than step height)
   2.5 One dimensional potential barrier. Qualitative discussion of alpha decay,
   2.6 One dimensional finite rectangular potential well (placed symmetric to origin). Parity and parity operators,

2.7 One dimensional harmonic oscillator (Algebraic method using raising and lowering operators and analytical method.)

[Eisberg: 6.2 – 6.6], [Griffiths: 2.1, 2.3, 2.6]

3. **Angular momentum and Spin** **[12 h]**

   Angular momentum operators, Angular momentum Eigenvalues and Eigenfunctions. Spin 1/2, Spinors, Pauli spin matrices, Eigenvalues and Eigenspinors of Spin. Electron in a Magnetic field.

   [Griffiths: 4.3, 4.4.1, 4.4.2]

4. **Fundamental issues in quantum mechanics** **[3 h]**

   EPR paradox, Bell's Theorem and Schrödinger's cat.

   [Griffiths: 12.1, 12.2, 12.4]

Experiments:

1. Introduction to Numerov method.
2. Numerically solving the Time Independent Schrödinger equation for the case of Infinite potential well.
3. Numerically solving the Time Independent Schrödinger equation for the case of finite potential well.
4. Numerically solving the Time Independent Schrödinger equation for the case of Infinite potential well with a cosine bump.
5. Numerically solving the Time Independent Schrödinger equation for the case of Step potential.
6. Numerically solving the Time Independent Schrödinger equation for the case of Sloping potential well.
7. Numerically solving the Time Independent Schrödinger equation for the case of Potential barrier.

References:

1. Eisberg, R. And Resnick, R. 2010, *Quantum Physics of Atoms, Molecules, Solids, Nuclei and particles*, 2nd Edition, Wiley India Pvt Ltd.
2. Griffiths, D. 2015, *Introduction to Quantum Mechanics*, Pearson Education, India.
3. Singh, K. And Singh, S. 2013, *Elements of Quantum Mechanics*, S. Chand, New Delhi.

Additional References:

1. Beiser, A. 1969, *Perspectives of Modern Physics*, McGraw-Hill Book Company, Singapore.
2. Flugge, S. 2008, *Practical Quantum Mechanics*, Springer (SIE).

3. Rajasekar, S. and Veluswamy, R. 2014, *Quantum Mechanics I: The Fundamentals*, CRC Press, New York.
4. Richtmyer, F., Kennard, E., Cooper, J. 2001, *Introduction to Modern Physics*, 6th ed. Tata McGraw-Hill Book Company, New Delhi.
5. Verma, H. 2012, *Quantum Physics*, TBS, Calicut.
6. Wichmann, E. 2010, *Quantum Physics: Berkeley Physics Course Vol 4*, Tata McGraw-Hill Book Company, New Delhi.

Course Title **: Solid State Physics**

Course Code **: PHY-E9**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Course Objective: To give the students a firm understanding of the basics of Solid State Physics. The course broadly deals with the topics related to structural aspects and the various physical properties of crystalline solids.

Learning Outcome: After completion of this course, students will develop a comprehensive broad knowledge in topic such as: Bondings in Solids, Crystal Physics, Electrical properties of solids, Origin of energy band structure in solids and Magnetic properties of materials.

Pre-requisites: Quantum Mechanics

Theory:

1. Bonding in Solids: **[5h]**

Introduction, Bonding in Solids, Cohesive energy, Ionic bonding, Calculation of Cohesive energy of ionic solids, Covalent bonding, Metallic bonding, Hydrogen bonding, Van der Waals (Molecular) bonding.

[Palanisamy: 1.1, 1.2, 1.3, 1.4, 1.4.1, 1.5 - 1.5.2, 1.6 - 1.9]

2. Crystal Structure: **[12h]**

Introduction, Space Lattice, Unit cell, Lattice Parameter of unit cell, Bravais lattices, Crystal Symmetry, Stacking sequences in metallic crystal structure, SC, BCC, FCC and HCP structures, Crystal structures- NaCl, diamond, CsCl, ZnS, Directions in crystals, Planes in crystals- Miller indices, Distances of Separation between Successive (*hkl*) Planes.

[Palanisamy: 2.1, 2.2 - 2.2.3, 2.3 - 2.3.4, 3.1, 3.2, 3.3 -3.3.2, 3.4]

3. Diffraction of X-rays by Crystals: **[5h]**

Introduction, Bragg's law, Production of X-rays, Determination of lattice parameters and X-ray Diffraction methods: Laue method and Debye Scherrer method.

[Palanisamy: 4.9 - 4.9.3, 4.10 - 4.10.2]

4. Electron Theory of Metals: **[18h]**

Introduction, Classical free electron theory, Quantum theory of free electrons, Fermi distribution function, Density of energy states, Sources of electrical resistance, Electrons in a periodic potentials, Energy bands in Solids.

[Palanisamy: 6.1, 6.2 - 6.2.2, 6.3, 6.3.1, 6.4, 6.5, 6.6, 6.7-6.7.5, 6.8]

5. Magnetic Properties: **[5h]**

Introduction, Classification of magnetic materials, The quantum numbers, Origin of magnetic moment, Ferromagnetism, Ferromagnetic domains, Hysteresis, Hard and soft materials.

[Palanisamy: 8.1, 8.2, 8.3, 8.4, 8.7, 8.7.3, 8.7.5, 8.7.6]

Experiments: (Minimum Six)

1. Energy band gap of a semiconductor
2. Energy band gap of LEDs
3. To determine value of Planck's constant using LEDs of at least 4 different colours.
4. Fermi energy of Copper
5. Measurement of Hysteresis loss using CRO
6. Calculation of lattice constant by of Copper – X-ray diffraction pattern is given and student calculates: d-spacing, miller indices and lattice constant
7. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four-probe method (room temperature to 150 ^{o}C) and to determine its band gap
8. Investigating crystal structure using Vesta software.

References:

1. Palanisamy P. K., 2004, *Solid State Physics,* Scitech Publications (India) Pvt. Ltd.
2. Pillai S. O., 1999, *Solid State Physics*, 3rd Edition, New Age International (P) Ltd, Publisher.
3. Kittel C., 2004, *Introduction to Solid State Physics*, 8th Edition,John Wiley and Sons.
4. Dekker A. J., 1998, *Solid State Physics*, Macmillan India Ltd. Publisher.

Course Title : **Thermodynamics and Statistical Mechanics**

Course Code : **PHY-E10**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Pre-requisite: PHY-II.C-3

Course Objectives: This course will introduce kinetic theory, classical thermodynamics, probability and statistical methods.

Learning Outcome: After completion of this course, students:

- will understand basics of kinetic theory of gases.
- will learn about probability and probability distribution functions
- will learn the foundations of statistical mechanics, emphasizing its microscopic approach, its probabilistic methods and its applications.

Theory

1. **Kinetic theory of Gases:** **[9 h]**
   Basic assumptions, Equation of State of an Ideal Gas, Collisions with a moving wall, the principle of equi-partition of energy, classical theory of specific heat capacity, specific heat capacity of a solid.
   [Sears and Salinger: 9.1, 9.2, 9.4 – 9.8]

2. **Thermodynamic Potentials** **[6 h]**
   The Helmholtz function and Gibbs function, Thermodynamic Potentials, Maxwell Relations.
   [Sears and Salinger: 7.1-7.3]

3. **Probability** **[10 h]**
   Random Events, Probability, Probability and Frequency, Some basic rules of Probability theory, Continuous random variables, Mean value of discrete and continuous variables, Variance: Dispersion, Probability Distribution, Binomial distribution: Mean value and fluctuation, Stirling's Approximation, Poisson Distribution: Mean value and Standard deviation, Gaussian Distribution: Standard deviation.
   [Laud: 2.1-2.3, 2.5, 2.6, 2.8- 2.19]

4. **Statistical Thermodynamics** **[10 h]**
Phase space, Probability of distribution, The most probable distribution, Maxwell Boltzmann Statistics. Molecular speeds: mean, most probable and r. m. s. speeds. Experimental verification of Maxwell Boltzmann statistics.
[Beiser: 15.1 – 15.5]

5. **Quantum Statistics** **[10 h]**
Bose Einstein statistics, Blackbody Radiation, Rayleigh Jeans formula, Plank radiation formula, Fermi Dirac statistics, Fermi energy, Electron energy distribution.
[Beiser: 16.1 – 16.6, 19.6, 19.7]

Experiments: (Minimum Six)

1. Specific heat of Graphite
2. Study the temperature dependence of resistivity.
3. OPAMP as a bridge amplifier and its application in temperature measurement.
4. Determination of Boltzmann constant.
5. Study of Stefan's Law.
6. Determination of Stefan's constant
7. Tutorial on Maxwell Equation and Free energy
8. Tutorial on Statistical Thermodynamics
9. Tutorial on Statistical Thermodynamics

References:

1. Brijlal, Subrahmanyam N., 2008, *Heat thermodynamics and Statistical Physics*, S Chand Company Ltd.
2. Laud B., 2003, *Introduction to Statistical Mechanics*, New Age International.
3. Saha M. and Shrivastava B., 1965, *Treatise on heat*, The Indian Press.
4. Beiser A., 1995, *Perspectives of modern physics*, 5th edition, McGraw hill.
5. Sears F. and Salinger G., 1998, *Thermodynamics, Kinetic Theory and Statistical Thermodynamics*, 3rd Edition, Narosa.

Additional References:

1. Garg S., Bansal R.and Ghosh C., 1993, *Thermal Physics*, Tata McGraw Hill.
2. Zemansky M. and Ditman R., 1997, Heat *and Thermodynamics*, McGraw Hill.
3. Reif F., 1965, *Fundamentals of Statistical and Thermal Physics*, Mc Graw Hill

Course Title **: Atomic and Molecular Physics**

Course Code **: PHY-VI.C-8**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Pre-requisite: Quantum Mechanics (PHY-IV.C-6)

Course Objectives: Atomic and molecular physics is the study of dynamics and interactions of the basic building blocks of matter. The objective of this course is to study the behaviour of the electrons that surround the atomic nucleus which will help students to understand the dynamics atoms and molecules.

Learning outcome: After successful completion of this course, student will be able to understand the atomic structure, and dynamics of atoms and molecules. They will also gain insight to the physics of atomic and molecular spectral lines.

Theory:

1. **Quantum Theory of the Hydrogen Atom**: **[6 h]**
   Schrodinger's equation for the H-atom. Separation of variables, Eigen values, Quantum numbers and Magnetic moment. Angular momentum, Electron Probability density.
   [Beiser 9.1-9.9]

2. **Many Electron Atoms:** **[7 h]**
   Electron Spin.. Pauli Exclusion Principle and classification of elements in periodic table. Symmetric and Antisymmetric wave functions. Electron configuration. Hund's rule. Total angular momentum. L-S coupling. J-J coupling.
   [Beiser 10.1, 10.3- 10.9]

3. **Atoms in a Magnetic Field:** **[7 h]**
   Effects of magnetic field on an atom. Larmor Precession. The Stern-Gerlach experiment. Spin Orbit Coupling. The Normal Zeeman effect, Lande 'g' factor. Zeeman pattern in a weak field (Anomalous Zeeman effect).
   [Eisberg 8.1-8.4, 10.6]

4. **Atomic Spectra:** **[4 h]**
   Origin of Spectral lines. Selection rules (derivation from transition probabilities). Alkali metal type spectra. Principal, Sharp, Diffused and Fundamental series, fine structure in alkali spectra.
   [Beiser 11.1-11.2, Mcgervey 9.1]

5. **X-ray Spectra:** **[4 h]**
Characteristic spectrum. Moseley's law. Explanation of X-ray spectra on the basis of quantum mechanics. Energy levels and characteristic X-ray lines. X-ray absorption spectra. Fluorescence and Auger effect.
[Richtmayer: 7.6, 7.7, 16.1-16.3, 16.5]

6. **Spectra of Diatomic Molecules:** **[10 h]**
Rotational energy levels. Rotational spectra. Vibrational energy levels. Vibration - Rotation spectra. Fortrat Parabolas and explanation of band structure on its basis. Electronic spectra.
[Beiser 14.1, 14.3, 14.5, 14.7, 14.8 and Rajam 11.2]

7. **Raman Effect:** **[7 h]**
Quantum theory of Raman effect. Classical theory of Raman effect. Pure rotational Raman spectra. Vibrational Raman spectra. Rotational fine structure. Experimental set up for Raman effect.
[Banwell 4.1-4.3]

Experiments: (Minimum Six)

1. To find the wavelengths of Balmer series of visible emission lines and to determine the value of Rydberg constant.
2. Numerically solving the Time Independent Schrödinger equation for the case of Harmonic oscillator.
3. Numerically solving the Radial Schrödinger equation for the case of Hydrogen atom.
4. Numerically solving the Time Independent Schrödinger equation for the case of Morse potential.
5. Absorption spectra of $KMnO_4$
6. X-ray Emission (characteristic lines of copper target)- Calculation of wavelength and Energy.
7. Resolving Sodium D-lines using grating.
8. Resolving Mercury lines using prism.
9. Determination of wavelength of Sodium light using Lloyd's Mirror.
10. Determination of wavelength of Sodium light using a cylindrical obstacle.
11. Double Refraction

References:

1. Beiser, A. 1969, *Perspectives of Modern Physics*, McGraw-Hill Book Company, Singapore.
2. Eisberg, R. And Resnick, R. 2010, *Quantum Physics of Atoms, Molecules, Solids, Nuclei and particles*, 2nd Edition, Wiley India Pvt Ltd.
3. Mcgervey, J. 1983, *Introduction to Modern Physics*, Academic Press, USA.
4. Richtmyer, F., Kennard, E., Cooper, J. 2001, *Introduction to Modern Physics*, 6th ed. Tata McGraw-Hill Book Company, New Delhi.

5. Rajam, J. 2000, *Atomic Physics*, S. Chand and Company limited, New Delhi.
6. Banwell, C. 1994, *Fundamentals for Molecular Spectroscopy*, 4^{th} Edition, McGraw-Hill Higher Education.

Additional References:

1. White, H. 1934, *Introduction to Atomic Spectra*, McGraw-Hill Inc., USA.

Course Title : **Nuclear and Elementary Particle Physics**

Course Code : **PHY-E14**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Pre-requisite : **Quantum Mechanics (PHY-IV.C-6)**

Course objectives: The objective of this course is to introduce students to the fundamental principles and concepts governing nuclear and particle physics.

Learning outcome: After successful completion of this course, student will be able to understand the fundamental principles governing the basic properties of nuclei, nuclear structure and particle physics. Students will also be able to solve elementary problems, relating theoretical predictions and measurement results, in nuclear and particle physics.

Theory:

1. Basic Nuclear Properties: **[4 h]**
Nomenclature, Nuclear Size(Electron scattering and Mirror Nuclei), Nuclear Charge, Nuclear Mass, Nuclear Density, Nuclear Spin, Nuclear Magnetic Moment, Nuclear Electric Quadrupole Moment, Parity, Binding Energy, Nuclear Stability, Packing Fraction
[Jain:1.1,1.2,3.1-3.9]

2. Nuclear forces: **[3 h]**
Main characteristics of Nuclear Forces, Meson theory of Nuclear forces, Estimation of the mass of a meson using Heisenberg's Uncertainty Principle, Yukawa potential
[Patel: 8.6] [Ilangovan:1.9]

3. Radioactivity: **[4 h]**
Soddy-Fazan's Displacement Law, Law of Radioactive Decay, Law of Successive Disintegration, Radioactive series, Units of Radioactivity, Radioactive Dating
[Jain:6.1-6.5] [Ilangovan:2.8]

4.Nuclear Reactions: **[3 h]**
Nuclear Reactions, The Balance of mass and energy in Nuclear Reactions(Q-Value), The Q-Equation.
[Patel: 3.2-3.4][Jain:11.1,11.2]

5. Radioactive decay: **[8 h]**
Alpha decay: Magnetic Spectrograph-Velocity and Energy of Alpha Particles, Bragg's Experiment-Range of Alpha Particles, Geiger Law, Geiger-Nuttal Law, Disintegration energy of

Spontaneous Alpha-decay, The Alpha Spectra and Fine structure: Short Range and Long Range Alpha Particles, Alpha Decay Paradox-Barrier Penetration(Qualitative treatment)
[Ilangovan: 3.1-3.1.7] [Patel: 4.2.1-4.2.3]

Beta Decay: Magnetic Spectrograph-Velocity and Energy of Beta Particles, Origin of Continuous Beta –ray Spectrum and difficulties in understanding it, Pauli's Neutrino Hypothesis. Types of Beta decay, Energies of Beta -decays
[Ilangovan: 3.2.1,3.2.5][Patel: 4.3.1- 4.3.3][Jain:8.1]

Gamma Decay: Origin of Gamma Decay, Internal Conversion, Nuclear isomerism, The Absorption of Gamma Rays with Matter, Detection of Gamma rays using G. M. Counter
[Patel: 4.4.1- 4.3.3] [Ilangovan: 3.3.2, 3.3.3,3.3.5,3.3.6] [Jain:13.6]

6. Liquid drop model of a nucleus: **[6 h]**
Analogy between liquid drop and a nucleus, Assumptions of Liquid Drop Model, Wiezsacker Semi- Empirical Mass Formula, Equation for Mass Parabola For Isobaric Nuclei, Merit and Demerit of Semi-Empirical Mass Formula, Potential Barrier for Fission, Stability Limit against Spontaneous Fission(Bohr and Wheeler Theory for Fission Process), Energetic of Symmetric Fission
[Jain:4.1-4.4][Patel:5.5]

7. Nuclear Shell Model: **[4 h]**
Experimental basis of Shell Model, Single-Particle Shell Model, Shell Model with Spin-Orbit Coupling, Prediction of ground state spin and parity, Prediction of Magnetic Moment, Prediction of Quadruple moment,
[Jain:5.1-5.6][Patel:7.3]

8. Nuclear Energy: [6 h]
Neutron Induced Fission, Asymmetrical Fission-Mass Yield, Energy released in the fission of U-235, Fission Chain Reaction, Principle of a Nuclear Reactor, Neutron cycle in a Thermal Nuclear Reactor (The four factor formula), Principle of a Breeder Reactor.
[Patel: 6.1-6.5, 6.7-6.9]

9. Elementary Particle Physics: [7 h]
Origin of Cosmic ray, Composition of Cosmic rays, Cosmic ray showers, Positron, Mesons, Classification of Elementary Particles, Particles and Antiparticles, Fundamental Interactions, Quantum Numbers, Conservation Laws, Gell-Mann-Nishijima Formula, The Quark Model, Baryons and Mesons as Bound States of Quarks
[Ilangovan:11.1, 11.5-11.8, 12.2-12.7][Jain:15.1-15.3]

Experiments:

1. Study of the characteristics of a GM tube and determination of its operating voltage, plateau length / slope etc
2. Determination of Absorption Coefficient
3. Verification of Inverse Square Law
4. Study of nuclear counting statistics
5. Measurement of short half-life
6. Simulation of Radioactive Decay using Rolling of Dice
7. Tutorial on Properties of the Nucleus and Q-value of Nuclear Reaction
8. Tutorial on Radioactivity and Radioactive decays
9. Tutorial on Liquid drop model

References:

1. Jain, Vimal Kumar. 2015, *Nuclear and Particle Physics*, Ane Books Pvt. Ltd., New Delhi.
2. Patel, S. 2011, *Nuclear Physics: An Introduction*, 2nd Edition. New Age International Limited, New Delhi.
3. Ilangovan, K. 2012, *Nuclear Physics*, MJP Publishers, Chennai.

Additional References:

1. Krane, K. 1987, *Introductory Nuclear Physics*, 3rd Edition. Wiley, New Jersey.
2. Kaplan, I. 1956, *Nuclear Physics*, 3rd Edition, Addison-Wesley, Boston.
3. Beiser, A. 1969, *Perspectives of Modern Physics*, McGraw-Hill Book Company, Singapore.

Annexure III

Course Title : Elementary Physics – I

Course Code : PHY-I1

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Prerequisite : Nil.

Course Objective: To provide introduction to topics on properties of matter, optics and lasers, thermometry, basic semiconductor, p-n junction theory and digital electronics which are essential allied learning components for most of the subjects of Natural Sciences.

Learning Outcomes:

- Students will be able to comprehend the phenomenon of elasticity, surface tension, viscosity and their application.
- Students will get necessary foundation in optics and on the topic of thermometry.
- Students will understand the basics of semiconductors, p-n junction theory, digital electronics and correlate with the experiments.

Theory:

Unit 1- Properties of Matter and Sound [17h]

a) Elasticity

Hooke’s Law, Types of Elasticity: Young’s Modulus, Bulk Modulus and Modulus of rigidity. Poisson's ratio. Torsion in a string-couple per unit twist, Torsional Pendulum.

[Mathur: **106-109, 114, 117, 122, 126]**

b) **Surface Tension**

Brief review of molecular theory of surface tension. Relation between surface tension and urface energy. Angle of contact. Capillarity-rise of liquid in a capillary tube.

[Mathur: 232-236, 246, 248]

c) **Viscosity**

Streamline flow, Turbulent flow, Critical velocity, Coefficient of viscosity, Poiseuille's formula for flow ofliquid through a capillary tube.

[Mathur:200, 201, 205, 206, 208, 209]

d) Sound

Velocity of longitudinal waves in gases. Newton's formula for velocity of sound. Velocity in a homogeneous medium. Laplace’s correction. Intensity level and Bel and Decibel. Doppler Effect. Source and listener in relative motion (Normal incidence only).

[Khanna: 5.3-5.5, 11.2, 11.3, 12.1-12.4]

Unit 2- Optics and Lasers: [15 h]

a) **Interference:** Light as a wave, Young’s interference experiment, coherence, intensity in double slit interference, interference from thin films.

   [Halliday: 36.2-36.7]

b) **Diffraction:**

   Diffraction and wave theory of light, diffraction by a single slit, intensity in single slit diffraction, diffraction by a circular aperture.

   [Halliday: 37.1-37.5]

c) **Polarisation:**

   Polarisation, reflection and refraction, total internal reflection, polarization b reflection.

   [Halliday: 34.6-34.9]

d) **Lasers:**

   Attenuation of light in an optical media. Thermal Equilibrium. Interaction of light with matter. Einstein’s A and B coefficients and their relations. Population inversion. Principal pumping schemes. Ruby Laser, He-Ne Laser. Applications of Laser.

   [Subrahmanyam: 22.1-22.11, 22.14.1, 22.14.3, 22.16, 22.17]

Unit 3- Thermometry: [5 h]

Principle of Thermometry

Review of concept of heat and temperature, Thermometry, Types of thermometers, Centrigrade, Fahrenheit, Rankine Scales and relations between them, Platinum resistance thermometer, Thermocouple (thermoelectric) thermometers.

[Brijlal: 13.1 – 13.5, 13.15, 13.23]

Unit 4- Electronics [8 h]

a) **Basic Semiconductor and pn-Junction Theory:**

   Conductors, Semiconductors and Insulators, *p*-Type and *n*-Type Semiconductors. Semiconductor conductivity, The *pn*-Junction, Biased Junctions.

   [Bell: 1.3-1.6]

b) Logic Gates:

Binary number system, Binary to Decimal and Decimal to Binary conversion. Boolean Algebra, Basic logic gates: OR, AND, NOT, NOR, NAND, and EX-OR gates. De Morgan's Theorems, NAND and NOR gates as universal building blocks in logic circuits.

[Mehta: 26.3-26.6, 26.20, 26.12-26.17, 26.22]

Experiments: (Minimum Six)

1. Experiment using measuring devices
2. Y by vibration
3. Determination of surface tension using capillary rise method.
4. Coefficient of viscosity using Poiseuille's method.
5. Single slit diffraction using Laser source.
6. Double slit diffraction using Laser source.
7. Thermocouple
8. Callender Griffith Bridge
9. Forward and reverse bias characteristics of a junction diode.
10. Verification of truth tables of:
    AND, OR, NOT, NAND, NOR, EX-OR gates
11. Verification of De-Morgan's theorem.

References:

1. Mathur D. S., *Elements of Properties of Matter*,S. Chand and Company, New Delhi, Seventh Edition.
2. Halliday D., Resnick R. and Walker J., 2003, *Fundamentals of Physics*, John Wiley and Sons, Inc., USA, 6^{th} Edition
3. Subhramanyam N., Lal Brij, Avadhanulu M. N.,2006,*A Text book of Optics*, S. Chand & Company Ltd., New Delhi, First-multicolor Edition
4. Brijlal, Subramanyam N., Hemne P.S., 2007, *Heat Thermodynamics and Statistical Physics*, S. Chand
5. Bell David A.,2013.,*Electronics Devices and Circuits*, Oxford University Press, New Delhi, 5^{th} Edition.

6. Metha V. K. and Mehta Rohit, 2008, *Principles of Electronics*,S. Chand & Company, Multicolour Revised Edition.

Additional References:

1. Jenkins F. A. and White H. E., 1981,*Fundamentals of Optics*, Tata McGraw-Hill Publishing Company Ltd.
2. Saha M.N., Shrivastava B.N.,1965,*Treatise on Heat*, The Indian Press 5th Ed.
3. Bhargava N. N., Kulshreshtha D. C. and Gupta S. C., 2010, *Basic Electronics and Linear Circuits*, Tata McGraw Hill Education Private Ltd., 54th Reprint

Course Title : **Elementary Physics-II**

Course Code : **PHY-I2**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Course Objective: To provide introduction to topics on Relativity, wave-mechanics, crystal Physics, Nuclear Physics which are essential allied learning components for most of the subjects of Physical Sciences.

Learning outcomes:

Students will get acquainted to special theory of relativity, wave mechanics, crystal Physics and Nuclear Physics.

Theory:

Unit 1- Theory of Relativity

a) **Special Theory of Relativity:** **[6 h]**

The Galilean Transformation. The Lorentz Transformation. The Lorentz-Fitzgerald Contraction. Time Dilation. Simultaneity.

[Beiser 1.2-1.8]

b) **Relativistic Mechanics:** **[4 h]**

Velocity addition. The relativity of mass. Mass and energy

[Beiser 2.1-2.5]

Unit 2- Wave Particle Duality **[12 h]**

a) **Particle Properties of waves:**

The Photoelectric effect, Compton Effect,

[Beiser: 3.1, 3.2, 3.5]

b) **Wave Properties of Particles :**

De Broglie's hypothesis. Davisson-Germer Experiment, Interference pattern of bullets, waves and electrons. Wave Particle duality. The Uncertainty principle and its application.

[Beiser 4.1, 4.5,4.6 - 4.8, Feynman 1.1-1.8]

Unit 3-Mass Spectrographs and Particle Accelerators: **[4 h]**

Thomson's positive ray analysis, Dempster's Mass spectrograph, Bainbridge Mass spectrograph. Linear accelerator and Cyclotron.

[**Rajam: 227-233, 240-244, Murugeshan: 30.3, 30.4]**

Unit -4 Crystal Physics **[7 h]**

a) **Crystal Structure:**

Crystal lattice, crystal planes and Miller indices, unit cells and typical crystal structures.

[Beiser: 18.1-18.3]

b) **X-rays:**

Coolidge tube generator, Origin of X ray Spectra: Continuous X-ray spectra and Characteristic X-ray spectra, Diffraction and Bragg's law. Experimental approaches to X-ray Diffraction: Bragg's Diffraction experiment and Laue's Diffraction of X-rays.

[Kakani: 5.1-5.7, 5.17]

Unit 5- Nuclear Physics **[8 h]**

a) **Basic Properties of the nucleus**:

Mass and radius, Nuclear spin, Binding energy, Binding energy vs A plot. Saturation of nuclear forces.

[Beiser: 21.2, 21.4-21.6]

b) **Radioactivity:**

Properties of radioactive rays, The law of radioactive Decay, Mean Life, Half life and Decay Constant. Radioactive series, Artificial Radioactivity. Carbon dating.

[Patel: 2.3, 2.9, 2.11, 2.13]

Experiments: (Minimum Six)

1. Photoelectric effect.
2. Study of Stefan's law.
3. Calculation of lattice constant by of Copper – X-ray diffraction pattern is given and student calculates: d-spacing, miller indices and lattice constant.
4. X-ray Emission (characteristic lines of copper target)- Calculation of wavelength and Energy.
5. Study of the characteristics of a GM tube and determination of its operating voltage, plateau length / slope.
6. Verification of inverse square law
7. Linear absorption co-efficient
8. Simulation of radioactive decay using rolling of dice.

References:

1. Beiser, A 1969,*Perspectives of Modern Physics*, McGraw-Hill Book Company, Singapore.
2. Feynman, R P 2012, *Feynman Lectures on Physics: Quantum Mechanics (Volume - 3)*, Pearson Education, India.
3. Rajam, J. 2000, *Atomic Physics*, S. Chand and Company limited, New Delhi.
4. Murugeshan, R 2009, *Modern Physics*, S. Chand and Company limited, New Delhi.
5. Kakani S. L.,2009,*Modern Physics*, Viva Books,
6. Patel S. B., 2011, Nuclear Physics An Introduction, New age international publishers, New Delhi.

Additional References:

1. Resnick, R. 2010, *Introduction to Special Relativity*, Wiley India Pvt. Ltd, India.
2. Verma, HC 2012, *Quantum Physics*, TBS, Calicut.
3. Wichmann E 2010, *Quantum Physics: Berkeley Physics Course Vol 4*, McGraw Hill Education, India.

Course Title : **The Physics of Energy and Energy Sources-I**

Course Code : **PHY-I3**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Contact Hours : **45H (Theory) + 30H (Practical)**

Course Objectives: Providing energy for the world to use in a sustainable fashion is measure challenge for the twenty-first century. Economic considerations and policy decisions will be central to any global attempt to address this energy challenge. For individuals, organizations, and nations to make rational choices regarding energy policies, however, a clear understanding of science of energy is essential. The aim of this course is to provide an in-depth introduction to energy systems, from basic physical principle to practical consequences in real system. This course is designed for <u>any science student</u>, who wants to understand the fundamental laws and physical processes underlying all energy systems. The course will enable students to approach energy issues in a sophisticated and scientific fashion, but without having to take advanced subjects in thermodynamics, quantum mechanics, or nuclear physics beforehand. The Physics of Energy and Energy Sources-I and II are offered as <u>interdisciplinary elective courses</u> in the odd and even semesters, respectively.

Learning Outcome: After successful completion of the course entitled "The Physics of Energy and Energy Sources-I", student will be able to understand the basic concepts related to mechanical, electromagnetic, and thermal energy; the basic notions of quantum mechanics; and the concepts of entropy and thermodynamics.

Theory:

1. Introduction: [1h]

Units and Energy quantities, Types of Energy, Scales of Energy

2. Mechanical Energy: [4h]

Kinetic Energy, Potential Energy, Air resistance and Friction, and Rotational Mechanics

3. Electromagnetic Energy: [6h]

Electrostatic, Capacitance, Energy Storage; Current, Resistance and Resistive energy loss, Magnetism, Electric motors and Generator, Induction and Inductors, Maxwell's equations

4. Waves and Light: [4h]

Waves and a wave equation, Waves on a String, Electromagnetic Waves, Energy and Momentum in Electric and Magnetic fields, General features of wave and wave equations

5. Heat and Thermal Energy: [4h]

What is Heat? Pressure and Work, First Law of Thermodynamics, Heat Capacity, Enthalpy, Phase Transitions

6. Heat Transfer: [4h]

Mechanics of Heat Transfer, Heat conduction, Heat Transfer by Convection and Radiation, Heat Equations

7. Entropy and Temperature: [7h]

Introduction to Entropy and Second Law of Thermodynamics, Information Entropy, Thermodynamic Entropy, Thermal Equilibrium and Temperature, Limit to Efficiency, Boltzmann Distribution, Partition Function and Simple Thermodynamic Systems, Spontaneous process and Free Energy

8. Thermal Energy Conversion: [7h]

Thermodynamic variables, Idealizations and Representations, Thermodynamic process in gas phase engines, Carnot engine, Limitation to efficiency of Real engines, Heat extraction devices: Refrigerators and Heat Pumps

9. Introduction to Quantum Mechanics: [8h]

Motivation Double Slit experiment, Quantum Wave Functions and Schrodinger Wave Equation, Energy and Quantum States, Quantum Superposition, Quantum Measurements, Time Dependence, Quantum Mechanics of Free particles, Particle in potentials

Experiments (Any six):

1. Air Resistance: Determination of Damping Factor using simple pendulum

2. Capacitance: Step response of RC circuit

3. Resistance: Energy loss in Resistance

4. Inductor: Resistance and Inductance of a coil

5. Double Slit: Determination of wavelength of Laser Source

6. Heat: Thermometry

7. Visit to Goa Science Centre

References:

1. Jaffe Robert L. And Taylor Washington, 2018, *The Physics of Energy*, Cambridge University Press.

Additional References:

1. Halliday D., Resnick R. and Walker J., 2003, *Fundamentals of Physics*, John Wiley and Sons, Inc., USA, 6th Edition
2. Brijlal, Subramanyam N., Hemne P.S., 2007, *Heat Thermodynamics and Statistical Physics*, S. Chand
3. Beiser, A 1969,*Perspectives of Modern Physics*, McGraw-Hill Book Company, Singapore.

Course Title : **The Physics of Energy and Energy Sources-II**

Course Code : **PHY-I4**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Contact Hours : **45H (Theory) + 30H (Practical)**

Pre-requisite : **The Physics of Energy and Energy Sources-I**

Course Objectives: Providing energy for the world to use in a sustainable fashion is measure challenge for the twenty-first century. Economic considerations and policy decisions will be central to any global attempt to address this energy challenge. For individuals, organizations, and nations to make rational choices regarding energy policies, however, a clear understanding of science of energy is essential. The aim of this course is to provide an in-depth introduction to energy systems, from basic physical principle to practical consequences in real system. This course is designed for any science student, who wants to understand the fundamental laws and physical processes underlying all energy systems. The course will enable students to approach energy issues in a sophisticated and scientific fashion, but without having to take advanced subjects in thermodynamics, quantum mechanics, or nuclear physics beforehand. The Physics of Energy and Energy Sources-I and II are offered as interdisciplinary elective courses in the odd and even semesters, respectively.

Learning Outcome: After successful completion of the course entitled "The Physics of Energy and Energy Sources-II", student will be able to understand the four fundamental forces that govern all the natural processes, some aspects of quantum mechanics such as tunneling, and the basic physics principles related to nuclear energy, solar energy, and wind energy.

Theory:

1. Forces of Nature: [2h]

Forces, Energies and distance scale, Elementary particles, The weak Interactions and beta decay

2. Quantum Phenomena in Energy system: [4h]

Decays and other time dependent quantum processes, Origin of Tunneling, Barrier penetration, Tunneling lifetimes, Pauli Exclusion Principles

3. Structure, Properties and Decay of Nuclei: [4h]

Basic Nuclear Properties, Semi-emperical mass formula, Nuclear binding systematic, Nuclear decays.

4. Nuclear Energy Processes: [4h]

Comparing Fission and Fusion, Cross-section, Physics of Nuclear Fission, Physics of Nuclear Fusion.

5. Nuclear Fission Reactor: [4h]

Nuclear fission reactor dynamics, Physics issues affecting fission reactor operation and safety, Breeding and fission reactors, Fission reactor design, Nuclear reactor Power cycles

6. Solar Energy: [4h]

Solar Production and Radiation: Nuclear source of solar energy, Black body radiation and solar radiation, derivation of black body radiation formula

7. **Solar Radiation on Earth:** [4h]

Insolation and the Solar constants, Earth's orbit, Variation of insolation, Interaction of light with matter, Atmospheric absorption, Extend of resource

8. Solar Thermal Energy: [4h]

Solar Absorption and radiation balance, Low-temperature solar Collectors, Concentrators, Solar thermal electricity

9. Photovoltaic Solar Cells: [6h]

Introductory aspects of Solid State Physics, Quantum mechanics on a lattice, Electrons in Solids and Semiconductors, The PV concept and limit on collection efficiency, Band structure of Silicon, p-n junction, p-n junction as a photodiode, Silicon Solar scale, Advanced Solar cells, Use of Photovoltaic

10. Wind and Wind Turbines: [5h]

The nature of the wind, Characterization of Wind Resource, The potential of wind energy

Axial momentum theory and Betz's limit, Turbine blades and power

11. Basics of Fluids: [2h]

Defining characteristics of a fluid, Simplifying Assumptions and conservation laws, Viscosity

12. Energy from Moving Water: [2h]

Hydropower, Wave power and Tidal power

Experiments (Any six):

1. Half Life Time:
2. GM Counter : Characterization, Inverse Square Law and Absorption Coefficient
3. Stefan's Law
4. p-n junction
5. Photodiode/ Solar Cell
6. Viscosity
7. Visit to GEDA, Goa

References:

Jaffe Robert L. And Taylor Washington, 2018, *The Physics of Energy*, Cambridge University Press.

Additional References

1. Beiser, A 1969,*Perspectives of Modern Physics*, McGraw-Hill Book Company, Singapore.
2. Sukhatme S. P., Nayak J. K., 2015, Solar Energy Principles of thermal collection and storage, 3rd Edition, McGraw Hill Education, New Delhi.
3. Rai G. D., 2014, Solar energy utilization, 5th Edition, Khanna publishers, New Delhi.
4. Rai G. D., 2014 Non-conventional energy sources, 5th Edition, Khanna publishers, New Delhi.

Annexure IV

Mini Projects may be undertaken by students instead of doing some experiments in the laboratory in following practical courses:

Course	No. of Hours	Experiments to be combined for mini projects
Optics	12 Hours	1. Study of Diffraction Grating and determination of wavelength 2. Polarisation experiments 3. Determination of wavelength using Biprism 4. Determination of wavelength using Loyd's Mirror (Any two of the above can be chosen)
Quantum Mechanics	8 Hours	Numerically solving TISE for the case of alpha-decay.
Electronics - I	24 Hours	Oscillators and amplifiers
Solid State Devices	16 Hours	Experiments on UJT, SCR, DIAC/TRIAC, FET
Electronics-II	24 Hours	Multivibrators and Timers
Nuclear Physics	12 Hours	G.M. counter

MARKING SCHEME FOR MINI PROJECT

Total 25 marks to be allocated as follows:

Practical work	10 marks
Maintenance of work record	5 marks
Report of work	5 marks
Viva-voce/Presentation	5 marks
Total	25 marks

Marking Scheme for the mini project will be decided by the course in-charge based on the parameters stated above.

Annexure V

Following courses for minor students to be given from regular courses.

Semester	Course
I	Mechanics-I
II	Electricity and Magnetism Or Heat and Thermodynamics
III	Modern Physics Or Electromagnetic theory -I
IV	Computational Physics Or Quantum Mechanics
V	Thermodynamics and Statistical Mechanics Or Electromagnetic theory -II
VI	Mechanics II Or Introduction to Materials Science

Annexure VI

Online Courses

1. Free online course on Mechanics, Heat, Oscillations and waves, listed in SWAYAM programme initiated by Government of India, may be offered to the students and evaluated by the course in-charge.
2. Practicals related to the content of the online courses may be offered and evaluated by the course in-charge. [If it is plausible to include practicals for a particular online course, it (practicals) may be offered to students depending on the availability of the equipments in our lab. In such a case, these practicals may be conducted and evaluated by course In-charge for 25 marks and theory marks may be scaled to 75 marks].
3. Any online course identified by Departmental council of Physics Department may be offered to students as an elective course only after receiving approval from all the BoS members through email.
4. BoS Physics recommends that the online courses shall be offered to the students who have completed all core courses in semester I and II with a minimum score of 60%.
5. BoS Physics recommends that the workload of two hours per week per course may be assigned to the course in-charge for monitoring the progress of the students through continuous interaction and evaluation.

Annexure VII

Marking Scheme for Practicals

Each experiment of 20 marks will be assessed as per the following marking scheme:

CRITERIA	ALLOTED MARKS
Systematic, Grasp of the Experiment/ Circuit Connections and Pre-lab Questions.	05
Observations [Quality and Quantity]	05
Calculations and Graph	05
Result and Conclusion, Analysis of Results and Post-lab Questions.	05
VIVA	05
Total marks per practical	**25**

Annexure I

The course structure is proposed to be revised as follows:

SEMESTER	CORE		ELECTIVE				
I	PHY-I.C-1 Introduction to Mathematical Physics	PHY-I.C-2 Mechanics-I	-------	-------	-------	-------	-------
II	PHY-II.C-3 Heat and Thermodynamics	PHY-II.C-4 Electricity and Magnetism	-------	-------	-------	-------	-------
III	PHY-III.C-5 Electromagnetic Theory-I	-------	PHY-E1 *Optics	PHY-E2 Modern Physics	PHY-E3 Oscillations, Waves and Sound	PHY-E17 Introduction to Astronomy and Astrophysics	PHY-E8 Instru mentati on
IV	PHY-IV.C-6 Quantum Mechanics	-------	PHY-E5 *Electronics-I	PHY-E18 Introduction to Error Analysis	PHY-E4 Properties of Matter and Acoustics	PHY-E7 Computational Physics	-------
V	PHY-V.C-7 Electromagnetic Theory-II	-------	PHY-E9 *Solid State Physics	PHY-E10 Thermodynamics and Statistical Mechanics	PHY-E11 Electronics-II	PHY-E12 Mathematical Physics	PHY-E6 Solid State Devices
VI	PHY-VI.C-8 Atomic and Molecular Physics	-------	PHY-E13 *Mechanics II	PHY-E14 Nuclear and Elementary Particle Physics	PHY-E15 Introduction to Special Theory of Relativity	PHY-E16 Introduction to Material Science	

* BoS Physics recommends these elective courses to be taken by students as a prerequisite to the M.Sc. (Physics) Program.

Interdisciplinary courses	**CODE**
Elementary Physics – I	PHY-I1
Elementary Physics – II	PHY-I2
The Physics of Energy and Energy Sources-I	PHY-I3
The Physics of Energy and Energy Sources-II	PHY-I4

COURSES FOR STUDENTS OPTING PHYSICS AS MINOR SUBJECT

Semester	Course
I	Mechanics-I
II	Electricity and Magnetism Or Heat and Thermodynamics
III	Modern Physics Or Electromagnetic theory -I
IV	Computational Physics Or Quantum Mechanics
V	Thermodynamics and Statistical Mechanics Or Electromagnetic theory -II
VI	Mechanics II Or Introduction to Materials Science

Annexure II

SYLLABUS OF COURSES FOR STUDENTS OPTING PHYSICS AS THEIR MAJOR SUBJECT

Course Title : **Introduction to Mathematical Physics**

Course Code : **PHY-I.C-1**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Course Objectives : To develop basic competence in certain areas of mathematics required for understanding several important topics in physics.

Course Outcomes : At the end of this course students will be able to:

CO1: Have a good understanding of vector analysis and its application in physics.

CO2: Have a good grasp on various tests used to test the convergence and divergence of different kinds of series and learn how to expand a function in power series.

CO3: Understand the basics of complex numbers.

CO4: Have an understanding of matrix operations and properties of matrices.

CO5: Learn basics of partial differentiation and its application in physics.

CO6: Be able to solve ordinary first and second order differential equations important in the physical sciences,

CO7: familiarize with spherical and cylindrical coordinate systems.

CO8: Use mathematical techniques to solve several problems in physics and enhance problem solving skills.

Theory:

1. **Vector Analysis** **[6 h]**
   Scalars and vectors, Basis vectors and components, Multiplication of Vectors. Equation of lines and planes. Using vectors to find distances. Reciprocal vectors. Differentiation and Integration of vectors.
   [Riley 7.1, 7.3-7.9, Boas 6.4, 6.8]

2. **Infinite Series and Power Series** **[6 h]**
   Geometric Series and other infinite series. Convergent and Divergent Series. Testing series for convergence. Power series. Expanding functions in power series. Techniques for obtaining power series expansion.
   [Boas 1.1-1.7, 1.10-1.13]

3. **Complex Numbers** **[6 h]**
   Real and imaginary Parts of a complex number. Complex plane. Complex algebra. Euler's formula. Powers and roots of complex numbers. Exponential and trigonometric functions.
   [Boas 2.1-2.5, 2.9-2.11]

4. **Matrices** **[6 h]**
   Matrix Analysis and Notation, Matrix Operations, Properties of matrices. Transpose matrix. Complex Conjugate Matrix, Hermitian Matrix, Unit matrix, Diagonal matrix, Adjoint and self-adjoint matrix, symmetric matrix, anti-symmetric matrix, unitary matrix, orthogonal matrix, trace of a matrix, inverse matrix.
   [Harper 2.3, 2.4, 2.5 and 2.6]

5. **Partial Differentiation** **[7 h]**
   Definition of the partial derivative. Total differentials. Exact and inexact differentials. Theorems of partial differentiation. Chain rule. Thermodynamic relations. Differentiation of Integrals.
   [Riley 4.1-4.5, 4.10-4.11]

6. **Ordinary Differential Equation** **[8 h]**
   Introduction. Linear differential equation of the first order. Homogenous and inhomogeneous linear differential equation of the second order.
   [Boas 8.1-8.6 and Harper 5.1-5.2]

7. **Coordinate Systems** **[6 h]**
   Plane polar coordinates. Cylindrical and Spherical polar coordinates.
   [Harper 1.6.6, Riley 8.9]

Experiments: (Minimum Six)

1. Introduction Error Analysis: Propagation of Errors
2. Statistical Analysis of Random measurement
3. Simulation of Radioactive Decay using Rolling of Dice
4. Plotting of various algebraic and trigonometric functions using Excel.
5. Curve fitting using Excel.
6. Interpretation of graphs.
7. Solving Integration, Ordinary Differential Equation and Matrices using Mathematica.
8. Tutorial on vector analysis
9. Tutorial on infinite series
10. Tutorial on differential equations
11. Tutorial on matrices and partial differentiation

References:

1. K. F. Riley, M. P. Hobson and S. J. Bence, *Mathematical Methods for Physics and Engineering* (Cambridge University Press, 1998)
2. Mary L. Boas, *Mathematical Methods in Physical Sciences* (John Wiley and Sons, 3rd Edition)
3. Charlie Harper, *Introduction to Mathematical Physics*- (Prentice Hall)

Additional References:

1. B. D. Gupta, *Mathematical Physics* (Vikas Publishing House, 2004)
2. M. Spiegel, S. Lipschutz, D. Spellman, *Schaum's Outline of Vector Analysis,* (Mc-Graw Hill Education, 2009)

Course Title : **Mechanics I**

Course Code : **PHY-I.C-2**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Course Objectives : This course provides an introduction to topics in mechanics, which are essential for advanced work in physics. An objective of this course is to train students to think about some of the physical phenomenon in mathematical terms.

Course Outcomes : At the end of this course students will be able to:

CO1: develop qualitative and quantitative understanding of Newtonian mechanics in one and two dimensions and solve the Newton equations for simple configurations.
CO2: understand the Law of Conservation of Linear Momentum and Angular Momentum and apply these laws to understand elastic and inelastic collision, motion of a rocket and Kepler's law.
CO3: demonstrate the knowledge of work and energy in kinetics
CO4: understand the Principle of Conservation of Mechanical Energy (for conservative forces) and apply this law to problems of objects moving under the influence of conservative forces.
CO5: develop ideas of Newtons Law of gravity, gravitational field and potential energy by solving various problems.

Theory:

1. **Newton's Laws of Motion** **[10 h]**
   Brief description of classical view of Space and Time (vector operations). The concept of Mass and Force. Newton's First and Second Laws; Inertial frames. Equations of motion. Interpretation of Newton's third Law as Conservation of Momentum. Newton's Second Law in Cartesian coordinates and in two dimensional Polar coordinates. Applications of Newtons Laws: Atwood Machine, Free fall near surface of the earth, simple harmonic motion and time dependent force.
   [Taylor 1.1-1.7, Kleppner 2.4]

2. **Projectiles and Charged Particles** **[10 h]**
   Motion of projectile in air resistance/drag (function of velocity.) Linear Air Resistance. Horizontal and vertical motion with linear drag, Trajectory and Range in a Linear Medium. Quadratic Air Resistance. Horizontal motion with quadratic drag (ignoring gravity), Motion of a charged particle with a velocity perpendicular to the direction of a uniform constant (1) electric field, (2) magnetic field and (3) electric and magnetic field (crossed) in mutually perpendicular directions. Lorentz force.
   [Taylor 2.1 - 2.7, Symon 3.17]

3. **Momentum and Angular Momentum** **[7 h]**
   Principle of conservation of momentum (Elastic and Inelastic collision), Analysis of Rocket motion. The Centre of Mass, Angular Momentum for a Single Particle. Kepler's second law as a consequence of conservation of angular momentum.
   [Taylor 3.1-3.5]

4. **Work and Energy** **[10 h]**
   Kinetic Energy and Work: Work energy theorem. Potential Energy and Conservative Forces. Force as a Gradient of Potential Energy, Time dependent potential energy (one dimension). Energy for Linear One-Dimensional Systems. Curvilinear one-dimensional systems. Energy of interaction of two particles in one dimension.
   [Taylor 4.1-4.3, 4.5-4.7, 4.9]

5. **Gravitation Field and potentials** **[8 h]**
   Newton's Law of Gravitation. Gravitational field. Gravitational potential energy. Equipotential surface. Gravitational potential and field due to a (1) thin spherical shell, (2) uniform hollow sphere and (3) thin circular plate.

   [Brijlal 5.5-5.8, 5.10, 5.11]

Experiments: (Minimum Six)

1. Dimensions of different solid body
2. Moment of Inertia of a flywheel
3. Atwood Machine
4. Verification of Newton's Second Law using Air Track
5. Conservation of linear momentum using Air Track
6. Spring Mass System: Determining the Spring Constant
7. Simple Pendulum
8. Determining "**g**" using time of flight method using Python

References:

1. John Taylor, *Classical Mechanics,* (University Science Books, 2004)
2. Kleppner and Kolenkow, *Introduction to Mechanics*,(Cambridge University Press, 2013)
3. K. R. Symon, *Mechanics* (Addison Wesley, 1971)
4. Brij Lal and N. Subrahmanyam, *Mechanics and Electrodynamics*, (S. Chand and Company LTD , 2005)

Additional References:

1. Kittle and Knight, Mechanics (Berkeley Physics Course, Vol. 1), (McGraw Hill Education, 2011)
2. D. S. Mathur, *Mechanics* (S. Chand & Co., 2005)
3. R. G. Takawale and P. S. Puranik, *Introduction to Classical Mechanics*, (Tata McGraw-Hill, 1997)

4. Javier E. Hasbun, *Classical Mechanics* (Jones and Bartlett India Pvt. Ltd. 2010)
5. Atam Arya, *Introduction to Newtonian Mechanics,* (Addison-Wesley, 1997))
6. R. G. Takawale and P. S. Puranik, *Introduction to Classical Mechanics* (Tata McGraw-Hill, 1997)
7. Javier E. Hasbun, *Classical Mechanics* (Jones and Bartlett India Pvt. Ltd. 2010)

Course Title : **Electricity and Magnetism**

Course Code : **PHY-II.C-4**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Course Objectives : The objective of this course is to introduce fundamentals of electricity and magnetism to the students, which is an essential preparation for more advanced courses like Electromagnetic theory.

Course Outcomes : At the end of this course students will be able to:
CO1 : Comprehend basic concepts like: laws of electrostatics and magneto statics and also related applications.
CO2 : Understand the interrelated concepts of Electricity and Magnetism.
CO3 : Understand the working of transient circuits and alternating current circuits.
CO4 : Correlate the theoretical basis of various concepts of electricity and magnetism while performing experiments.

Theory:

1: Electrostatics **[10 h]**

Coulomb's law: Statement, Vector form of Coulomb's law for like and unlike charges, Variation of force with distance (F.vs.r graph), Concept of electric field and Electric Field Lines: Electric field, Electric field due to (i) a Point Charge, (ii) an Electric Dipole, (iii) a Line of Charge and a Charged Disk, Concept of electric flux: Gauss' Law of electrostatics (Conceptual explanation), Applications of Gauss law: Coulomb's Law from Gauss' Law, Electric Field due to (i) an isolated uniformly charged sphere, (ii) an uniform distribution of charge throughout the sphere and (iii) an uniformly charged hollow cylinder, Electric Field near (i) a charged infinite cylindrical conductor or a cable and (ii) a plane of sheet charge Concept of Electric Potential: Electric Potential Energy, Equipotential Surfaces, Calculating the Potential from the Field Potential due to (i) a Point Charge, (ii) a Group of Point Charges and (iii) an Electric Dipole Calculating the Field from the Potential.
[Ref. No.1: 22.4, 23.2-23.7, 24.1-24.5, 25.1-25.7, 25.9] [Ref. No.2: 2.4(1-6)]

2: Capacitors and Dielectrics **[5 h]**

Capacitance: Calculation of capacitance of (i) a Parallel-Plate Capacitor, (ii) a Cylindrical Capacitor and (iii) a Spherical Capacitor; Energy stored in an electric field, Capacitor with a Dielectric, Dielectrics: An Atomic View, Dielectrics and Gauss' Law, Relation between three electric vectors (E, D and P)(Without derivation, qualitative discussion only)
[Ref. No.1: 26.1- 26.3, 26.5-26.8]

3: Magnetostatics **[9 h]**

Concept of magnetic field: Definition and properties of magnetic field Biot–Savart's law and its applications: (i) a long straight wire and (ii) a current carrying circular loop (for a point on the axis only) Ampere's circuital law and its applications: (i) Field of solenoid and (ii) Field of toroidal solenoid Magnetic Field lines and Magnetic flux; Gauss' law for magnetism [Ref. No.1: 29.1, 29.2, 30.1, 30.3, 30.4, 32.2][Ref. No.3:27.2, 27.3]

4: Self and Mutual Inductance **[6 h]**

Self induction; Calculation of self inductance of (i) a long solenoid, (ii) long parallel wires and (iii) a coaxial cable Mutual inductance, Coefficient of coupling; Calculation of mutual inductance between two coaxial solenoids, Mutual inductance of two coils in series Energy stored in a magnetic field and Energy density of a magnetic field

[Ref. No.4: 5.1, 5.2, 5.8, 5.9] [Ref. No.1:31.8, 31.10, 31.11, 31.12]

5: Transient Circuits **[6 h]**

Transient currents: Growth and Decay of current in an inductive (L-R) circuit, Physical meaning of time constant Charging and Discharging of a capacitor through resistor in C-R circuit, Physical meaning of time constant Charging and Discharging of a capacitor through resistor and inductor in L-C-R circuit: Over damped, Critically damped and Under damped conditions of L-C-R circuit.

[Ref. No.4:5.3, 5.4, 5.13, 5.14]

6: Alternating Current Circuits **[9 h]**

Inductive and Capacitive reactance, Variation of inductive reactance and capacitance reactances with frequency. Introduction to vector or phasor diagrams method and its application to A.C. circuits(Series L-R, Series C-R, Series L-C-R and Parallel L-C-R) Introduction to j-operator method and its application to A.C. circuits(Series L-C-R and Parallel L-C-R). Physical significance of Series resonance, Parallel resonance, Quality factor and Bandwidth, Graphical representation of resonance. A.C. bridges: Maxwell's inductive bridge, Maxwell's L/C bridge, de Sauty's capacitance bridge, Wien's frequency bridge.

[Ref. No.2:22.3, 22.4, 22.6, 22.7, 22.8, 22.9, 22.10, 22.13, 22.14]

[Ref. No.2: 22.19, 22.20, 22.21(b), 22.22]

[Ref. No.4:6.5, 6.6, 6.7(c), 6.9, 6.14, 6.20, 6.21, 6.22, 6.24]

Experiments: (Minimum Six)

1. Susceptibility measurement of a parallel plate capacitor in a dielectric medium
2. Step Response of RC circuit
3. Study of LR circuit using spreadsheets.
4. Transient response of L-C-R circuit using square wave generator and C.R.O.
5. Response of LR circuits to A.C. - phasor diagrams
6. Response of CR circuits to A.C. - phasor diagrams
7. LCR series resonance –Resonant frequency, Q value and Bandwidth

8. LCR parallel resonance –Resonant frequency, Q value and Bandwidth
9. Determination of Mutual Inductance using LCR series resonance
10. de Sauty's bridge
11. Maxwell's L/C bridge

References:

1. Halliday David, Resnik Robert and Walker Jearl, Fundamentals of Physics, John Wiley & Sons, Inc., 6th Edition (2003)
2. Vasudeva D. N., Fundamentals of Magnetism and Electricity, S. Chand & Company Ltd., 12th Revised Edition (1999)
3. Young Hugh D., Freedman Roger A. and Ford A. Lewis, Sears and Zemansky's University Physics with Modern Physics, Addison-Wesley Publishers, 13th Edition(PDF) (2012)
4. Fewkes J. H. and Yarwood John, Electricity, Magnetism and Atomic Physics, Volume I, Oxford University Press Ltd., 10th Impression (1991)

Additional References:

1. Purcell Edward M., Electricity and Magnetism-Berkeley Physics Course,Volume 2, McGraw-Hill Book Company (PDF)

Course Title : **Electromagnetic Theory – I**

Course Code : **PHY-III.C-5**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Pre-requisite : Electricity and Magnetism (PHY-II.C-4) and Introduction to Mathematical Physics (PHY-I.C-1)

Course Objectives : To acquaint students with fundamental principles of Electrostatics part of the Electromagnetic Theory.

Course Outcomes : At the end of this course students will be able to:
CO1: Apply vector calculus to understand concepts in electrostatics.
CO2: Comprehend the interaction between charges in vacuum as well as in medium.
CO3: Calculate the electric field and electrical potential for discrete charges and continuous distribution of charge.
CO4: Apply suitable techniques to solve various electrostatic problems.
CO5: Understand how ferroelectric materials can be used as memory devices.

Theory:

1. **Vector Analysis** **[8 h]**

Vector Algebra: Vector Operations, Vector Algebra: Component form, Triple Products, Position, Displacement and Separation Vectors, Differential Calculus: Ordinary Derivatives, Gradient, The Operator $\vec{\nabla}$, The Divergence and Curl, Product Rules, Second Derivatives, Integral Calculus: Line, Surface and Volume Integrals, The fundamental Theorem for Divergences, The fundamental Theorem for Curls, Different Co-ordinate Systems: Cartesian Co-ordinate System, Cylindrical Co-ordinate System, Spherical Co-ordinate System, Some Useful Vector Identities with Proofs.

[Ref. No. 1 pp. 1 – 8, 13 – 22, 28]

[Ref. No. 2 pp. 20, 26 30-31, 36]

2. Electrostatics **[15 h]**

The Electric Field: Coulomb's Law, The Electric Field, Continuous Charge Distributions, Divergence and Curl of Electrostatic Fields: Field Lines, Flux and Gauss's Law, The Divergence of E, Applications of Gauss's Law, The Curl of E, Electric Potential: Introduction to Potential, Poisson's Equation and Laplace's Equation, Potential of a Localized Charged Distribution, Summary: Electrostatic Boundary Condition, Work and Energy in Electrostatics: Work Done to Move a Charge, The Energy of a Point Charge Distribution, The Energy of a Continuous Charge Distribution, Comments on Electrostatic Energy, Conductors: Basic Properties of Conductor, Induced Charges, Surface Charge and the Force on a Conductor, Capacitors.

[Ref. No. 1, pp. 58 – 103]

3. Techniques to Solve Electrostatic Problems **[8 h]**

Poisson's Equation, Laplace's Equation: Laplace's Equation in One Dimension, Laplace's Equation in Two Dimensions, Laplace's Equation in Rectangular Co-ordinates, Solution to Laplace's Equation in Spherical Co-ordinates (Zonal Harmonics), Conducting Sphere in Uniform Electric Field, Electrostatic Images: Point Charge and Conducting Sphere, Line Charge and Line Images.

[Ref. No. 3 pp. 51 – 67]

4. Electrostatic Field in Matter **[8 h]**

Polarization, Gauss's Law in a Dielectric, Electric Displacement Vector, Electric Susceptibility and Dielectric Constant, Boundary Conditions on the Field Vectors, Boundary Value Problems Involving Dielectric, Dielectric Sphere in a Uniform Electric Field

[Ref. No. 3 pp. 75 – 93]

5. Microscopic Theory of Dielectrics **[6 h]**

Molecular field in a dielectric: Clausius Mossotti Relation, Polar and Non-Polar Molecules, Induced Dipoles, Langevin's Debye Formula, Permanent Polarization, Ferroelectricity.

[Ref. No. 3 pp. 101 – 109]

Experiments: (Minimum Six)

1. Van-de-graff Generator. [Demonstration]
2. Measurement of dielectric constant and susceptibility of liquid using parallel metal plates.
3. Measurement of dielectric constant and susceptibility of liquid using coaxial metal tubes.
4. Measurement and Study of variation of dielectric constant of $BaTiO_3$ ferroelectric and determination of its Curie temperature.
5. E and D measurement for a parallel plate capacitor and calculation of dielectric constant.
6. Law of Capacitance using Dielectric Constant Measurement Kit.
7. Absolute capacity by ballistic galvanometer.
8. C_1/C_2 by De-Sauty's method using ballistic galvanometer.
9. Dipole Moment and Polarizability of Benzene.

References:

1. Griffiths D. J., Introduction to Electrodynamics, Prentice Hall of India, 3rd Ed. (2011)

2. Harper Charlie, Introduction to Mathematical Physics, Prentice Hall of India, 5th reprint, (1993)

3. Reitz J. R., Milford F. J., Christy R. W., Foundations of Electromagnetic Theory, Addison-Wesley Publishing Company, 3rd Ed., (1979)

Additional Reference:

1. Mukherji U., Electromagnetic Field Theory and Wave Propagation, Narosa Publishing House, (2008)

Course Title **: Optics**

Course Code **: PHY-E1**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Pre-requisite **: Nil**.

Course Objectives: The course aims to enable the students to develop understanding towards the different phenomena exhibited by light.

Course Outcomes: At the end of this course students will be able to:
CO1 : Understand the image formation for various optical systems.
CO2 : Differentiate between optical phenomena like Interference, Diffraction and Polarization.
CO3 : Correlate the theoretical basis of various concepts of Geometrical Optics and Physical Optics while performing experiments
CO4 : Develop understanding towards the different phenomena exhibited by light.

Theory:

Unit-I **[13 h]**

Geometrical Optics: (5 h)

Fundamentals of Reflection and Refraction: Refractive index and optical path, Fermat's Principle of least time, Derivation of the laws of reflection and refraction using Fermat's Principle.
Lenses: thin and thick lenses, Lens equation, Lens maker's formula, Cardinal points of an optical system, Combination of coaxially placed two thin lenses (equivalent lenses) (including derivation for focal length and cardinal points).

[Ref.1: Chapter.1: 1.6, 1.7; Ref.2: Chapter.1: 1.2, 1.3, 1.4; Ref.1: Chapter.4: 4.8, 4.9, 4.10, 4.11, 4.12, 4.15, 4.17; Chapter.5: 5.2, 5.2.1, 5.2.2, 5.2.3, 5.3, 5.10, Chapter.6: 6.1, 6.2]

Lens Aberrations: (4 h)

Introduction, Types of aberrations: monochromatic and chromatic aberration, Monochromatic aberration and its reduction: Spherical aberration, Types of chromatic aberration: Achromatism (lenses in contact and separated by finite distance).

[Ref.1: Chapter.9: 9.1, 9.2, 9.5, 9.5.1, 9.10, 9.11, 9.12, 9.13]

Optical Instruments: (4 h)

Objective and Eyepiece, Huygen's eyepiece, Ramsden's eyepiece, Telescopes, Refracting and Reflecting type of telescopes and Constant deviation Spectrometer.

[Ref.1: Chapter.10: 10.8, 10.10, 10.10.1, 10.11, 10.11.1,10.12, 10.15, 10.15.1, 10.16, 10.16.1, 10.17]

Unit-II **[10 h]**

Interference: (6 h)

Introduction: Superposition of waves, Interference, Coherence, Conditions for Interference, Techniques of obtaining Interference, Young's Double Slit Experiment, Phase Change on reflection: Stoke's law.

[Ref.1: Chapter.14: 14.3, 14.4, 14.4.2, 14.4.4, 14.6, 14.7, 14.8 and Ref.2: Chapter6: 6.3]

Interference in Thin Films: Thin Film, Plane Parallel Film, Interference due to Transmitted light, Haidinger Fringes, Wedge-shaped Film, Newton's Rings.

[Ref.1: Chapter.15: 15.1, 15.2, 15.2.1 to 15.2.5, 15.3, 15.4, 15.5, 15.5.1 to 15.5.4, 15.6, 15.6.1 to 15.6.9]

Interferometry: (4 h)

Michelson's Interferometer: Principle, Construction, Working, Circular Fringes, Localised Fringes, White Light Fringes, Application of Michelson's Interferometer: Measurement of Wavelength and Determination of the difference in the wavelength of two waves.

[Ref.1: Chapter.15: 15.7, 15.7.1 to 15.7.5, 15.8, 15.8.1, 15.8.2]

Unit-III **[12 h]**

Diffraction: (5h)

Difference between Interference and Diffraction, Types of diffraction: Fresenel Class and Fraunhoffer Class.

[Ref.1: Chapter.17: 17.6, 17.7 and Ref.2: Chapter7: 7.5, 7.6]

Diffraction of Light (Fresnel Class): Division of cylindrical wave-front into Fresnel's half period strips, Diffraction at straight edge, Diffraction at a narrow wire.

[Ref.2: Chapter.7: 7.9, 7.10, 7.11]

Diffraction of Light (Fraunhoffer Class): (7 h)

Diffraction at a single slit (Central maximum, Secondary maxima and Secondary minima), Diffraction at double slit, Distinction between single slit and double slit diffraction patterns, Missing orders in a double slit diffraction pattern, Diffraction at N slits(only conceptual), Determination of wavelength of a spectral line using Plane Transmission Grating. Resolving Power, Rayleigh's criterion, Resolving power of telescope and Resolving Power of Prism.

[Ref.1: Chapter.18: 18.2, 18.2.1, pg.431 to 433, 18.4, 18.4.1, 18.4.2, 18.4.3, 18.7, 18.7.1, 18.7.2, 18.7.6 and Chapter.19: 19.1, 19.2, 19.6, 19.7, 19.11]

Unit-IV **[10 h]**

Polarization:

Polarized Light, Natural Light, Production of Linearly Polarised Light, Anisotropic Crystal, Calcite Crystal, Huygens Theory of Double Refraction in Uniaxial crystal, Nicol prism- its fabrication, working and use, Effect of Polarizer on Natural Light, Effect of Analyser on Plane Polarized Light, Types of Polarized Light, Retardation plates - Quarter wave plate and Half wave plate, Production of Elliptically and Circularly Polarized Lights, Detection of plane, circularly, elliptically polarized lights, Analysis of polarized light, Optical activity, Specific rotation, Simple Polarimeter, Laurent's Half-Shade Polarimeter.

[Ref.1: Chapter.20: 20.3, 20.4, 20.5, 20.5.1 to 20.5.5, 20.7, 20.8, 20.8.1 to 20.8.3, 20.9, 20.9.1, 20.9.2, 20.6.1, 20.6.3, 20.15, 20.17.1, 20.17.2, 20.18, 20.18.1, 20.19, 20.19.1, 20.20, 20.24, 20.24.1, 20.25, 20.26]

Experiments: (Minimum six)

1) Cardinals points of Two lenses
2) Prism Spectrometer: Optical levelling, Angle of Prism
3) Dispersive power of prism
4) Newton's Rings
5) Wedge shaped air film
6) Single Slit Diffraction using LASER/Sodium source.
7) Diffraction Grating using LASER/Sodium source.
8) Brewster's Law using LASER source
9) Polarimeter (Demonstration)
10) Lloyd's Mirror/Biprism (Demonstration)
11) Cylindrical Obstacle (Demonstration)

References:

1. Subhramanyam N., Lal Brij, Avadhanulu M. N., A Text book of Optics, S. Chand & Company Ltd., New Delhi, Firstmulticolour Edition (2006).
2. Singh S. P. and Agarwal J. P., Optics, PragatiPrakashan, 8th Edition (2001).

Additional References:

1. Mathur B. K., Principles of Optics, New Global Printing Press, Kanpur.
2. GhatakAjoy, Optics, Tata McGraw-Hill Publicashing Company Ltd. (1977)
3. Jenkins F. A. and White H. E., Fundamentals of Optics, Tata McGraw-Hill Publishing Company Ltd., (1981)

Course Title **: Oscillations, Waves and Sound**

Course Code **: PHY-E3**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Prerequisite **: Nil**

Course Objectives **:** Simple harmonic motion is one of the fundamental types of motion that exists in nature. The objective of this course is to cover the fundamental physical concepts of Simple harmonic motion, waves and sound.

Course Outcomes **:** After successful completion of this course, students will be able to
CO1 : Set up an equation of motion for simple harmonic motion and obtain its solution.
CO2 : Explain how superposition of waves leads to different Lissajous figures.
CO3 : Set and solve the equation of motion for damped and driven damped harmonic oscillators and analyse the nature of oscillations.
CO4: Understand the dependence of velocity of sound waves on various factors like temperature, pressure, density, humidity.
CO5: Solve problems for different cases of Doppler effect.

Theory:

1. **Undamped free oscillation** **[15 h]**

   Different type of equilibria (Stable, unstable and neutral equilibrium). Periodic oscillations and potential well.
   [Mathur: 5.9]

   Differential equation for simple harmonic oscillator and its solutions. Energy of the harmonic oscillator.
   [Taylor: 5.1-5.2]

   Examples of simple harmonic oscillations: spring and mass system, simple and compound pendulum, torsional pendulum, bifilar oscillations, Helmholtz resonator.
   [Mathur: 7.7.1-7.7.5]

   Superposition of two simple harmonic motions of the same frequency along the same line. Superposition of two mutually perpendicular simple harmonic vibrations of the same

frequency. Superposition of two mutually perpendicular simple harmonic vibrations and having time periods in the ratio 1:2. Uses of Lissajous' figures.
[Subrahmanyam: 2.1, 2.2, 2.4, 2.6, 2.9]

2. **Damped Oscillations** **[8 h]**
   Introduction. Differential equation of damped harmonic oscillator and its solution, discussion of different cases (Strong, weak and Critical damping).Logarithmic decrement. Energy equation of damped oscillations. Power dissipation. Quality factor.

   [Taylor: 5.4 and Mathur: 8.2-8.4]

3. **Driven Damped Oscillations** **[6 h]**
   Introduction, Differential equation of forced oscillation and its solution (transient and steady state). Resonance. Width of the resonance; the Q factor. The phase at resonance. Velocity resonance.
   [Taylor: 5.5-5.6 and Mathur: 8.9]

4. **Waves and Sound** **[10 h]**
   Transverse vibrations in strings. Velocity of longitudinal waves in gases. Newton's formula for velocity of sound. Velocity in a homogeneous medium. Laplace's correction. Kundt's tube-determination of velocity of sound in a gas and in solids. Intensity level and Bel and Decibel.

   Production and detection of Ultrasonic waves and its applications

   [Khanna 4.2, 5.3-5.5, 11.1, 11.3, 12.1-12.4, 19.6 and Subrah.: 11.23 11.25,11.27]

5. **Doppler Effect:** **[6 h]**
   Explanation of Doppler effect in sound. Observer in rest and source in motion. Source at rest and observer in motion. When both source and observer are in motion. Effect of wind velocity. Doppler effect in light. Applications of Doppler effect.
   [Subrahmanyam: 8.1-8.6]

Experiments: (Minimum Six)

1. To determine the equivalent length of the Kater's pendulum and the acceleration due to gravity using a resonance pendulum.
2. To determine the damping constant using Damped harmonic oscillator
3. To determine the velocity of Sound using Helmholtz resonator
4. To determine the value of acceleration due to gravity using a bar pendulum.
5. To determine the frequency of AC mains using Sonometer.
6. Bifilar suspension: Dependence of the time period on the geometry of non-parallel bifilar suspension.

7. Log Decrement.
8. Velocity of Sound using CRO.
9. Lissajous Figures (Demonstration).

References:

1. Khanna, D. and Bedi, R. 1992, *A Textbook of Sound*, Atma Ram and sons, Delhi.
2. Mathur, D. 2012, *Mechanics*, S. Chand, New Delhi.
3. Taylor, J. 2005, *Classical Mechanics,* University Science Books, USA
4. Subrahmanyam, N. and Lal, B. 1994, Waves and Oscillation, Vikas Publishing House, Noida

Additional References:

1. French, AP 2003, Vibration and Waves, CBS Publisher, India.
2. Halliday, D., Resnick, R. and Walker, J. 2003, Fundamentals of Physics, 6th edition, John Wiley and Sons, USA.
3. Pain, J. 2005, *The Physics of Vibration and Waves,* 6th Edition, Wiley.

Title : **Instrumentation**

Course Code : **PHY-E8**

Marks : **75 (Theory) + 25 (Practical)**

Credit : **3 (Theory) + 1(Practical)**

Pre-requisite : **Nil**

Course Objectives : The objective of this course is to understand basic concepts related to the various types of measuring instruments and measuring techniques.

Course Outcomes : At the end of the course students will be able to:
CO1 : Understand basic concepts related to the various types of measuring instruments and measuring techniques.
CO2 : Comprehend basic principles involved in measuring instruments like Ammeter, Voltmeter, Ohmmeter and Multimeters.
CO3 : Understand working and use of CROs and Signal Generators
CO4 : Understand working and usage of the various types of transducers.

Theory:

1. **Fundamentals of Measurement:** **[6 h]**
   Introduction, Performance Characteristics, Static Characteristics, Errors in Measurements, Types of Static Error, Sources of Error, Dynamic Characteristics, Standard, Electrical Standards.
   [Ref.1: Chapter 1.2 to 1.7, 1.9, 1.10]

2. **Indicators and Display Devices:** **[5 h]**
   Types of Instrument, Basic Meter Movement: PMMC Movement and Practical PMMC Movement, Classification of Displays, Use of LED and LCD as Display Devices, Segmental Displays using LEDs.
   [Ref.1: Chapter 2.1, 2.2, 2.8, 2.10, 2.11, 2.12.3]

3. **Measuring Instruments:** **[12 h]**
   DC Ammeter, Multirange Ammeter, Universal Shunt, Requirements of a Shunt, Extending of Ammeter Ranges. Basic Meter as a DC Voltmeter, DC Voltmeter, Multirange Voltmeter, Extending Voltmeter Ranges, Loading, Transistor Voltmeter(TVM), FET DC Voltmeter. AC Voltmeter using Rectifiers, Multirange AC Voltmeter, AC current measurements using AC Voltmeter and a series Resistor. Ohmmeter: Series type and Shunt type, Multimeter.

Digital voltmeter: Ramp Technique, Digital Multimeters and Frequency meter (with help of Block Diagrams), Q meter.
[Ref.1: Chapter 3.1 to 3.5, 4.2 to 4.7,4.12to 4.15, 4.21, 4.22, 4.25, 5.2, 6.2,6.3,10.7 and Ref.2: Chapter 22: 22-9]

4. Oscilloscope: [6 h]
Basic Principle, Block Diagram of Oscilloscope, Simple CRO, Vertical Amplifier, Horizontal Deflecting System, sweep generator, Delay line.
[Ref.1: Chapter 7.2.1, 7.4, 7.5, 7.5.1, 7.6, 7.7.1, 7.10]

5. Signal Generator: [4 h]
Standard Signal Generator, AF Sine and Square Wave Generator, Function Generator.
[Ref.1: Chapter 8.4, 8.5, 8.7, 8.8]

6. Transducers: [12 h]
Introduction, Electrical Transducer, Selecting a Transducer, Strain Gauges, Resistance Wire Gauge, Types of Strain Gauges(Wire), Foil Strain Gauge, Semiconductor Strain Gauge, Inductive Transducer, Differential Output Transducers, Linear Variable Differential Transducers (LVDT), Capacitive Transducer, Piezo-Electric Transducer, Semiconductor Diode Temperature Sensor, Temperature Transducers: Resistance Temperature Detectors, Thermistors, Thermocouples.
[Ref.3: Chapter 36.1 to 36.3, 36.12 to36.15] [Ref.1: Chapter 13.1 to 13.3, 13.6, 13.6.1 to 13.6.4, 13.9,13.9.1, 13.9.2, 13.10, 13.11,13.13, 13.15, 13.20.7]

Experiments: **(Minimum six)**

1. Use of CRO and Function Generator (AC/DC voltage measurement, frequency measurement).
2. To measure displacement (linear and angular) using potentiometer/variable inductor/variable capacitor.
3. Construction and design of analog two ranges Voltmeter.
4. Construction and design of analog two ranges Ohmmeter.
5. Crystal Oscillator: Determination of velocity of ultrasonic waves in a liquid medium.
6. Study of strain Gauges
7. Study of LVDT (including calibration) and its use in any one application.
8. Calibration of Thermocouple
9. Thermistor as a temperature sensor.

References:
1. Kalsi H S, Electronics Instrumentation, Tata McGraw Hill Education Pvt. Ltd. New Delhi, 3rd Edition (2010).
2. Mottershead Allen, Electronics Devices and Circuits An Introduction, Prentice-Hall of India Pvt. Ltd., New Delhi, 23rd Printing, (2000).
3. Theraja B. L., Basic Electronics (Solid State), S. Chand and Company Ltd., New Delhi, 1st Multicolour Edition (2005).

Additional References:

1. Boylestad Robert and Nashelsky Louis, Electronic Devices and Circuit Theory, Prentice-Hall of India Pvt. Ltd., New Delhi, 6th Edition (2000).

Course Title : **Quantum Mechanics**

Course Code : **PHY-IV.C-6**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1(Practical)**

Pre-requisite : **Nil**

Course Objectives **:** The objective of this course is to provide an introduction to quantum mechanics and its application.

Course Outcomes **:** At the end of this course students will be able to:
CO1 : understand central concepts and principles in quantum mechanics, such as the Schrödinger equation, the wave function and its statistical interpretation, the uncertainty principle, stationary and non-stationary states, time evolution of solutions.
CO2 : solve the Schrödinger equation to obtain wave functions for some important types of potential in one and three dimension and give concise physical interpretations and reasoning underlying the mathematical results.
CO3 : grasp the concepts of angular momentum and spin.
CO4 : have an insight into fundamental issues in quantum mechanics like the EPR paradox, Bells theorem and Schrödinger's cat
CO5: develop an understanding of why both analytic and numerical solutions are important in quantum mechanics and have acquired experience in using both types of methods on quantum mechanical problems
CO6: use numerical tools and software to solve the Schrodinger equation for more complicated cases.

Theory:

1. **Schrödinger's Theory of Quantum Mechanics:** **[12 h]**
   Plausibility argument leading to Schrödinger equation, Born interpretation of wave functions, Operators in quantum mechanics: position, momentum, kinetic energy and Hamiltonian, Expectation values, The time independent Schrödinger equation, Required properties of Eigen functions, Energy quantization in the Schrödinger theory. Postulates of quantum mechanics.

   [Eisberg: 5.1- 5.8][Singh: 4.6]

2. **Applications of Schrödinger's Steady state equation:** **[18 h]**
   Free particle.

One dimensional infinite rectangular potential well (Particle in a one dimensional box). Stationary states, Concept of parity, parity operator and its eigen values.

Particle in a three dimensional rigid box. Degree of degeneracy.
One dimensional step potential of finite height (Energy less than step height and energy greater than step height)

One dimensional potential barrier. Qualitative discussion of alpha decay,

One dimensional finite rectangular potential well (placed symmetric to origin). Parity and parity operators.

One dimensional harmonic oscillator (Algebraic method using raising and lowering operators and analytical method.)
[Eisberg: 6.2 – 6.6], [Griffiths: 2.1-2.3, 2.6]

3. **Angular momentum and Spin** **[12 h]**
   Angular momentum operators, Angular momentum Eigenvalues and Eigenfunctions. Spin 1/2, Spinors, Pauli spin matrices, Eigenvalues and Eigenspinors of Spin. Electron in a Magnetic field.
   [Griffiths: 4.3, 4.4.1, 4.4.2]

4. **Fundamental issues in quantum mechanics** **[3 h]**
   EPR paradox, Bell's Theorem and Schrödinger's cat.
   [Griffiths: 12.1, 12.2, 12.4]

Experiments:

1. Introduction to Numerov method.
2. Numerically solving the Time Independent Schrödinger equation for the case of Infinite potential well. / Tutorial.
3. Numerically solving the Time Independent Schrödinger equation for the case of finite potential well. / Tutorial.
4. Numerically solving the Time Independent Schrödinger equation for the case of Infinite potential well with a cosine bump. / Tutorial.
5. Numerically solving the Time Independent Schrödinger equation for the case of Step potential. / Tutorial
6. Numerically solving the Time Independent Schrödinger equation for the case of Sloping potential well. / Tutorial.
7. Numerically solving the Time Independent Schrödinger equation for the case of Potential barrier. / Tutorial.
8. Tunnel Diode.

References:

1. Eisberg, R. And Resnick, R. 2010, *Quantum Physics of Atoms, Molecules, Solids, Nuclei and particles,* 2^{nd} Edition, Wiley India Pvt Ltd.
2. Griffiths, D. 2015, *Introduction to Quantum Mechanics*, Pearson Education, India.
3. Singh, K. And Singh, S. 2013, *Elements of Quantum Mechanics,* S. Chand, New Delhi.

Additional References:

1. Beiser, A. 1969, *Perspectives of Modern Physics,* McGraw-Hill Book Company, Singapore.
2. Flugge, S. 2008, *Practical Quantum Mechanics*, Springer (SIE).
3. Rajasekar, S. and Veluswamy, R. 2014, *Quantum Mechanics I: The Fundamentals,* CRC Press, New York.
4. Richtmyer, F., Kennard, E., Cooper, J. 2001, *Introduction to Modern Physics*, 6^{th} ed. Tata McGraw-Hill Book Company, New Delhi.
5. Verma, H. 2012, *Quantum Physics*, TBS, Calicut.
6. Wichmann, E. 2010, *Quantum Physics: Berkeley Physics Course Vol 4*, Tata McGraw-Hill Book Company, New Delhi.

Course Title **: Properties of Matter and Acoustics**

Course Code **: PHY-E4**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Pre-requisite **: Oscillations, Waves and Sound**

Course Objectives **:** This course provides an introduction to dynamics of rigid bodies and calculation of moment of inertia, properties of matter and acoustics of rooms. An objective of this course is to build up an understanding of fundamental physical principles which are required for most of other physical sciences.

Course Outcomes **:** At the end of this course students will be able to:

CO1 : Gain an introductory knowledge of dynamics of rigid bodies, and its applications to basic physical problems.
CO2 : Familiarize with of acoustics of rooms and musical scales.
CO3 : Comprehend the phenomenon of elasticity, surface tension, viscosity and their application.

Dynamics of Rigid bodies: **[11 h]**

Rigid bodies, Rotational Kinetic energy, Moment of inertia and its physical significance, Angular acceleration, angular moment, law of conservation of momentum, Analogy between translatory and rotatory motion, Theorem of perpendicular axis, Theorem of parallel axis, Moment of inertia of thin uniform bar, Moment of Inertia of a bar about an axis passing through one end and perpendicular to its length, Moment of Inertia of a bar about an axis perpendicular to its at a distance ‘a’ from one end, Moment of inertia of rectangular lamina, Moment of inertia of solid uniform bar of rectangular cross section, Moment of inertia of ring, Moment of inertia of disc, ,Moment of inertia of Annular disc, Moment of inertia of hollow cylinder, Moment of inertia of solid sphere, ,Moment of inertia of hollow sphere, Moment of inertia of spherical shell, ,Moment of inertia of a uniform elliptical lamina, Moment of inertia of a uniform triangular lamina, Moment of inertia of a solid cone.

[Reference#1 : Section 3.1-3.25]

Properties of Matter Elasticity: **[12 h]**

Modulii of elasticity, Poisson's ratio and relationship between them. Bending of beams-bending moment, flexural rigidity. Cantilever (rectangular bar). Depression of a beam supported at the ends and loaded at the center. A vibrating cantilever. Torsion in a string-couple per unit twist, Torsional Pendulum.

[Reference # 2, Section 8.8, 8.9, 8.12, 8.13, 8.14, 8.15, 8.16, 8.17, 8.18, 8.22, 8.26, 8.29, 8.30(a(i)), 8.32, 8.33(i)]

Surface Tension: [6 h]

Brief review of molecular theory of surface tension. Relation between surface tension and surface energy. Excess pressure inside a spherical Liquid drop, difference of pressure across a curved surface, Angle of contact. Capillarity-rise of liquid in a capillary tube.

[Reference # 2, Section 14.1, 14.2, 14.3, 14.4 14.6, 14.8, 14.14, 14.15 and 14.17]

[Reference #1 section 8.7 -8.9]

Viscosity [9 h]

Equation of continuity: Euler's equation for liquid flow, Bernoulli's theorem and its applications.

Streamline flow, Turbulent flow, Critical velocity, Coefficient of viscosity, Poiseuille's formula for flow of liquid through a capillary tube. Criticism of Poiseuille's equation

[Reference # 2, Section 12.1 - 12.12 (12.8 upto equation b)]

Acoustics of Rooms and Musical Scales [7 h]

Reverberation of Sound, Reverberation time, Absorption coefficient, Sabine's formula for reverberation time (discussions only) , Acoustic requirements of an auditorium. Musical interval, harmony, melody. Diatonic scale. Tempered scale. (only concepts)

[Reference # 3,Section: 23.1-23.17, Section:17.1-17.12]

Experiments: (Minimum Six)

1) Cantilever : Determination of Young's modulus by vertical vibrations of a cantilever.
2) Torsional Pendulum : Determination of Rigidity Modulus of the material of a wire.
3) Jagger's Method : Determination of Surface Tension
4) Viscosity of a liquid by Poiseuilles method
5) Bending of beams: determination of Young's modulus
6) Capillarity: determination of Surface tension
7) Flat Spiral Spring: determination of elastic constants by vertical and torsional oscillations of a loaded spring
8) Young's Modulus of Brass by Flexural Vibrations of Bar.
9) Rigidity Modulus of Brass.

References:

1) Properties of matter by Brij Lal N. Subrahmanyam, Eurasia Publishing House New Delhi (1999)
2) Elements of Properties of Matter, by D. S. Mathur, S. Chand and Company, New Delhi.
3) Text book of Sound. D. R. Khanna and R.S. Bedi, Atma Ram, New Delhi (1994).

Additional References:

1) Sound. F. G. Mee, Heinemann Ltd., London (1967)
2) Newman and Searle, General properties of Matter
3) C. J. Smith, Properties of Matter

Course Title : **Computational Physics**

Course Code : **PHY-E7**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Pre-requisite : **Nil**

Course Objectives **:** The course aims to enable the students to solve problems in Physics which involves numerical methods by using FORTRAN as a programming language.

Course Outcomes **:** At the end of this course students will be able to:
CO1 : Understand various numerical methods
CO2 : Use FORTRAN language for numerical calculations.
CO3 : Understand various concepts of Physics using numerical methods using FORTRAN as a programming language.
CO4 : Solve problems in Physics by numerical methods using FORTRAN as a programming language.

Theory:

1. Concepts of programming: **[5 h]**

Definition and Properties of algorithms, Algorithm development, Flow charts- symbols and simple flowcharts.

2. FORTRAN Programming **[20 h]**

Evolution of Fortran.

Simple Fortran Programs:

Writing a Program, Input statements, Some Fortran program examples.

Numerical Constants and Variables:

Constants, Scalar Variables, Declaring Variable Names, Implicit Declaration, Named Constants.

Arithmetic Expressions:

Arithmetic Operators and Modes of Expression, Integer Expressions, Real Expressions, Precedence of Operations in Expressions, Assignment Statements, Defining Variables, Some problems due to rounding of real numbers, mixed mode expressions, Intrinsic functions, Examples of Use of Functions.

Input-Output Statements:

List-directed input statements, List-directed output statements.

Conditional Statements:

Relational Operators, The block IF construct, Example programs Using IF structure.

Implementing Loops in Program:

The block DO loop, count control DO loop, Rules to be followed in writing DO loops.

Logical expressions and More Control statements:

Introduction, Logical constants, variables and expressions, precedence rules for logical operators, Some examples of use of Logical expressions, The case statements.

Functions and subroutines:

Introduction, function subprogram, syntax rules for function subprograms, Generic functions, Subroutines, Internal Procedures.

Defining and Manipulating Arrays:

Arrays Variables, Use of multiple subscripts, Do type notation for Input/Output Statements, Initializing arrays, Terminology used for multidimensional arrays, use of arrays in DO loops, whole array operations.

[Ref.1: Chapter-1 to Chapter-10]

3. Computational Physics: **[20 h]**

Errors in Computation:

Inherent errors in storing, Numbers due to finite bit representation to use in Computer, Truncation error, round off errors (Explain with the help of examples)

Iterative methods:

Discussion of algorithm and flowcharts and writing FORTRAN programs for finding single root of equation using bi-section method, Newton-Raphson method.

Least Square Curve fitting:

Discussion of algorithm and flowcharts and writing FORTRAN program for straight line fit with example in physics.

Numerical Integration:

Discussion of algorithm and flowcharts and writing FORTRAN program for trapezoidal rule and Simpson's 1/3rd rule.

Solution of Differential equations:

Discussion of algorithm and flowcharts and writing FORTRAN program for Euler's method for finding solution of differential equation.

(*Derivation of formula is not expected for all the above numerical methods*)

[Ref.2: Chapters - 2, 3, 6, 8 and 9]

Experiments:

Following programs may be discussed thoroughly in theory lectures and implemented in the practicals.

1. Sum of digits of an integer
2. To find factorial of a number
3. Checking and printing of prime numbers
4. Generation of Fibonacci numbers
5. To find sin(X), cos(X) using series method
6. Sorting of Numerical data - ascending, descending.
7. Matrix operations – addition, subtraction, multiplication
8. Graphics- line, circle, arc, bar, ellipse.
9. Root of equation-Bisection method, Newton Raphson method
10. Numerical integration- Trapezoidal, Simpson's 1/3rd rule.
11. Least square curve fitting- data for ohm's law.
12. Freely falling body and motion of falling body including air drag. (using Euler's method)
13. Electric field due to a point charge
14. Charging and Discharging of Capacitor in RC circuit/Growth and Decay of current in RL Circuit.

References:

1. Rajaraman V., Computer Programming in Fortran 90 and 95, Prentice-Hall of India, New Delhi, 2nd Edition (1987).
2. Rajaraman V., Computer Oriented Numerical Methods, Prentice-Hall of India, New Delhi, 2nd Printing (1999).

Additional Reference:

Verma P. K. and Ahluwalia and Sharma K. C., Computational Physics, New Age International Publishers, India, (1999).

Course Title : Introduction to Error Analysis

Course Code : PHY-E18

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Course Objectives: The objective of this course is that the students will be able to comprehend some of the important methods used in estimate uncertainties and should be able to use these methods in estimating uncertainty in laboratory experiments.

Course Outcomes: After successful completion of this course, the students will be able to understand:
CO1: the techniques involved in analyzing measurement data and the errors associated with the measurement system used.
CO2: the importance of knowing the uncertainty and nature of uncertainty that occurs during measurements
CO3: the method of propagation of errors and applying it to estimate uncertainties.
CO4: the method of statistical analysis in applying it to estimate uncertainties.
CO5: several probability distribution functions like Gaussian distribution, Binomial distribution, and Poisson distribution.
CO6: plotting of graphs and estimate the best fit lines through the data points.

Theory:

1. **Preliminary description** **[6 h]**
   Errors as uncertainty and its inevitability. Importance of knowing the uncertainties. Estimating uncertainties. Significant figures. Discrepancy. Comparison of measures and accepted values. Comparison of two measured numbers. Checking relationship with graphs. Fractional uncertainties. Multiplying two measured numbers.
   [Taylor: 1.1-1.6, 2.1-2.9]

2. **Propagation of uncertainties** **[6 h]**
   Uncertainties in direct measurements. The square root rule for a counting experiment. Sums and differences; product and quotient. Arbitrary functions of one variable. General formula for error propagation.
   [Taylor: 2.1-2.9]

3. **Statistical analysis of random uncertainties** **[6 h]**
Random and systematic errors. The mean and standard deviation. The standard deviation as the uncertainty in the single measurement. The standard deviation of the mean. Systematic errors.
[Taylor: 4.1- 4.6]
4. **The Normal Distribution** **[9 h]**
Histograms and Distributions, Limiting distributions. The normal distribution. The standard deviation as 68% confidence limit. Justification of the mean as the best estimate. Justification of addition in quadrature. Standard deviation of the mean. Acceptability of the measured answer.
[Taylor: 5.1-5.8]

5. **Least-Squares fitting** **[6 h]**
Data that should fit a straight line. Calculation of slope and intercept. Uncertainty in the slope and intercept. Least-squares fit to other curves.
[Taylor: 8.1-8.6]

6. **The Binomial Distribution** **[7 h]**
Distributions. Probability in dice throwing. Definition of binomial distribution. Properties of binomial distribution. The Gauss distribution for random errors. Application: testing of hypothesis
[Taylor: 10.1-10.6]

7. **The Poisson Distribution** **[5 h]**
Definition of Poisson distribution. Properties of Poisson distribution. Applications. Subtracting a background.
[Taylor: 11.1-11.4]

Experiments: (Minimum Six)

1. Tutorial on Propagation of uncertainties
2. Tutorial on Statistical Analysis of Random measurement
3. Tutorial on Normal Distribution
4. Tutorial on Binomial distribution
5. Tutorial on Poisson Distribution
6. Application of Error Analysis based on experimental data.
7. Application of Error analysis based on experimental data.
8. Application of Error analysis based on experimental data.

References:

1. Taylor J, *An Introduction to Error analysis* (University Science Books, 1997)

Additional References:

1. Drosg M., *Dealing with Uncertainties: A guide to error analysis* (Springer, 2007)

Course Title : **Electromagnetic Theory – II**

Course Code : **PHY-V.C-7**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Pre-requisite : **Electromagnetic Theory – I (PHY-III.C-5)**

Course Objectives : To acquaint students with fundamental principles of Magnetostatics part of the Electromagnetic Theory.

Course Outcomes : At the end of this course, students would be able:

CO1 : Calculate magnetic field induction using Biot-Savart's law and Ampere's law.

CO2 : Interpret bound currents and calculate magnetic fields in matter.

CO3 : Comprehend microscopic theory magnetism.

CO4 : Establish the link between electrostatics and magnetostatics using Maxwell's equations.

CO5: Develop the wave equation for propagation of electromagnetic waves through material media and vacuum at different angles of incidence.

Theory:

1. Magnetostatics **[12 h]**

Lorentz force law: Magnetic fields, Magnetic forces, Currents, Biot-Savart law: Steady currents, Magnetic fields of a steady current, Divergence and Curl of **B**: Straight-line currents, divergence and curl of **B**, applications of Ampere's law, comparison of magnetostatics and electrostatics, Magnetic vector Potential: Vector potential, magnetostatic boundary conditions, multipole expansion of the vector potential.

[Griffiths: 5.1: 5.1.1 – 5.1.3, 5.2: 5.2.1 – 5.2.2, 5.3: 5.3.1 – 5.3.4, 5.4: 5.4.1 – 5.4.3]

2. Magnetic Fields in Matter **[14 h]**

Magnetization: Diamagnets, paramagnets and ferromagnets, torques and forces on magnetic dipoles, effect of a magnetic field on atomic orbits, magnetization, the field of a magnetized object: Bound currents, physical interpretation of bound currents, magnetic field inside matter, The auxiliary field H: Ampere's law in magnetized materials, a deceptive parallel, boundary conditions, Linear and nonlinear media: Magnetic susceptibility and permeability, Energy in magnetic fields.

[Griffiths: 6.1: 6.1.1 – 6.1.4, 6.2: 6.2.1 – 6.2.3, 6.3: 6.3.1 – 6.3.3, 6.4: 6.4.1 – 6.4.2, 7.2.4]

3. Microscopic Theory of Magnetism **[5 h]**

Molecular field inside matter, origin of diamagnetism, origin of paramagnetism, theory of ferromagnetism, ferromagnetic domains, ferrites

[Reitz: 10.1 – 10.2]

4. Maxwell's Equations **[4 h]**

Generalization of Ampere's law, displacement current, Maxwell's equations and their empirical basis, electromagnetic energy, Poynting theorem.

[Reitz: 16.1 – 16.3]

5. Propagation of Electromagnetic Waves **[10 h]**

The wave equation, plane monochromatic waves in non-conducting media, polarization, plane monochromatic waves in conducting media, reflection and refraction at the boundary of two non-conducting media: normal incidence and oblique incidence, Brewster's angle, critical angle.

[Reitz: 16.4, 17.1, 17.2, 17.4, 18.1, 18.2]

Experiments: (Minimum Six)

1. Hysteresis by magnetometer.
2. B-H curve in a hard magnetic material and in a soft ferrite.
3. Core losses and copper losses in a transformer.
4. Measurement of mutual inductance using ballistic galvanometer.
5. Calibration of lock-in-amplifier and determination of mutual inductance.
6. Determination of magnetic susceptibility of $FeCl_3$ by Quincke's method.
7. M/C using ballistic galvanometer
8. Helmholtz coils.

References:

1. Griffiths D. J., 2011, *Introduction to Electrodynamics,*3rd Ed. , Prentice Hall of India.

2. Reitz J. R., Milford F. J., Christy R. W., 1979, *Foundations of Electromagnetic Theory*,3rd Ed., Addison-Wesley Publishing Company.

Additional Reference:

Mukherji U., 2008, *Electromagnetic Field Theory and Wave Propagation*, Narosa Publishing House.

Course Title : **Solid State Physics**

Course Code : **PHY-E9**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Pre-requisites : **Quantum Mechanics (PHY-IV.C-6)**

Course Objective : To give the students a firm understanding of the basics of Solid State Physics. The course broadly deals with the topics related to structural aspects and the various physical properties of crystalline solids.

Course Outcomes : At the end of this course, students would be able:

CO1 : Understand firmly the basics of Solid State Physics.

CO2 : Understand the link between the structural aspects and the various physical properties of crystalline solids.

CO3 : Gain a comprehensive broad knowledge in topic such as: Bonding in Solids, Crystal Physics, Electrical properties of solids, Origin of energy band structure in solids and Magnetic properties of materials.

Theory:

1. Bonding in Solids: **[5h]**

Introduction, Bonding in Solids, Cohesive energy, Ionic bonding, Calculation of Cohesive energy of ionic solids, Covalent bonding, Metallic bonding, Hydrogen bonding, Van der Waals (Molecular) bonding.

[Palanisamy: 1.1, 1.2, 1.3, 1.4, 1.4.1, 1.5 - 1.5.2, 1.6 - 1.9]

2. Crystal Structure: **[12h]**

Introduction, Space Lattice, Unit cell, Lattice Parameter of unit cell, Bravais lattices, Crystal Symmetry, Stacking sequences in metallic crystal structure, SC, BCC, FCC and HCP structures, Crystal structures- NaCl, diamond, CsCl, ZnS, Directions in crystals, Planes in crystals- Miller indices, Distances of Separation between Successive (*hkl*) Planes.

[Palanisamy: 2.1, 2.2 - 2.2.3, 2.3 - 2.3.4, 3.1, 3.2, 3.3 -3.3.2, 3.4]

3. Diffraction of X-rays by Crystals: **[5h]**

Introduction, Bragg's law, Production of X-rays, Determination of lattice parameters and X-ray Diffraction methods: Laue method and Debye Scherrer method.

[Palanisamy: 4.9 - 4.9.3, 4.10 - 4.10.2]

4. Electron Theory of Metals: [18h]

Introduction, Classical free electron theory, Quantum theory of free electrons, Fermi distribution function, Density of energy states, Sources of electrical resistance, Electrons in a periodic potentials, Energy bands in Solids.

[Palanisamy: 6.1, 6.2 - 6.2.2, 6.3, 6.3.1, 6.4, 6.5, 6.6, 6.7-6.7.5, 6.8]

5. Magnetic Properties: [5h]

Introduction, Classification of magnetic materials, The quantum numbers, Origin of magnetic moment, Ferromagnetism, Ferromagnetic domains, Hysteresis, Hard and soft materials.

[Palanisamy: 8.1, 8.2, 8.3, 8.4, 8.7, 8.7.3, 8.7.5, 8.7.6]

Experiments: (Minimum Six)

1. Energy band gap of a semiconductor using a diode.
2. Energy band gap of a semiconductor using LEDs
3. Energy band gap of a thermistor.
4. To determine value of Planck's constant using LEDs of at least 4 different colours.
5. Fermi energy of Copper
6. Measurement of Hysteresis loss using CRO
7. Calculation of lattice constant by of Copper – X-ray diffraction pattern is given and student calculates: d-spacing, miller indices and lattice constant
8. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four-probe method (room temperature to 150 ^{o}C) and to determine its band gap
9. Investigating crystal structure using Vesta software.

References:

1. Palanisamy P. K., 2004, *Solid State Physics,* Scitech Publications (India) Pvt. Ltd.
2. Pillai S. O., 1999, *Solid State Physics,* 3rd Edition, New Age International (P) Ltd, Publisher.
3. Kittel C., 2004, *Introduction to Solid State Physics*, 8th Edition, John Wiley and Sons.
4. Dekker A. J., 1998, *Solid State Physics*, Macmillan India Ltd. Publisher.

Course Title : **Thermodynamics and Statistical Mechanics**

Course Code : **PHY-E10**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Pre-requisite : **Heat and Thermodynamics (PHY-II.C-3)**

Course Objectives : This course will introduce kinetic theory, classical thermodynamics, probability and statistical methods.

Learning Outcome : After completion of this course, students will be able to:
CO1 : Understand basics of kinetic theory of gases and thermodynamic potentials.
CO2 : Understand Maxwell-Boltzmann, Fermi-Dirac, and Bose-Einstein statistics and its application to the classical gas, electrons in a metal and blackbody radiation
CO3 : Understand the specific heat of solids by invoking statistical mechanics.

Theory

1. **Kinetic theory of Gases:** **[9 h]**
   Basic assumptions, Equation of State of an Ideal Gas, Collisions with a moving wall, the principle of equi-partition of energy, classical theory of specific heat capacity, specific heat capacity of a solid.
   [Sears and Salinger: 9.1, 9.2, 9.4 – 9.8]

2. **Thermodynamic Potentials** **[6 h]**
   The Helmholtz function and Gibbs function, Thermodynamic Potentials, Maxwell Relations.
   [Sears and Salinger: 7.1-7.3]

3. **Statistical Thermodynamics** **[10 h]**
   Phase space, Probability of distribution, The most probable distribution, Maxwell Boltzmann Statistics. Molecular speeds: mean, most probable and r. m. s. speeds. Experimental verification of Maxwell Boltzmann statistics.
   [Beiser: 15.1 – 15.5]

4. **Quantum Statistics** **[10 h]**
   Bose Einstein statistics, Blackbody Radiation, Rayleigh Jeans formula, Plank radiation formula, Fermi Dirac statistics, Fermi energy, Electron energy distribution.
   [Beiser: 16.1 – 16.6, 19.6, 19.7]

5. **Specific Heats of Solids** **[10 h]**
   Thermal Vibrations: Frequencies. Thermal Vibrations: Amplitudes. Specific Heats of Solids. The Einstein's theory. The Debye Theory. Fermi energy, Electron energy distribution.
   [Beiser: 19.1 – 19.7]

Experiments: (Minimum Six)

1. Specific heat of Graphite
2. Study the temperature dependence of resistivity.
3. OPAMP as a bridge amplifier and its application in temperature measurement.
4. Determination of Boltzmann constant.
5. Study of Stefan's Law.
6. Determination of Stefan's constant
7. Tutorial on Maxwell Equation and Free energy
8. Tutorial on Statistical Thermodynamics
9. Tutorial on Statistical Thermodynamics

References:

1. Brijlal, Subrahmanyam N., 2008, *Heat thermodynamics and Statistical Physics*, S Chand Company Ltd.
2. Laud B., 2003, *Introduction to Statistical Mechanics*, New Age International.
3. Saha M. and Shrivastava B., 1965, *Treatise on heat*, The Indian Press.
4. Beiser A., 1995, *Perspectives of modern physics*, 5th edition, McGraw hill.
5. Sears F. and Salinger G., 1998, *Thermodynamics, Kinetic Theory and Statistical Thermodynamics*, 3rd Edition, Narosa.

Additional References:

1. Garg S., Bansal R.and Ghosh C., 1993, *Thermal Physics*, Tata McGraw Hill.
2. Zemansky M. and Ditman R., 1997, Heat *and Thermodynamics*, McGraw Hill.
3. Reif F., 1965, *Fundamentals of Statistical and Thermal Physics*, Mc Graw Hill

Course Title : **Atomic and Molecular Physics**

Course Code : **PHY-VI.C-8**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Pre-requisite : **Quantum Mechanics (PHY-IV.C-6)**

Course Objectives : Atomic and molecular physics is the study of dynamics and interactions of the basic building blocks of matter. The objective of this course is to study the behaviour of the electrons that surround the atomic nucleus which will help students to understand the dynamics atoms and molecules.

Course Outcomes : After successful completion of this course, student will be able to:
CO1 : solve the case of the hydrogen atom using the three dimension time-independent Schroedinger equation, identify atomic effect such as space quantization and interpret the wave functions and probability densities.
CO2 : become familiar with the orbital, spin and total angular momentum of many electron atoms.
CO3 : explain the observed dependence of atomic spectral lines on externally applied magnetic fields.
CO4: grasp the physics of diatomic molecules, their electronic states, vibrations and rotations and their spectra.
CO5: comprehend classical and quantum theory of Raman effect.
CO6: develop analytical and computing skills through problem solving, and computer based exercises, which involve quantum mechanical
Theory:

1. **Quantum Theory of the Hydrogen Atom**: **[6 h]**
   Schrodinger's equation for the H-atom. Separation of variables, Eigen values, Quantum numbers and Magnetic moment. Angular momentum, Electron Probability density.
   [Beiser 9.1-9.9]

2. **Many Electron Atoms:** **[7 h]**
   Electron Spin.. Pauli Exclusion Principle and classification of elements in periodic table. Symmetric and Antisymmetric wave functions. Electron configuration. Hund's rule. Total angular momentum. L-S coupling. J-J coupling.
   [Beiser 10.1, 10.3- 10.9]

3. **Atoms in a Magnetic Field:** **[7 h]**
   Effects of magnetic field on an atom. Larmor Precession. The Stern-Gerlach experiment.

Spin Orbit Coupling. The Normal Zeeman effect, Lande 'g' factor. Zeeman pattern in a weak field (Anomalous Zeeman effect).
[Eisberg 8.1-8.4, 10.6]

4. **Atomic Spectra: [4 h]**
Origin of Spectral lines. Selection rules (derivation from transition probabilities). Alkali metal type spectra. Principal, Sharp, Diffused and Fundamental series, fine structure in alkali spectra.
[Beiser 11.1-11.2, Mcgervey 9.1]

5. **X-ray Spectra: [4 h]**
Characteristic spectrum. Moseley's law. Explanation of X-ray spectra on the basis of quantum mechanics. Energy levels and characteristic X-ray lines. X-ray absorption spectra. Fluorescence and Auger effect.
[Richtmayer: 7.6, 7.7, 16.1-16.3, 16.5]

6. **Spectra of Diatomic Molecules: [10 h]**
Rotational energy levels. Rotational spectra. Vibrational energy levels. Vibration -Rotation spectra. Fortrat Parabolas and explanation of band structure on its basis. Electronic spectra.
[Beiser 14.1, 14.3, 14.5, 14.7, 14.8 and Rajam 11.2]

7. **Raman Effect: [7 h]**
Quantum theory of Raman effect. Classical theory of Raman effect. Pure rotational Raman spectra. Vibrational Raman spectra. Rotational fine structure. Experimental set up for Raman effect.
[Banwell 4.1-4.3]

Experiments: (Minimum Six)

1. To find the wavelengths of Balmer series of visible emission lines and to determine the value of Rydberg constant.
2. Numerically solving the Time Independent Schrödinger equation for the case of Harmonic oscillator./Tutorial.
3. Numerically solving the Radial Schrödinger equation for the case of Hydrogen atom./Tutorial.
4. Numerically solving the Time Independent Schrödinger equation for the case of Morse potential./ Tutorial.
5. Absorption spectra of $KMnO_4$
6. X-ray Emission (characteristic lines of copper target)- Calculation of wavelength and Energy.
7. Resolving Sodium D-lines using grating.
8. Resolving Mercury lines using prism.
9. Determination of wavelength of Sodium light using Lloyd's Mirror.
10. Determination of wavelength of Sodium light using a cylindrical obstacle.

11. Double Refraction

References:

1. Beiser, A. 1969, *Perspectives of Modern Physics,* McGraw-Hill Book Company, Singapore.
2. Eisberg, R. And Resnick, R. 2010, *Quantum Physics of Atoms, Molecules, Solids, Nuclei and particles*, 2nd Edition, Wiley India Pvt Ltd.
3. Mcgervey, J. 1983, *Introduction to Modern Physics*, Academic Press, USA.
4. Richtmyer, F., Kennard, E., Cooper, J. 2001, *Introduction to Modern Physics*, 6th ed. Tata McGraw-Hill Book Company, New Delhi.
5. Rajam, J. 2000, *Atomic Physics*, S. Chand and Company limited, New Delhi.
6. Banwell, C. 1994, *Fundamentals for Molecular Spectroscopy*, 4th Edition, McGraw-Hill Higher Education.

Additional References:

1. White, H. 1934, *Introduction to Atomic Spectra*, McGraw-Hill Inc., USA.

Course Title : **Nuclear and Elementary Particle Physics**

Course Code : **PHY-E14**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Contact Hours : **45 (Theory) + 30 (Practical)**

Pre-requisite : **Quantum Mechanics (PHY-IV.C-6)**

Course Objectives : The objective of this course is to introduce students to the fundamental principles and concepts governing nuclear and particle physics.

Course Outcomes : After successful completion of this course, student will be able to:
CO1 : Understand the fundamental principles governing the basic properties of nuclei, nuclear structure and particle physics.
CO2 : Able to solve elementary problems, relating theoretical predictions and measurement results, in nuclear and particle physics.

Theory:

1. Basic Nuclear Properties: **[4 h]**
Nomenclature, Nuclear Size(Electron scattering and Mirror Nuclei), Nuclear Charge, Nuclear Mass, Nuclear Density, Nuclear Spin, Nuclear Magnetic Moment, Nuclear Electric Quadrupole Moment, Parity, Binding Energy, Nuclear Stability, Packing Fraction
[Jain: 1.1, 1.2, 3.1-3.9]

2. Nuclear forces: **[3 h]**
Main characteristics of Nuclear Forces, Meson theory of Nuclear forces, Estimation of the mass of a meson using Heisenberg's Uncertainty Principle, Yukawa potential
[Patel: 8.6] [Ilangovan: 1.9]

3. Radioactivity: **[4 h]**
Soddy-Fazan's Displacement Law, Law of Radioactive Decay, Law of Successive Disintegration, Radioactive equilibrium, Radioactive series, Units of Radioactivity, Radioactive Dating.
[Jain: 6.1-6.5] [Ilangovan: 2.8]

4.Nuclear Reactions: **[3 h]**
Nuclear Reactions, The Balance of mass and energy in Nuclear Reactions(Q-Value), The Q-Equation.
[Patel: 3.2-3.4][Jain: 11.1,11.2]

5. Radioactive decay: [8 h]

Alpha decay: Magnetic Spectrograph-Velocity and Energy of Alpha Particles, Bragg's Experiment-Range of Alpha Particles, Geiger Law, Geiger-Nuttal Law, Disintegration energy of Spontaneous Alpha-decay, The Alpha Spectra and Fine structure: Short Range and Long Range Alpha Particles, Alpha Decay Paradox-Barrier Penetration(Qualitative treatment)
[Ilangovan: 3.1-3.1.7] [Patel: 4.2.1- 4.2.3]

Beta Decay: Magnetic Spectrograph-Velocity and Energy of Beta Particles, Origin of Continuous Beta –ray Spectrum and difficulties in understanding it, Pauli's Neutrino Hypothesis. Types of Beta decay, Energies of Beta -decays
[Ilangovan: 3.2.1, 3.2.5][Patel: 4.3.1- 4.3.3][Jain: 8.1]

Gamma Decay: Origin of Gamma Decay, Internal Conversion, Nuclear isomerism, The Absorption of Gamma Rays with Matter, Detection of Gamma rays using G. M. Counter
[Patel: 4.4.1- 4.4.3] [Ilangovan: 3.3.2, 3.3.3, 3.3.5, 3.3.6] [Jain:13.6]

6. Liquid drop model of a nucleus: **[6 h]**

Analogy between liquid drop and a nucleus, Assumptions of Liquid Drop Model, Wiezsacker Semi- Empirical Mass Formula, Equation for Mass Parabola For Isobaric Nuclei, Merit and Demerit of Semi-Empirical Mass Formula, Potential Barrier for Fission, Stability Limit against Spontaneous Fission(Bohr and Wheeler Theory for Fission Process), Energetic of Symmetric Fission
[Jain: 4.1-4.4][Patel: 5.5]

7. Nuclear Shell Model: **[4 h]**

Experimental basis of Shell Model, Single-Particle Shell Model, Shell Model with Spin-Orbit Coupling, Prediction of ground state spin and parity, Prediction of Magnetic Moment, Prediction of Quadruple moment,
[Jain: 5.1-5.6][Patel: 7.3]

8. Nuclear Energy: [6 h]

Neutron Induced Fission, Asymmetrical Fission-Mass Yield, Energy released in the fission of U-235, Fission Chain Reaction, Principle of a Nuclear Reactor, Neutron cycle in a Thermal Nuclear Reactor (The four factor formula), Principle of a Breeder Reactor.
[Patel: 6.1-6.5, 6.7-6.9]

9. Elementary Particle Physics: [7 h]

Origin of Cosmic ray, Composition of Cosmic rays, Cosmic ray showers, Positron, Mesons, Classification of Elementary Particles, Particles and Antiparticles, Fundamental Interactions, Quantum Numbers, Conservation Laws, Gell-Mann-Nishijima Formula, The Quark Model, Baryons and Mesons as Bound States of Quarks
[Ilangovan: 11.1, 11.5-11.8, 12.2-12.7][Jain: 15.1-15.3]

Experiments:

1. Study of the characteristics of a GM tube and determination of its operating voltage, plateau length / slope etc
2. Determination of Absorption Coefficient using GM counter
3. Verification of Inverse Square Law using GM counter
5. Measurement of short half-life using GM counter
6. Study of radioactive decay using spreadsheets.
7. Tutorial on Properties of the Nucleus
8. Tutorial on Q-value of Nuclear Reaction
9. Tutorial on Radioactivity
10. Tutorial on Radioactive decays
11. Tutorial on nuclear models
12. Tutorial on Nuclear energy

References:

1. Jain, Vimal Kumar. 2015, *Nuclear and Particle Physics*, Ane Books Pvt. Ltd., New Delhi.
2. Patel, S. 2011, *Nuclear Physics: An Introduction*, 2nd Edition. New Age International Limited, New Delhi.
3. Ilangovan, K. 2012, *Nuclear Physics*, MJP Publishers, Chennai.

Additional References:

1. Krane, K. 1987, *Introductory Nuclear Physics,* 3rd Edition. Wiley, New Jersey.
2. Kaplan, I. 1956, *Nuclear Physics,* 3rd Edition, Addison-Wesley, Boston.
3. Beiser, A. 1969, *Perspectives of Modern Physics,* McGraw-Hill Book Company, Singapore.

Annexure III

Course Title : Introduction to Error Analysis

Course Code : PHY-E18

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Course Objectives: The objective of this course is that the students will be able to comprehend some of the important methods used in estimate uncertainties and should be able to use these methods in estimating uncertainty in laboratory experiments.

Course Outcomes: After successful completion of this course, the students will be able to understand

CO1: the techniques involved in analyzing measurement data and the errors associated with the measurement system used.
CO2: the importance of knowing the uncertainty and nature of uncertainty that occurs during measurements
CO3: the method of propagation of errors and applying it to estimate uncertainties.
CO4: the method of statistical analysis in applying it to estimate uncertainties.
CO5: several probability distribution functions like Gaussian distribution, Binomial distribution, and Poisson distribution.
CO6: plotting of graphs and estimate the best fit lines through the data points.

Theory:

1. **Preliminary description** **[6 h]**
   Errors as uncertainty and its inevitability. Importance of knowing the uncertainties. Estimating uncertainties. Significant figures. Discrepancy. Comparison of measures and accepted values. Comparison of two measured numbers. Checking relationship with graphs. Fractional uncertainties. Multiplying two measured numbers.
   [Taylor: 1.1-1.6, 2.1-2.9]

2. **Propagation of uncertainties** **[6 h]**
   Uncertainties in direct measurements. The square root rule for a counting experiment. Sums and differences; product and quotient. Arbitrary functions of one variable. General formula for error propagation.
   [Taylor: 2.1-2.9]

3. **Statistical analysis of random uncertainties** **[6 h]**
   Random and systematic errors. The mean and standard deviation. The standard deviation as the uncertainty in the single measurement. The standard deviation of the mean. Systematic errors.
   [Taylor: 4.1- 4.6]

4. **The Normal Distribution** **[9 h]**
   Histograms and Distributions, Limiting distributions. The normal distribution. The standard deviation as 68% confidence limit. Justification of the mean as the best estimate. Justification of addition in quadrature. Standard deviation of the mean. Acceptability of the measured answer.
   [Taylor: 5.1-5.8]

5. **Least-Squares fitting** **[6 h]**
   Data that should fit a straight line. Calculation of slope and intercept. Uncertainty in the slope and intercept. Least-squares fit to other curves.
   [Taylor: 8.1-8.6]

6. **The Binomial Distribution** **[7 h]**
   Distributions. Probability in dice throwing. Definition of binomial distribution. Properties of binomial distribution. The Gauss distribution for random errors. Application: testing of hypothesis
   [Taylor: 10.1-10.6]

7. **The Poisson Distribution** **[5 h]**
   Definition of Poisson distribution. Properties of Poisson distribution. Applications. Subtracting a background.
   [Taylor: 11.1-11.4]

Experiments: (Minimum Six)

1. Tutorial on Propagation of uncertainties
2. Tutorial on Statistical Analysis of Random measurement
3. Tutorial on Normal Distribution
4. Tutorial on Binomial distribution
5. Tutorial on Poisson Distribution
6. Application of Error Analysis based on experimental data.
7. Application of Error analysis based on experimental data.
8. Application of Error analysis based on experimental data.

References:

1. Taylor J, *An Introduction to Error analysis* (University Science Books, 1997)

Additional References:

1. Drosg M., *Dealing with Uncertainties: A guide to error analysis* (Springer, 2007)

Annexure IV

Following courses may be offered by the Department of Physics as General Elective courses:

- Semester I: PHY-I.C-1 Mechanics I
- Semester II: PHY-I.C-3 Heat and Thermodynamics
- Semester III: PHY-E3 Oscillations, Waves and Sound
- Semester IV: PHY-E4 Properties of Matter and Acoustics

Annexure V

Following courses may be offered as Skill Enhancement Courses:

- Numerical methods
- Python programming
- Computational Physics
- Instrumentation
- Circuit designing
- Remote sensing
- Elementary GIS
- Photography
- Animation skills
- Video and Audio editing
- Sound engineering and editing
- Horticulture
- Mushroom culture
- Interpersonal skills.
- Basic skills in analytical Chemistry
- Domestic electrical wiring and repair of appliances.

Annexure VI

PROGRAMME SPECIFIC OUTCOMES (PSOs)

- **PSO1 :** Strengthen the understanding of basic concepts of Physics and impart required mathematical skills.
- **PSO2 :** Provide a strong base in Experimental Physics to pursue higher studies/research in Experimental Physics.
- **PSO3 :** Provide a sound foundation in Theoretical Physics to pursue higher studies/research in Theoretical Physics
- **PSO4 :** Developing analytical thinking and logical reasoning.
- **PSO5:** Enhancing problem solving skills.
- **PSO6 :** Promote self-learning, self-confidence, communication skills and team work.
- **PSO7:** Enhancing employability through skill enhancement courses.

COURSE OUTCOMES

S. No.	Course Code	Course Title	**Course Outcomes** At the end of this course students will be able to:
1	**PHY-I.C-1**	**Introduction to Mathematical Physics**	**CO1:** Have a good understanding of vector analysis and its application in physics. **CO2:** Have a good grasp on various tests used to test the convergence and divergence of different kinds of series and learn how to expand a function in power series. **CO3:** Understand the basics of complex numbers. **CO4:** Have an understanding of matrix operations and properties of matrices. **CO5:** Learn basics of partial differentiation and its application in physics.

			CO6: Be able to solve ordinary first and second order differential equations important in the physical sciences, **CO7:** familiarize with spherical and cylindrical coordinate systems. **CO8:** Use mathematical techniques to solve several problems in physics and enhance problem solving skills.
2	**PHY-I.C-2**	**Mechanics I**	**CO1:** develop qualitative and quantitative understanding of Newtonian mechanics in one and two dimensions and solve the Newton equations for simple configurations. **CO2:** understand the Law of Conservation of Linear Momentum and Angular Momentum and apply these laws to understand elastic and inelastic collision, motion of a rocket and Kepler's law. **CO3:** demonstrate the knowledge of work and energy in kinetics **CO4:** understand the Principle of Conservation of Mechanical Energy (for conservative forces) and apply this law to problems of objects moving under the influence of conservative forces. **CO5:** develop ideas of Newtons Law of gravity, gravitational field and potential energy by solving various problems.
3	**PHY-II.C-3**	**Heat and Thermodynamics**	**CO1:** Understand different types of temperature scales and relationship between different scales of temperature. **CO2:** Able to relate the effects of changes in temperature, pressure and volume on physical systems at macroscopic scale by analyzing collective motion of their particles. **CO3:** Able to comprehend the first law of thermodynamics to represent the relationship between heat and mechanical work.

			CO4: Able to comprehend the second law of thermodynamics to depict the manner in which thermodynamic changes take place. **CO5:** Explain the usefulness of these concepts for wide range of applications that include heat engines, refrigerators and air conditioners. **CO6:** Calculate change in entropy in matter during change in phase.
4	**PHY-II.C-4**	**Electricity and Magnetism**	**CO1 :** Comprehend basic concepts like: laws of electrostatics and magneto statics and also related applications. **CO2 :** Understand the interrelated concepts of Electricity and Magnetism. **CO3 :** Understand the working of transient circuits and alternating current circuits. **CO4 :** Correlate the theoretical basis of various concepts of electricity and magnetism while performing experiments.
5	**PHY-II.C-5**	**Electromagnetic Theory – I**	**CO1:** Apply vector calculus to understand concepts in electrostatics. **CO2:** Comprehend the interaction between charges in vacuum as well as in medium. **CO3:** Calculate the electric field and electrical potential for discrete charges and continuous distribution of charge. **CO4:** Apply suitable techniques to solve various electrostatic problems. **CO5:** Understand how ferroelectric materials can be used as memory devices.
6	**PHY-E1**	**Optics**	**CO1 :** Understand the image formation for various optical systems. **CO2 :** Differentiate between optical phenomena like Interference, Diffraction and Polarization.

			CO3 : Correlate the theoretical basis of various concepts of Geometrical Optics and Physical Optics while performing experiments **CO4 :** Develop understanding towards the different phenomena exhibited by light.
7	**PHY-E2**	**Modern Physics**	**CO1 :** have an understanding of constituents of an atom and atomic structure. **CO2 :** discuss and interpret experiments that reveal the wave properties of matter. **CO3 :** discuss and interpret experiments that reveal the particle properties of waves and wavelike properties of particle. **CO4:** apply uncertainty principle to solve physics problems **CO5:** understand the working of mass spectrographs and accelerators **CO6:** understand the basic operating principle of the laser and the optical fiber.
8	**PHY-E3**	**Oscillations, Waves and Sound**	**CO1 :** Set up an equation of motion for simple harmonic motion and obtain its solution. **CO2 :** Explain how superposition of waves leads to different Lissajous figures. **CO3 :** Set and solve the equation of motion for damped and driven damped harmonic oscillators and analyse the nature of oscillations. **CO4:** Understand the dependence of velocity of sound waves on various factors like temperature, pressure, density, humidity. **CO5:** Solve problems for different cases of Doppler effect.
9	**PHY-E17**	**Introduction to Astronomy and Astrophysics**	**CO1 :** Understand the various Extra-galactic objects. **CO2 :** Understand the construction, working and mounting of modern telescopes. **CO3 :** Understand co-ordinate system of Celestial Objects. **CO4 :** Understand types of stars and their life cycle.
10	**PHY-II.C-6**	**Quantum Mechanics**	**CO1 :** understand central concepts and principles in quantum mechanics, such as the Schrödinger equation, the wave function and its statistical interpretation, the uncertainty principle, stationary and non-stationary states, time evolution of solutions.

			CO2 : solve the Schrödinger equation to obtain wave functions for some important types of potential in one and three dimension and give concise physical interpretations and reasoning underlying the mathematical results **CO3 :** grasp the concepts of angular momentum and spin. **CO4 :** have an insight into fundamental issues in quantum mechanics like the EPR paradox, Bells theorem and Schrödinger's cat **CO5:** develop an understanding of why both analytic and numerical solutions are important in quantum mechanics and have acquired experience in using both types of methods on quantum mechanical problems **CO6:** use numerical tools and software to solve the Schrodinger equation for more complicated cases.
11	**PHY-E5**	**Electronics-I**	**CO1 :** Understand the fundamentals of semiconductor behavior and the operation of basic semiconductor devices. **CO2 :** Understand basic circuit laws; semiconductor based analog circuits from a fundamental point of view. **CO3 :** Use this knowledge to describe bipolar transistors and its applications. **CO4 :** Understand and apply the concept of feedback to study operational amplifier and sinusoidal oscillators.
12	**PHY-E6**	**Solid State Devices**	**CO1 :** Comprehend the p-n junction theory and analyse the effect of heat and light on the performance of the semiconductor devices. **CO2:** Understand different types of special diodes and their uses in various electronics applications. **CO3 :** Understand different types of optoelectronic devices and their uses in various electronics applications. **CO4:** Design, construct and study the performance of circuits based on breakdown devices. **CO5 :** Corelate the theory to understand the working of these devices.

13	**PHY-E4**	**Properties of Matter and Acoustics**	**CO1 :** Gain an introductory knowledge of dynamics of rigid bodies, and its applications to basic physical problems. **CO2 :** Familiarize with of acoustics of rooms and musical scales. **CO3 :** Comprehend the phenomenon of elasticity, surface tension, viscosity and their application.
14	**PHY-E7**	**Computational Physics**	**CO1 :** Understand various numerical methods **CO2 :** Use FORTRAN language for numerical calculations. **CO3 :** Understand various concepts of Physics using numerical methods using FORTRAN as a programming language. **CO4 :** Solve problems in Physics by numerical methods using FORTRAN as a programming language.
15	**PHY-II.C-7**	**Electromagnetic Theory – II**	**CO1 :** Calculate magnetic field induction using Biot-Savart's law and Ampere's law. **CO2 :** Interpret bound currents and calculate magnetic fields in matter. **CO3 :** Comprehend microscopic theory magnetism. **CO4 :** Establish the link between electrostatics and magnetostatics using Maxwell's equations. **CO5:** Develop the wave equation for propagation of electromagnetic waves through material media and vacuum at different angles of incidence.
16	**PHY-E9**	**Solid State Physics**	**CO1 :** Understand firmly the basics of Solid State Physics. **CO2 :** Understand the link between the structural aspects and the various physical properties of crystalline solids. **CO3 :** Gain a comprehensive broad knowledge in topic such as: Bonding in Solids, Crystal Physics, Electrical properties of solids, Origin of energy band structure in solids and Magnetic properties of materials.
17	**PHY-E10**	**Thermodynamics and Statistical Mechanics**	**CO1 :** Understand basics of kinetic theory of gases and thermodynamic potentials.

			CO2 : Understand Maxwell-Boltzmann, Fermi-Dirac, and Bose-Einstein statistics and its application to the classical gas, electrons in a metal and blackbody radiation **CO3 :** Understand the specific heat of solids by invoking statistical mechanics.
18	**PHY-E11**	**Electronics-II**	**CO1** : Analyse AC circuits and apply the techniques in designing circuits. **CO2:** Generate different kinds of waves using OP-Amp **CO3:** Understand the basic concepts of 555 timer. **CO4:** Develop the ideas of monolithic linear regulators and understand different types of voltage regulators in LM series **CO5:** Apply binary operations to different digital circuits **CO6:** Understand the clocked digital electronics and its applications in different types of counters
19	**PHY-E12**	**Mathematical Physics**	**CO1 :** Comprehend the functions of complex variables. **CO2 :** Apply mathematical techniques such as: calculus of residues to evaluate definite integrals. **CO3:** Apply solutions of Legendre, Bessel and Hermite equations, Fourier transforms of different functions in solving various Physics problems. **CO3 :** Able to solve higher order problems in Physics.
20	**PHY-II.C-8**	**Atomic and Molecular Physics**	**CO1 :** solve the case of the hydrogen atom using the three dimension time-independent Schroedinger equation, identify atomic effect such as space quantization and interpret the wave functions and probability densities. **CO2 :** become familiar with the orbital, spin and total angular momentum of many electron atoms. **CO3 :** explain the observed dependence of atomic spectral lines on externally applied magnetic fields. **CO4:** grasp the physics of diatomic molecules, their electronic states, vibrations and rotations and their spectra.

			CO5: comprehend classical and quantum theory of Raman effect. **CO6:** develop analytical and computing skills through problem solving, and computer based exercises, which involve quantum mechanical systems such as the Harmonic oscillator, Hydrogen atom and Morse potential.
21	**PHY-E13**	**Mechanics – II**	**CO1 :** Separate two body problem into two equivalent single body problems **CO2 :** Establish equation of orbit for the motion under inverse square law force and study different types of orbits. **CO3 :** Establish the relation between time derivative of a vector in a fixed frame of reference with respect to moving frame of reference. **CO4:** Comprehend the occurrence of some pseudo forces due to relative motion between frames of references such as Coriolis's force, centrifugal force **CO5:** Understand the motion of rigid bodies by solving Euler's equations of motion. **CO6:** Understand the advantages of Lagrangian formulation over Newtonian formulation. **CO7:** Solve various mechanical problems using Lagrangian equation of motion
22	**PHY-E14**	**Nuclear and Elementary Particle Physics**	**CO1 :** Understand the fundamental principles governing the basic properties of nuclei, nuclear structure and particle physics. **CO2 :** Able to solve elementary problems, relating theoretical predictions and measurement results, in nuclear and particle physics.
23	**PHY-E15**	**Introduction to Special Theory of Relativity**	**CO1 :** Understand the limitations of Newtonian relativity at speeds close to the speed of light. **CO2 :** Learn the postulates of special theory of relativity and understand the connection between space and time. **CO3 :** Comprehend the concepts of relativistic velocity, relativistic mass and equivalence of energy and mass. **CO4 :** Learn about the doppler effect in relativity.

24	**PHY-E16**	**Introduction to Materials Science**	**CO1 :** Understand the fundamentals of materials science. **CO2 :** Understand the properties and applications of materials. **CO3 :** Investigate the relationship that exists between the structures and properties of materials.
25	**PHY-E8**	**Instrumentation**	**CO1 :** Understand basic concepts related to the various types of measuring instruments and measuring techniques. **CO2 :** Comprehend basic principles involved in measuring instruments like Ammeter, Voltmeter, Ohmmeter and Multimeters. **CO3 :** Understand working and use of CROs and Signal Generators **CO4 :** Understand working and usage of the various types of transducers.

Annexure VII

List of board of examiners:

Sr. No.	Name	Institute
1	Dr. Ramu Murthy	Dhempe College, Miramar
2	Dr. Swati Pawar	Dhempe College, Miramar
3	Dr. Miskil Naik	Dhempe College, Miramar
4	Dr. Bosco Lawrence	St. Xavier's College, Mapusa
5	Dr. Nelson Lobo	St. Xavier's College, Mapusa
6	Mr. Pradeep Morajkar	St. Xavier's College, Mapusa
7	Dr. Satish Keluskar	P.E.S. college, Farmagudi
8	Mrs. Mandakini Kundaikar	P.E.S. college, Farmagudi
9	Mr. Narayan Bandodkar	Government College, Quepem
10	Dr. Efrem Desa	Carmel College, Nuvem
11	Dr. Manoj Kothawale	D. M.'s College, Assagao
12	Dr. Jaison Joseph	Government College, Khandola
13	Mr. Prashant Chodankar	Government College, Kahndola
14	Mr. Ali Aga	Government College, Sanquelim
15	Mrs. Shilpa Amonkar	Goa Engineering College, Farmagudi
16	Mr. Harison Cota	Don Bosco College of Engineering, Fatorda
17	Dr. Saidi Reddy Parne	NIT Goa
18	Dr. Girish Kundaikar	P.E.S. college, Farmagudi
19	Mrs. Shilpa Amonkar	Goa Engineering College, Farmagudi

ANNEXURE A

(Summary of changes incorporated in the syllabus)

Semester	Course Title	Existing (Indicate only the unit where the change is proposed)	Changes Proposed	Specify the reason for the change
I	Introduction to Mathematical Physics	**Experiments:** 10. Least count of Instruments (Vernier Caliper, Screw Gauge, Travelling Microscope and Spectrometer). 11. Introduction Error Analysis: Propagation of Errors 12. Statistical Analysis of Random measurement 13. Application of Error Analysis 14. Least square fitting 15. Plotting of various algebraic and trigonometric functions using Excel. 16. Curve fitting using Excel. 17. Interpretation of graphs. 18. Solving Integration, Ordinary Differential Equation and Matrices using Mathematica. 19. Tutorial 20. Tutorial	**Experiments:** 12. Introduction Error Analysis: Propagation of Errors 13. Statistical Analysis of Random measurement 14. Simulation of Radioactive Decay using Rolling of Dice 15. Plotting of various algebraic and trigonometric functions using Excel. 16. Curve fitting using Excel. 17. Interpretation of graphs. 18. Solving Integration, Ordinary Differential Equation and Matrices using Mathematica. 19. Tutorial on vector analysis 20. Tutorial on infinite series 21. Tutorial on differential equations 22. Tutorial on matrices and partial differentiation	• Experiment number 1 from existing list is removed since it is too elementary and done in XI/XII standard. • Experiment numbers 4, 5 from existing list are Shifted to the course on "Introduction to Error Analysis" • Experiments 2, 10, 11 in changes proposed are added to make – up for above deleted experiments • Experiment numbers 10 and 11 in existing list is specified with titles.
I	Mechanics – I	**Experiments:**	**Experiments:**	Experiment number 8 from

		9. Dimensions of different solid body 10. Moment of Inertia of a flywheel 11. Atwood Machine 12. Verification of Newton's Second Law using Air Track 13. Conservation of linear momentum using Air Track 14. Spring Mass System: Determining the Spring Constant 15. Simple Pendulum 16. Log Decrement 17. Determining "**g**" using time of flight method using Python	1. Dimensions of different solid body 2. Moment of Inertia of a flywheel 3. Atwood Machine 4. Verification of Newton's Second Law using Air Track 5. Conservation of linear momentum using Air Track 6. Spring Mass System: Determining the Spring Constant 7. Simple Pendulum 8. Determining "**g**" using time of flight method using Python	existing list is removed since it is done in a course on Oscillations, Waves and Sound in Semester III
II	Electricity and Magnetism	**Experiments:** 1. Measurement of Dielectric constant of a liquid using two co-axial metal tubes. 2. Susceptibility measurement of a parallel plate capacitor in a dielectric medium 3. Step Response of RC circuit 4. Transient response of L-C-R circuit using square wave generator and C.R.O. 5. Response of LR and CR circuits to A.C. - phasor diagrams 6. LCR Series and parallel resonance –Resonant frequency, Q value and Bandwidth 7. Determination of Mutual Inductance using LCR series resonance 8. de Sauty's bridge 9. Maxwell's L/C bridge	**Experiments:** 1. Susceptibility measurement of a parallel plate capacitor in a dielectric medium 2. Step Response of RC circuit 3. Study of LR circuit using spreadsheets. 4. Transient response of L-C-R circuit using square wave generator and C.R.O. 5. Response of LR circuits to A.C. - phasor diagrams 6. Response of CR circuits to A.C. - phasor diagrams 7. LCR series resonance – Resonant frequency, Q	• Experiment number 1 from existing list is shifted to course on Electromagnetic Theory – I. • Experiment number 3 in the changes proposed list is added to compensate for the above. • Experiments 5, 6 in existing list cannot be completed in two hours and are separated as experiments 5,6,7,8 in proposed changes list.

			value and Bandwidth 8. LCR parallel resonance – Resonant frequency, Q value and Bandwidth 9. Determination of Mutual Inductance using LCR series resonance 10. de Sauty's bridge 11. Maxwell's L/C bridge	
III	Electromagnetic Theory - I		**Experiments:** "Measurement of Dielectric constant of a liquid using two co-axial metal tubes" is added	Shifted from sem. II since theory of this topic is covered in EMT-I.
III	Optics		One experiment on Wedge shaped air film is introduced.	To demonstrate concept of interference.
III	Oscillations, waves and sound		Pre-requisite of Introduction to Mathematical Physics is removed	Pre-requisite is not essential. This course is also proposed to be introduced as a generic elective course for non-physics students.
IV	Quantum Mechanics		New experiment on Tunnel-diode is introduced	Since we are in a process of procuring the necessary equipment.
IV	Properties of Matter, Acoustics and Sound.		Pre-requisite of Oscillations, Waves and sound is added	To understand acoustics, knowledge of concept of sound is necessary.

V	Electromagnetic Theory - II		New experiment on Helmholtz coil is introduced.	To study the behaviour of materials under uniform magnetic field.
V	Solid State Physics		One experiment on Energy band gap of a thermistor is introduced.	To enhance understanding of measurement of energy band gap.
V	Thermodynamics and statistical mechanics	Unit 2: Probability is deleted	Unit 5: Specific Heats of solids is added	Probability unit is shifted to course on introduction to error analysis. Unit on Specific heats of solids is more relevant in this course.
VI	Nuclear Physics		Following three tutorials are added 1. Tutorial on Radioactive decays 2. Tutorial on nuclear models 3. Tutorial on Nuclear energy	Topics are covered in the theory course

Annexure I

Parvatibai Chowgule College of Arts and Science (Autonomous)
Margao, Goa

Syllabus for

Semester-I, III and V

of the undergraduate degree courses

in

Physics

(2020-2021)

Course Title **: Introduction to Mathematical Physics**

Course Code **: PHY-I.C-1**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Course Objectives **:** To develop basic competence in certain areas of mathematics required for understanding several important topics in physics.

Course Outcomes **:** At the end of this course students will be able to:

CO1: Have a good understanding of vector analysis and its application in physics.

CO2: Have a good grasp on various tests used to test the convergence and divergence of different kinds of series and learn how to expand a function in power series.

CO3: Understand the basics of complex numbers.

CO4: Have an understanding of matrix operations and properties of matrices.

CO5: Learn basics of partial differentiation and its application in physics.

CO6: Be able to solve ordinary first and second order differential equations important in the physical sciences,

CO7: familiarize with spherical and cylindrical coordinate systems.

CO8: Use mathematical techniques to solve several problems in physics and enhance problem solving skills.

Theory:

Unit I **[15 h]**

1. **Infinite Series and Power Series** **[8 h]**
   Geometric Series and other infinite series. Convergent and Divergent Series. Testing series for convergence. Power series. Expanding functions in power series. Techniques for obtaining power series expansion.
   [Boas 1.1-1.7, 1.10-1.13]

2. **Complex Numbers** **[4 h]**
   Real and imaginary Parts of a complex number. Complex plane. Complex algebra. Euler's formula. Powers and roots of complex numbers. Exponential and trigonometric functions.
   [Boas 2.1-2.5, 2.9-2.11]

3. **Coordinate Systems** **[3 h]**
   Plane polar coordinates. Cylindrical and Spherical polar coordinates.
   [Harper 1.6.6, Riley 8.9]

Unit II **[15 h]**

1. **Vector Algebra** **[5 h]**
   Scalars and vectors. Basis vectors and components. Multiplication of Vectors. Equation of lines and planes. Using vectors to find distances.
   [Boas 3.4-3.5]

2. **Vector Analysis** **[10 h]**
   Application of vector multiplication. Triple products. Differentiation of vectors. Gradient, divergence and curl of a vector. Line integrals. Divergence theorem. Curl and Stokes theorem.
   [Boas 6.1-6.11]

Unit III **[15 h]**

1. **Partial Differentiation** **[6 h]**
   Definition of the partial derivative. Total differentials. Exact and inexact differentials. Theorems of partial differentiation. Chain rule. Thermodynamic relations. Differentiation of Integrals.
   [Riley 4.1-4.5, 4.10-4.11]

2. **Ordinary Differential Equation** **[9 h]**

   Introduction. Linear differential equation of the first order. Homogenous and inhomogeneous linear differential equation of the second order.
   [Boas 8.1-8.6 and Harper 5.1-5.2]

Experiments: (Minimum Six)

1. Introduction Error Analysis: Propagation of Errors
2. Statistical Analysis of Random measurement
3. Simulation of Radioactive Decay using Rolling of Dice
4. Plotting of various algebraic and trigonometric functions using Excel.
5. Curve fitting using Excel.
6. Interpretation of graphs.
7. Solving Integration, Ordinary Differential Equation and Matrices using Mathematica.
8. Tutorial on vector analysis
9. Tutorial on infinite series
10. Tutorial on differential equations
11. Tutorial on matrices and partial differentiation

References:

1. K. F. Riley, M. P. Hobson and S. J. Bence, *Mathematical Methods for Physics and Engineering* (Cambridge University Press, 1998)
2. Mary L. Boas, *Mathematical Methods in Physical Sciences* (John Wiley and Sons, 3rd Edition)
3. Charlie Harper, *Introduction to Mathematical Physics*- (Prentice Hall)

Additional References:

1. B. D. Gupta, *Mathematical Physics* (Vikas Publishing House, 2004)
2. M. Spiegel, S. Lipschutz, D. Spellman, *Schaum's Outline of Vector Analysis,* (Mc-Graw Hill Education, 2009)

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1. https://ocw.mit.edu/resources/res-18-007-calculus-revisited-multivariable-calculus-fall-2011/
2. https://nptel.ac.in/courses/111108081/
3. https://www.math.upenn.edu/~deturck/m104/notes/week6.pdf
4. http://tutorial.math.lamar.edu/Classes/CalcIII/CalcIII.aspx
5. http://home.iitk.ac.in/~peeyush/102A/Lecture-notes.pdf
6. http://www.jimahoffman.com/MathB30/Matrices/Matrix1.pdf

Course Title **: Mechanics I**

Course Code **: PHY-I.C-2**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Course Objectives **:** This course provides an introduction to topics in mechanics, which are essential for advanced work in physics. An objective of this course is to train students to think about some of the physical phenomenon in mathematical terms.

Course Outcomes **:** At the end of this course students will be able to:

CO1: develop qualitative and quantitative understanding of Newtonian mechanics in one and two dimensions and solve the Newton equations for simple configurations.
CO2: understand the Law of Conservation of Linear Momentum and Angular Momentum and apply these laws to understand elastic and inelastic collision, motion of a rocket and Kepler's law.
CO3: demonstrate the knowledge of work and energy in kinetics
CO4: understand the Principle of Conservation of Mechanical Energy (for conservative forces) and apply this law to problems of objects moving under the influence of conservative forces.
CO5: develop ideas of Newtons Law of gravity, gravitational field and potential energy by solving various problems.

Theory:

UNIT – I: Newton's Laws of Motion, Projectiles and Charged Particles **[20 h]**

1. **Newton's Laws of Motion** **[10 h]**
   Brief description of classical view of Space and Time (vector operations). The concept of Mass and Force. Newton's First and Second Laws; Inertial frames. Equations of motion. Interpretation of Newton's third Law as Conservation of Momentum. Newton's Second Law in Cartesian coordinates and in two dimensional Polar coordinates. Applications of Newtons Laws: Atwood Machine, Free fall near surface of the earth, simple harmonic motion and time dependent force.
   [Taylor 1.1-1.7, Kleppner 2.4]

2. **Projectiles and Charged Particles** **[10 h]**

   Motion of projectile in air resistance/drag (function of velocity.) Linear Air Resistance. Horizontal and vertical motion with linear drag, Trajectory and Range in a Linear Medium. Quadratic Air Resistance. Horizontal motion with quadratic drag (ignoring gravity), Motion of a charged particle with a velocity perpendicular to the direction of a uniform constant (1) electric field, (2) magnetic field and (3) electric and magnetic field (crossed) in mutually perpendicular directions. Lorentz force.
   [Taylor 2.1 - 2.7, Symon 3.17]

UNIT – II: Momentum, Angular Momentum, Gravitation Field and potentials [15 h]

3. **Momentum and Angular Momentum** **[7 h]**

   Principle of conservation of momentum (Elastic and Inelastic collision), Analysis of Rocket motion. The Centre of Mass, Angular Momentum for a Single Particle. Kepler's second law as a consequence of conservation of angular momentum.
   [Taylor 3.1-3.5]

4. **Gravitation Field and potentials** **[8 h]**
   Newton's Law of Gravitation. Gravitational field. Gravitational potential energy. Equipotential surface. Gravitational potential and field due to a (1) thin spherical shell, (2) uniform hollow sphere and (3) thin circular plate.

UNIT – III: Work and Energy **[10 h]**

5. **Work and Energy** **[10 h]**
   Kinetic Energy and Work: Work energy theorem. Potential Energy and Conservative Forces. Force as a Gradient of Potential Energy, Time dependent potential energy (one dimension). Energy for Linear One-Dimensional Systems. Curvilinear one-dimensional systems. Energy of interaction of two particles in one dimension.
   [Taylor 4.1-4.3, 4.5-4.7, 4.9]

Experiments: (Minimum Six)

1. Dimensions of different solid body
2. Moment of Inertia of a flywheel
3. Atwood Machine
4. Verification of Newton's Second Law using Air Track
5. Conservation of linear momentum using Air Track
6. Spring Mass System: Determining the Spring Constant
7. Simple Pendulum
8. Determining "**g**" using time of flight method using Python

References:

1. John Taylor, *Classical Mechanics,* (University Science Books, 2004)
2. Kleppner and Kolenkow, *Introduction to Mechanics*,(Cambridge University Press, 2013)
3. K. R. Symon, *Mechanics* (Addison Wesley, 1971)
4. Brij Lal and N. Subrahmanyam, *Mechanics and Electrodynamics*, (S. Chand and Company LTD , 2005)

Additional References:

1. Kittle and Knight, Mechanics (Berkeley Physics Course, Vol. 1), (McGraw Hill Education, 2011)
2. D. S. Mathur, *Mechanics* (S. Chand & Co., 2005)
3. R. G. Takawale and P. S. Puranik, *Introduction to Classical Mechanics*, (Tata McGraw-Hill, 1997)
4. Javier E. Hasbun, *Classical Mechanics* (Jones and Bartlett India Pvt. Ltd. 2010)
5. Atam Arya, *Introduction to Newtonian Mechanics,* (Addison-Wesley, 1997))
6. R. G. Takawale and P. S. Puranik, *Introduction to Classical Mechanics* (Tata McGraw-Hill, 1997)
7. Javier E. Hasbun, *Classical Mechanics* (Jones and Bartlett India Pvt. Ltd. 2010)

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1. https://nptel.ac.in/courses/122106027/
2. https://ocw.mit.edu/courses/physics/8-01sc-classical-mechanics-fall-2016/
3. https://www.khanacademy.org/science/ap-physics-1/
4. https://www.feynmanlectures.caltech.edu/I_13.html
5. http://hep.physics.wayne.edu/~harr/courses/5200/f07/lecture06.htm

Course Title **: Electromagnetic Theory – I**

Course Code **: PHY-III.C-5**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Pre-requisite **:** Electricity and Magnetism (PHY-II.C-4) and Introduction to Mathematical Physics (PHY-I.C-1)

Course Objectives **:** To acquaint students with fundamental principles of Electrostatics part of the Electromagnetic Theory.

Course Outcomes **:** At the end of this course students will be able to:
CO1: Apply vector calculus to understand concepts in electrostatics.
CO2: Comprehend the interaction between charges in vacuum as well as in medium.
CO3: Calculate the electric field and electrical potential for discrete charges and continuous distribution of charge.
CO4: Apply suitable techniques to solve various electrostatic problems.
CO5: Understand how ferroelectric materials can be used as memory devices.

Theory:

UNIT – I: Vector Analysis [10 h]

1. **Vector Analysis** **[10 h]**

Vector Algebra: Vector Operations, Vector Algebra: Component form, Triple Products, Position, Displacement and Separation Vectors, Differential Calculus: Ordinary Derivatives, Gradient, The Operator $\vec{\nabla}$, The Divergence and Curl, Product Rules, Second Derivatives, Integral Calculus: Line, Surface and Volume Integrals, The fundamental Theorem for Divergences, The fundamental Theorem for Curls, Different Co-ordinate Systems: Cartesian Co-ordinate System, Cylindrical Co- ordinate System, Spherical Co-ordinate System, Some Useful Vector Identities with Proofs.

[Ref. No. 1 pp. 1 – 8, 13 – 22, 28]

[Ref. No. 2 pp. 20, 26 30-31, 36]

UNIT – II: Electrostatics and Techniques to Solve Electrostatic Problems [20 h]

2. Electrostatics [12 h]

The Electric Field: Coulomb's Law, The Electric Field, Continuous Charge Distributions, Divergence and Curl of Electrostatic Fields: Field Lines, Flux and Gauss's Law, The Divergence of E, Applications of Gauss's Law, The Curl of E, Electric Potential: Introduction to Potential, Poisson's Equation and Laplace's Equation, Potential of a Localized Charged Distribution, Summary: Electrostatic Boundary Condition, Work and Energy in Electrostatics: Work Done to Move a Charge, The Energy of a Point Charge Distribution, The Energy of a Continuous Charge Distribution, Comments on Electrostatic Energy, Conductors: Basic Properties of Conductor, Induced Charges, Surface Charge and the Force on a Conductor, Capacitors.

[Ref. No. 1, pp. 58 – 103]

3. Techniques to Solve Electrostatic Problems [8 h]

Poisson's Equation, Laplace's Equation: Laplace's Equation in One Dimension, Laplace's Equation in Two Dimensions, Laplace's Equation in Rectangular Co-ordinates, Solution to Laplace's Equation in Spherical Co-ordinates (Zonal Harmonics), Conducting Sphere in Uniform Electric Field, Electrostatic Images: Point Charge and Conducting Sphere, Line Charge and Line Images.

[Ref. No. 3 pp. 51 – 67]

UNIT – III: Electrostatic Field in Matter and Microscopic Theory of Dielectrics [15 h]

4. Electrostatic Field in Matter [8 h]

Polarization, Gauss's Law in a Dielectric, Electric Displacement Vector, Electric Susceptibility and Dielectric Constant, Boundary Conditions on the Field Vectors, Boundary Value Problems Involving Dielectric, Dielectric Sphere in a Uniform Electric Field

[Ref. No. 3 pp. 75 – 93]

5. Microscopic Theory of Dielectrics [7 h]

Molecular field in a dielectric: Clausius Mossotti Relation, Polar and Non-Polar Molecules, Induced Dipoles, Langevin's Debye Formula, Permanent Polarization, Ferroelectricity.

[Ref. No. 3 pp. 101 – 109]

Experiments: (Minimum Six)

1. Van-de-graff Generator. [Demonstration]
2. Measurement of dielectric constant and susceptibility of liquid using parallel metal plates.
3. Measurement of dielectric constant and susceptibility of liquid using coaxial metal tubes.
4. Measurement and Study of variation of dielectric constant of BaTiO3 ferroelectric and determination of its Curie temperature.
5. E and D measurement for a parallel plate capacitor and calculation of dielectric constant.
6. Law of Capacitance using Dielectric Constant Measurement Kit.
7. Absolute capacity by ballistic galvanometer.
8. C1/C2 by De-Sauty's method using ballistic galvanometer.
9. Dipole Moment and Polarizability of Benzene.

References:

1. Griffiths D. J., Introduction to Electrodynamics, Prentice Hall of India, 3rd Ed. (2011)

2. Harper Charlie, Introduction to Mathematical Physics, Prentice Hall of India, 5th reprint, (1993)

3. Reitz J. R., Milford F. J., Christy R. W., Foundations of Electromagnetic Theory, Addison-Wesley Publishing Company, 3rd Ed., (1979)

Additional Reference:

1. Mukherji U., Electromagnetic Field Theory and Wave Propagation, Narosa Publishing House, (2008)

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2. https://swayam.gov.in/nd1_noc19_ph08/preview
3. https://ocw.mit.edu/courses/physics/8-07-electromagnetism-ii-fall-2012/lecture-notes/
4. https://www.feynmanlectures.caltech.edu/II_10.html
5. https://www.iiserkol.ac.in/~ph324/ExptManuals/DielectricConstant.pdf

Course Title : **Optics**

Course Code : **PHY-E1**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Pre-requisite : **Nil**.

Course Objective: The course aims to enable the students to develop an understanding towards the properties of light, its nature, its propagation and the different phenomena exhibited by light. The whole branch is divided into: (1) Geometrical Optics involving geometrical consideration of image –formation based on the rectilinear propagation of light and (2) Physical Optics considering the wave nature of light, then explaining the optical phenomena such as Interference, Diffraction and Polarization exhibited by light using suitable theories. The primary aim of this course is to emphasize the different fundamental principles and the techniques used for different optical phenomena.

Course Outcomes: On completion of this course, the students will be able to:

CO1: Apply cardinal points technique and aberration to study the image formation in optical systems
CO2: Solve numerical problems based on aberration and cardinal points
CO3: Apply division by wave front and division by amplitude techniques to study interference patterns
CO4: Solve numerical problems based on interference in thin films
CO5: Derive conditions for Fresnel class diffraction and Fraunhofer class diffraction
CO6: Solve numerical problems based on diffraction grating, resolving power of telescope and prism
CO7: Apply Huygen's theory of double refraction to study the types of crystal
CO8: Analyze the types of polarized light with help of Nicol Prism and retardation plate
CO9: Determine optical rotation of sugar solution using Polarimeters

Theory:

Unit-I: Geometrical Optics **[15 h]**

I.1: Fundamentals of Reflection and Refraction [6 h]

Refractive index and optical path, Fermat's Principle of least time, Derivation of the laws of reflection and refraction using Fermat's Principle.
Lenses: thin and thick lenses, Lens equation, Lens maker's formula, Cardinal points of an optical system, Combination of coaxially placed two thin lenses (equivalent lenses) (including derivation for focal length and cardinal points).

[Subhramanyam; Chapter.1: 1.6, 1.7; Sing; Chapter.1: 1.2, 1.3, 1.4; Subhramanyam; Chapter.4: 4.8, 4.9, 4.10, 4.11, 4.12, 4.15, 4.17; Chapter.5: 5.2, 5.2.1, 5.2.2, 5.2.3, 5.3, 5.10, Chapter.6: 6.1, 6.2]

I.2: Lens Aberrations [5 h]

Introduction, Types of aberrations: monochromatic and chromatic aberration, Monochromatic aberration and its reduction: Spherical aberration, Types of chromatic aberration: Achromatism (lenses in contact and separated by finite distance).

[Subhramanyam; Chapter.9: 9.1, 9.2, 9.5, 9.5.1, 9.10, 9.11, 9.12, 9.13]

I.3: Optical Instruments [4 h]

Objective and Eyepiece, Huygen's eyepiece, Ramsden's eyepiece, Telescopes, Refracting and Reflecting type of telescopes and Constant deviation Spectrometer.

[Subhramanyam; Chapter.10: 10.8, 10.10, 10.10.1, 10.11, 10.11.1,10.12, 10.15, 10.15.1, 10.16, 10.16.1, 10.17]

Unit-II: Interference and Diffraction [20 h]

II.1: Introduction to Interference and Interference in Thin Films [6 h]

Superposition of waves, Interference, Coherence, Conditions for Interference, Techniques of obtaining Interference, Young's Double Slit Experiment, Phase Change on reflection: Stoke's law.

[Subhramanyam:Chapter.14: 14.3, 14.4, 14.4.2, 14.4.4, 14.6, 14.7, 14.8 and Singh Ref.2: Chapter6: 6.3]

Thin Film, Interference due to reflected and transmitted lights in thin films: Plane Parallel Film, Wedge-shaped Film, Newton's Rings, Types of fringes.

[Subhramanyam: Chapter.15: 15.1, 15.2, 15.2.1 - 15.2.5, 15.3, 15.4, 15.5, 15.5.1 - 15.5.4, 15.6, 15.6.1 - 15.6.9]

II.2: Interferometry [3 h]

Michelson's Interferometer: Principle, Construction, Working, Circular Fringes, Localised Fringes, White Light Fringes, Application of Michelson's Interferometer: Measurement of Wavelength and Determination of the difference in the wavelength of two waves.

[Subhramanyam; Chapter.15: 15.7, 15.7.1 - 15.7.5, 15.8, 15.8.1, 15.8.2]

II.3: Introduction to Diffraction and Fresnel Class Diffraction [5 h]

Difference between Interference and Diffraction, Types of diffraction: Fresnel Class and Fraunhoffer Class.

[Subhramanyam; Chapter.17: 17.6, 17.7 and Sing;: Chapter7: 7.5, 7.6]

Diffraction of Light (Fresnel Class): Division of cylindrical wave-front into Fresnel's half period strips, Diffraction at straight edge, Diffraction at a narrow wire.

[Singh: Chapter.7: 7.9, 7.10, 7.11]

II.4: Fraunhoffer Class Diffraction and Resolving Power of optical Instruments [6 h]

Diffraction at a single slit (Central maximum, Secondary maxima and Secondary minima), Diffraction at double slit, Distinction between single slit and double slit diffraction patterns, Missing orders in a double slit diffraction pattern, Diffraction at N slits(only conceptual), Determination of wavelength of a spectral line using Plane Transmission Grating. Resolving Power, Rayleigh's criterion, Resolving power of telescope and Resolving Power of Prism.

[Subhramanyam: Chapter.18: 18.2, 18.2.1, pg.431 to 433, 18.4, 18.4.1, 18.4.2, 18.4.3, 18.7, 18.7.1, 18.7.2, 18.7.6 and Chapter.19: 19.1, 19.2, 19.6, 19.7, 19.11]

Unit-III: Polarization [10 h]

III.1: Production and Analysis of Polarized lights [7 h]

Polarized Light, Natural Light, Production of Linearly Polarised Light, Anisotropic Crystal, Calcite Crystal, Huygens Theory of Double Refraction in Uniaxial crystal, Nicol prism- its fabrication, working and use, Types of Polarized Light, Retardation plates - Quarter wave plate and Half wave plate, Production of Elliptically and Circularly Polarized Lights, Detection of plane, circularly, elliptically polarized lights, Analysis of polarized light,

III.2: Polarimeter [3 h]

Optical activity, Specific rotation, Simple Polarimeter, Laurent's Half-Shade Polarimeter.

[Subhramanyam: Chapter.20: 20.3, 20.4, 20.5, 20.5.1 to 20.5.5, 20.7, 20.8, 20.8.1 to 20.8.3, 20.9, 20.9.1, 20.9.2, 20.6.1, 20.6.3, 20.15, 20.17.1, 20.17.2, 20.18, 20.18.1, 20.19, 20.19.1, 20.20, 20.24, 20.24.1, 20.25, 20.26]

Experiments: (Minimum six)

1) Cardinals points of Two lenses
2) Prism Spectrometer: Optical levelling, Angle of Prism
3) Dispersive power of prism
4) Newton's Rings
5) Wedge shaped air film
6) Single Slit Diffraction using LASER/Sodium source.
7) Diffraction Grating using LASER/Sodium source.
8) Malus's Law using LASER source.
9) Brewster's Law using LASER source.
10) Polarimeter (Demonstration)
11) Lloyd's Mirror/Biprism (Demonstration)
12) Cylindrical Obstacle (Demonstration)

References:

1. Subhramanyam N., Lal Brij, Avadhanulu M. N., A Text book of Optics, S. Chand & Company Ltd., New Delhi, Firstmulticolour Edition (2006).
2. Singh S. P. and Agarwal J. P., Optics, PragatiPrakashan, 8th Edition (2001).

Additional References:

1. Mathur B. K., Principles of Optics, New Global Printing Press, Kanpur.
2. GhatakAjoy, Optics, Tata McGraw-Hill Publicashing Company Ltd. (1977)
3. Jenkins F. A. and White H. E., Fundamentals of Optics, Tata McGraw-Hill Publishing Company Ltd., (1981)

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3. https://www.youtube.com/playlist?list=PL9jo2wQj1WCP2eeRb8UacmKJy850Y9DYQ
4. https://www.youtube.com/playlist?list=PLX2gX-ftPVXWA5TjEhVQSQQzZ-5_5Nui8
5. https://www.youtube.com/watch?v=htSPI7YHnP4&list=PLD707C7AF1A0BC358
6. https://www.youtube.com/watch?v=v1U38n52h9A&list=PLA435953DF9CC6BB9

Course Title : **Modern Physics**

Course Code : **PHY-E2**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Pre-requisite : **Nil**.

Course Objectives:

Modern Physics involves the study of radiation and matter at atomic levels and velocities close to the speed of light. This course will focus on the early development of the theory of atomic structure, wave particle duality, mass spectrographs, accelerators and Lasers. Lectures will help you clarify concepts of modern physics through various conceptual questions and problems.

Course Outcomes: At the end of this course students will be able to:

CO1 : have an understanding of constituents of an atom and atomic structure.
CO2 : discuss and interpret experiments that reveal the wave properties of matter.
CO3 : discuss and interpret experiments that reveal the particle properties of waves and wavelike properties of particle.
CO4: apply uncertainty principle to solve physics problems
CO5: understand the working of mass spectrographs and accelerators
CO6: understand the basic operating principle of the laser and the optical fiber.
Theory:

Unit I **[15 h]**

1. **Electrons, Nucleus and Atoms:** [4 h]
   Determination of e/m for cathode rays. Thomson's model of the atom and qualitative discussion of alpha scattering experiment. Rutherford's model of the atom. Determining upper limit to nuclear dimension. Electron orbits. Failure of Classical Physics.
   [Rajam: Pages 33-36, 44-50, Beiser: 5.1, 5.3, 5.5-5.7]

2. **Brief review of Atomic models:** [6 h]
   Atomic Spectra. Frank-Hertz experiment. The Bohr Atom: Quantization of energy. Bohr-Sommerfeld model. Nuclear motion and reduced mass. Bohr's Correspondence Principle.
   [**Beiser: 6.1, 6.3-6.8]**

3. **Particle Properties of waves:** [5 h]
   Concepts of Blackbody radiation.The Photoelectric effect.Compton Effect.Experimental verification of the Photoelectric effect.
   [Singh: 1.1-1.3, Beiser: 3.1,3.2, 3.5, Muregeshan: 8.5]

Unit II **[15 h]**

1. **De Broglie's Postulate - Wavelike properties of Particles:** [9 h]
   a. **Dual nature of matter:** Experiments with bullets, waves and electrons. The interference of electron waves. Watching the electrons.
   [Feynman: 1.1-1.6]
   b. Matter Waves: De Broglie's postulate. Davisson and Germer experiment. Electron diffraction experiment of G. P. Thomson. Review of the Bohr's postulate about stationary states in the light of De Broglie's concepts.
   [Eisberg: 3.1], [Singh: 2.8]
   c. Properties of Matter waves: Wave and group velocities. Relation between the group velocity and phase velocity. Velocity of De Broglie wave. Wave packet and its motion in one dimension.
   [Singh: 2.3-2.5, 2.9]

2. **Heisenberg's Uncertainty Principle:** [6 h]
   Uncertainty principle. Elementary proof of Heisenberg's uncertainty relation between position and momentum. Elementary proof of Heisenberg's uncertainty relation between energy and time. Illustration of Heisenberg's uncertainty principle with thought-experiments. Consequences of the uncertainty relation.

   [Singh: 3.1-3.5]

Unit III **[15 h]**

1. **Measurement of Mass and accelerators** [6 h]

   Measurement of Mass: Thomson's positive ray analysis, Dempster's Mass spectrometer, Bainbridge Mass spectrograph.

   Linear accelerator and Cyclotron.

   [**Rajam: pg. 227-233, 240-244, Muregeshan: 30.3, 30.4]**

2. **Lasers:** [9 h]
   Attenuation of light in an optical media. Thermal Equilibrium. Interaction of light with matter. Einstein's A and B coefficients and their relations. Population inversion. Principal pumping schemes. Ruby Laser, He-Ne Laser and Semiconductor laser. Applications of Laser.
   Optical fibres: Optical fibre, Total internal reflection, Propagation of light through optical fibre, Losses in optical fibre.
   [Subrahmanyam: 22.1-22.11,22.15, 22.16.1, 22.16.3, 22.7, 24.1-24.4, 24.15]

Experiments: (Minimum Six)

1. Determination of e/m of electrons using Thomson's method.
2. Measurement of k/e.
3. Measurement of diameter of Lycopodium powder.
4. To determine wavelength of Laser source by diffraction of single slit.
5. To determine wavelength of Laser source by diffraction of double slit.
6. Frank Hertz Experiment.
7. Photoelectric effect.
8. IV Characteristics of LASER
9. Optical fibre: Numerical aperture
10. Bending loss in optical fibre

References:

1. Beiser, A. 1969, *Perspectives of Modern Physics,* McGraw-Hill Book Company, Singapore.
2. Feynman, R. 2012, *Feynman Lectures on Physics: Quantum Mechanics (Volume - 3)*, Pearson Education, India.
3. Murugeshan, R 2009, *Modern Physics*, S. Chand and Company limited, New Delhi.
4. Rajam, J. 2000, *Atomic Physics*, S. Chand and Company limited, New Delhi.
5. Subrahmanyam, N., Lal, B. and Avadhanulu, M. 2004, *A Textbook of Optics*, S. Chand and Company limited, New Delhi.
6. Singh, K. And Singh, S. 2013, *Elements of Quantum Mechanics,* S. Chand, New Delhi.

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1. Ghatak 2012, *Optics,* Mcgraw Hill Education, India.
2. Richtmyer, F., Kennard, E., Cooper, J. 2001, *Introduction to Modern Physics*, 6th ed. McGraw-Hill Book Company, New Delhi.
3. Tipler, P. 2012, *Modern Physics*, WH Freeman, New York.

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1. https://hcverma.in/QuantumMechanics
2. https://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-solid-state-chemistry-fall-2010/
3. https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2016/
4. https://www.youtube.com/watch?v=VLU4dntonhE&list=PLLUpvzaZLf3LeHh3JgGDSfkLQX02BsDK1
5. https://phet.colorado.edu/en/simulations/category/physics

Course Title **: Oscillations, Waves and Sound**

Course Code **: PHY-E3**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Prerequisite **: Nil**

Course Objectives **:** Simple harmonic motion is one of the fundamental types of motion that exists in nature. The objective of this course is to cover the fundamental physical concepts of Simple harmonic motion, waves and sound.

Course Outcomes **:** After successful completion of this course, students will be able to
CO1 : Set up an equation of motion for simple harmonic motion and obtain its solution.
CO2 : Explain how superposition of waves leads to different Lissajous figures.
CO3 : Set and solve the equation of motion for damped and driven damped harmonic oscillators and analyse the nature of oscillations.
CO4: Understand the dependence of velocity of sound waves on various factors like temperature, pressure, density, humidity.
CO5: Solve problems for different cases of Doppler effect.

Theory:

UNIT – I: Undamped free oscillation **[15 h]**

1. **Undamped free oscillation** **[15 h]**

   Different type of equilibria (Stable, unstable and neutral equilibrium). Periodic oscillations and potential well.
   [Mathur: 5.9]

   Differential equation for simple harmonic oscillator and its solutions. Energy of the harmonic oscillator.
   [Taylor: 5.1-5.2]

   Examples of simple harmonic oscillations: spring and mass system, simple and compound pendulum, torsional pendulum, bifilar oscillations, Helmholtz resonator.
   [Mathur: 7.7.1-7.7.5]

   Superposition of two simple harmonic motions of the same frequency along the same line. Superposition of two mutually perpendicular simple harmonic vibrations of the same frequency. Superposition of two mutually perpendicular simple harmonic vibrations and having time periods in the ratio 1:2. Uses of Lissajous' figures.
   [Subrahmanyam: 2.1, 2.2, 2.4, 2.6, 2.9]

UNIT – II: Damped Oscillations and Driven Damped Oscillations **[15 h]**

1. **Damped Oscillations** **[5 h]**
   Introduction. Differential equation of damped harmonic oscillator and its solution, discussion of different cases (Strong, weak and Critical damping).Logarithmic decrement. Energy equation of damped oscillations. Power dissipation. Quality factor.

   [Taylor: 5.4 and Mathur: 8.2-8.4]

2. **Driven Damped Oscillations** **[5 h]**
   Introduction, Differential equation of forced oscillation and its solution (transient and steady state). Resonance. Width of the resonance; the Q factor. The phase at resonance. Velocity resonance.
   [Taylor: 5.5-5.6 and Mathur: 8.9]
3. **Coupled Oscillations** **[5 h]**
   Coupled oscillations. Normal Coordinates. Energy of coupled oscillations.

UNIT – III: Waves and Sound and Doppler Effect **[15 h]**

4. **Waves and Sound** **[10 h]**
   Transverse vibrations in strings. Velocity of longitudinal waves in gases. Newton's formula for velocity of sound. Velocity in a homogeneous medium. Laplace's correction. Kundt's tube-determination of velocity of sound in a gas and in solids. Intensity level and Bel and Decibel.

   Production and detection of Ultrasonic waves and its applications

   [Khanna 4.2, 5.3-5.5, 11.1, 11.3, 12.1-12.4, 19.6 and Subrah.: 11.23 11.25,11.27]

5. **Doppler Effect:** **[5 h]**
   Explanation of Doppler effect in sound. Observer in rest and source in motion. Source at rest and observer in motion. When both source and observer are in motion. Effect of wind velocity. Doppler effect in light. Applications of Doppler effect.
   [Subrahmanyam: 8.1-8.6]

Experiments: (Minimum Six)

1. To determine the equivalent length of the Kater's pendulum and the acceleration due to gravity using a resonance pendulum.
2. To determine the damping constant using Damped harmonic oscillator
3. To determine the velocity of Sound using Helmholtz resonator
4. To determine the value of acceleration due to gravity using a bar pendulum.
5. To determine the frequency of AC mains using Sonometer.

6. Bifilar suspension: Dependence of the time period on the geometry of non-parallel bifilar suspension.
7. Log Decrement.
8. Velocity of Sound using CRO.
9. Lissajous Figures (Demonstration).

References:

1. Khanna, D. and Bedi, R. 1992, *A Textbook of Sound*, Atma Ram and sons, Delhi.
2. Mathur, D. 2012, *Mechanics*, S. Chand, New Delhi.
3. Taylor, J. 2005, *Classical Mechanics,* University Science Books, USA
4. Subrahmanyam, N. and Lal, B. 1994, Waves and Oscillation, Vikas Publishing House, Noida

Additional References:

1. French, AP 2003, Vibration and Waves, CBS Publisher, India.
2. Halliday, D., Resnick, R. and Walker, J. 2003, Fundamentals of Physics, 6th edition, John Wiley and Sons, USA.
3. Pain, J. 2005, *The Physics of Vibration and Waves,* 6th Edition, Wiley.

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2. https://nptel.ac.in/courses/115/106/115106090/
3. https://ocw.mit.edu/courses/physics/8-03sc-physics-iii-vibrations-and-waves-fall-2016/part-i-mechanical-vibrations-and-waves/
4. http://galileo.phys.virginia.edu/classes/152.mf1i.spring02/OscWavesIndex.htm
5. http://www.qrg.northwestern.edu/projects/vss/docs/communications/3-what-is-the-doppler-effect.html

Course Title : **Introduction to Astronomy and Astrophysics**

Course Code : **PHY-E17**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Course Objectives : The course aims to introduce the students to the Exciting World of Extra-galactic Universe.

Course Outcomes : At the end of the course, students will be able:

CO1 : Understand the various Extra-galactic objects.
CO2 : Understand the construction, working and mounting of modern telescopes.
CO3 : Understand co-ordinate system of Celestial Objects.
CO4 : Understand types of stars and their life cycle.
Theory:

UNIT I: Fundamentals of Astronomy and Astronomical Instruments [20 h]

1. **Fundamentals of Astronomy: [10 h]**

Introduction: Components of the Universe; Stars, Planets, Asteroids, Meteors, Comets, Galaxies. Solar System: Age, Origin Basic measurements: Planetary orbits, distances, physical size, mass, density, temperature, rotation period determination, Kepler's laws, black body radiation and curves, Doppler effect.

[Ref#1: chapter1: 1.1-1.5, chapter 3: 3.1- 3.4]

2. **Astronomical Instruments: [10 h]**

Optical telescopes, mounts, light gathering power, magnification, resolution. Spectroscopes, CCD camera, photometer, filters Radio telescopes, interferometry UV, IR, X-ray and Gamma ray telescopes. Modern telescopes: HST, Chandra.

[Ref#1: chapter19: 19.1-19.5, chapter20: 20.1-20.5]

UNIT II: Star and Star Systems and Galaxies, Dark Matter and Dark Energy [15 h]

3. **Star and Star Systems [8 h]**

Stars life cycle, Neutron stars, black holes, white dwarf, Chandrasekhar limit. Spectral classification of stars, O,B,A,F,G,K,M. Sytem of stars: Binaries / Cepheids / RR Lyrae, HR diagram, sun and solar system.

[Ref#1: chapter5: 5.1-5.7, chapter12:12.3, 12.4]

4. Galaxies, Dark Matter and Dark Energy **[7 h]**

Galaxies, classification of galaxies, Hubble's tuning fork diagram, Open and Globular clusters,

ISM.

[Ref#1: chapter16: 16.4, chapter 17:17.1-17.4]

UNIT III: Observational Astronomy **[10 h]**

5. Observational Astronomy **[10 h]**

Co-ordinate system, Celestial hemisphere, Concept of time, Magnitudes: apparent and absolute, constellations. Star dial, Observation of Sun, Eclipses, Moon, planets, meteor showers, transits, occultation's.

[Ref#1: chapter2; 2.1-2., Ref#2; chapter1: 1.1-1.4]

Experiments: (Minimum six)

1. Resolving power of telescope.
2. Study of scattering of light (Diameter of Lycopodium powder).
3. Study of Diffraction using plane grating.
4. To find radius of curvature of a convex lens using optical lever.
5. Measurement of the solar constant.
6. To obtain proper motion of Barnard's star using Aladin.
7. Draw constellation map of a) Orion b) Auriga c) Taurus d) Ursa Major (Big Dipper) marking of pole star.
8. To determine the elements in sun using Fraunhofer spectra.
9. To estimate Astronomical Unit using Venus transit data by parallax method.
10. Data analysis technique using virtual observatory.
11. Determine the period of revolution of sun using virtual laboratory.

References:

1. Abhyankar K.D., 2001, *Astrophysics - Stars and Galaxies*, Tata McGraw Hill Pub.
2. Shu F., 1981, *Physical Universe-An Introduction to Astronomy*,University Science Books, U.S.

Additional References:

1. Roy A.E. and Clarke D., 1989, *Astronomy structure of the Universe*, Adam Hilger Pub.
2. Glasstone S., 1965, *Source book on theSpace Sciences*, Van Nostrand Reinhold Inc.,U.S
3. Bhatia V. B., 2001, *Textbook of Astronomy and Astrophysics with Elements of Cosmology*, Narosa Pub.
4. Narlikar J.V.,1976, *Structure of the Universe*, Oxford Paperbacks.
5. Badyanath and Basu., 2010, *An Introduction to Astrophysics*, 2nd Edition, Prentice Hall India Learning Private Limited

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1. https://nptel.ac.in/courses/115105046/
2. http://academics.smcvt.edu/abrizard/astronomy/Astronomy_Notes.pdf
3. https://ocw.mit.edu/courses/physics/8-282j-introduction-to-astronomy-spring-2006/
4. http://spiff.rit.edu/classes/phys445/phys445.html
5. https://science.nasa.gov/astrophysics/focus-areas/what-are-galaxies

Course Title : **Instrumentation**

Course Code : **PHY-E8**

Marks : **75 (Theory) + 25 (Practical)**

Credit : **3 (Theory) + 1(Practical)**

Pre-requisite : **Nil**

Course Objectives : The objective of this course is to understand basic concepts related to the various types of measuring instruments and measuring techniques.

Course Outcomes : At the end of the course, students will be able to:

CO1 : Understand basic concepts related to the various types of measuring instruments and measuring techniques.
CO2 : Comprehend basic principles involved in measuring instruments like Ammeter, Voltmeter, Ohmmeter and Multimeters.
CO3 : Understand working and use of CROs and Signal Generators
CO4 : Understand working and usage of the various types of transducers.

Theory:

Unit-I: Indicators, Display Devices and Signal Generator **[10 h]**

I.1: Fundamentals of Measurement [4 h]
Introduction, Performance Characteristics, Static Characteristics, Errors in Measurements, Types of Static Error, Sources of Error, Dynamic Characteristics, Standard, Electrical Standards.
[Kalsi: Chapter 1.2 to 1.7, 1.9, 1.10]

I.2: Indicators and Display Devices [4 h]
Types of Instrument, Basic Meter Movement: PMMC Movement and Practical PMMC Movement, Classification of Displays, Use of LED and LCD as Display Devices, Segmental Displays using LEDs.
[Kalsi: Chapter 2.1, 2.2, 2.8, 2.10, 2.11, 2.12.3]

I.3. Signal Generator: [2 h]
Standard Signal Generator, AF Sine and Square Wave Generator, Function Generator.
[Kalsi: Chapter 8.4, 8.5, 8.7, 8.8]

Unit- II: Measuring Devices **[20 h]**

II.1: Measuring Instruments [14 h]
DC Ammeter, Multirange Ammeter, Universal Shunt, Requirements of a Shunt, Extending of Ammeter Ranges. Basic Meter as a DC Voltmeter, DC Voltmeter, Multirange Voltmeter, Extending Voltmeter Ranges, Loading, Transistor Voltmeter(TVM), FET DC Voltmeter. AC Voltmeter using Rectifiers, Multirange AC Voltmeter, AC current measurements using AC Voltmeter and a series Resistor. Ohmmeter: Series type and Shunt type, Multimeter.

Digital voltmeter: Ramp Technique, Digital Multimeters and Frequency meter (with help of Block Diagrams), Q meter.
[Kalsi: Chapter 3.1 to 3.5, 4.2 to 4.7,4.12to 4.15, 4.21, 4.22, 4.25, 5.2, 6.2,6.3,10.7 and Mottershead: Chapter 22: 22-9]

II.2: Oscilloscope [6 h]
Basic Principle, Block Diagram of Oscilloscope, Simple CRO, Vertical Amplifier, Horizontal Deflecting System, sweep generator, Delay line.
[Kalsi: Chapter 7.2.1, 7.4, 7.5, 7.5.1, 7.6, 7.7.1, 7.10]

Unit-III: Introduction to Transducers and its applications [15 h]

III.1: Transducers [15 h]
Introduction, Electrical Transducer, Selecting a Transducer, Strain Gauges, Resistance Wire Gauge, Types of Strain Gauges(Wire), Foil Strain Gauge, Semiconductor Strain Gauge, Inductive Transducer, Differential Output Transducers, Linear Variable Differential Transducers (LVDT), Capacitive Transducer, Piezo-Electric Transducer, Semiconductor Diode Temperature Sensor, Temperature Transducers: Resistance Temperature Detectors, Thermistors, Thermocouples.
[Theraja: Chapter 36.1 to 36.3, 36.12 to 36.15] [Kalsi: Chapter 13.1 to 13.3, 13.6, 13.6.1 to 13.6.4, 13.9,13.9.1, 13.9.2, 13.10, 13.11,13.13, 13.15, 13.20.7]

Experiments: **(Minimum six)**

1. Use of CRO and Function Generator (AC/DC voltage measurement, frequency measurement).
2. To measure displacement (linear and angular) using potentiometer/variable inductor/variable capacitor.
3. Construction and design of analog two ranges Voltmeter.
4. Construction and design of analog two ranges Ohmmeter.
5. Crystal Oscillator: Determination of velocity of ultrasonic waves in a liquid medium.
6. Study of strain Gauges
7. Study of LVDT (including calibration) and its use in any one application.
8. Calibration of Thermocouple
9. Thermistor as a temperature sensor.
10. Application of Pt 100 as a temperature sensor.

References:

1. Kalsi H S, Electronics Instrumentation, Tata McGraw Hill Education Pvt. Ltd. New Delhi, 3rd Edition (2010).
2. Mottershead Allen, Electronics Devices and Circuits An Introduction, Prentice-Hall of India Pvt. Ltd., New Delhi, 23rd Printing, (2000).
3. Theraja B. L., Basic Electronics (Solid State), S. Chand and Company Ltd., New Delhi, 1stMulticolour Edition (2005).

Additional References:

1. Boylestad Robert and Nashelsky Louis, Electronic Devices and Circuit Theory, Prentice-Hall of India Pvt. Ltd., New Delhi, 6th Edition (2000).

Web References:

1. https://www.jameco.com/Jameco/workshop/TechTip/working-with-seven-segment-displays.html
2. https://electronics-diy.com/Function_Generator_XR2206.php
3. https://www.electronics-tutorials.ws/io/io_1.html
4. https://www.elprocus.com/cro-cathode-ray-oscilloscope-working-and-application/
5. https://www.google.com/amp/s/analyseameter.com/2015/09/digital-multimeter-dmm-working-principle.html/amp

Course Title : **Electromagnetic Theory – II**

Course Code : **PHY-V.C-7**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Pre-requisite : **Electromagnetic Theory – I (PHY-III.C-5)**

Course Objectives : To acquaint students with fundamental principles of Magnetostatics part of the Electromagnetic Theory.

Course Outcomes : At the end of this course, students would be able to:

CO1 : Calculate magnetic field induction using Biot-Savart's law and Ampere's law.

CO2 : Interpret bound currents and calculate magnetic fields in matter.

CO3 : Comprehend microscopic theory magnetism.

CO4 : Establish the link between electrostatics and magnetostatics using Maxwell's equations.

CO5: Develop the wave equation for propagation of electromagnetic waves through material media and vacuum at different angles of incidence.

Theory:

UNIT – I: Magnetostatics **[15 h]**

1. Magnetostatics **[15 h]**

Lorentz force law: Magnetic fields, Magnetic forces, Currents, Biot-Savart law: Steady currents, Magnetic fields of a steady current, Divergence and Curl of **B**: Straight-line currents, divergence and curl of **B**, applications of Ampere's law, comparison of magnetostatics and electrostatics, Magnetic vector Potential: Vector potential, magnetostatic boundary conditions, multipole expansion of the vector potential.

[Griffiths: 5.1: 5.1.1 – 5.1.3, 5.2: 5.2.1 – 5.2.2, 5.3: 5.3.1 – 5.3.4, 5.4: 5.4.1 – 5.4.3]

UNIT II: Magnetic Fiels in Matter and Microscopic Theory of Magnetism **[15 h]**

2. Magnetic Fields in Matter **[11 h]**

Magnetization: Diamagnets, paramagnets and ferromagnets, torques and forces on magnetic dipoles, effect of a magnetic field on atomic orbits, magnetization, the field of a magnetized object: Bound currents, physical interpretation of bound currents, magnetic field inside matter, The auxiliary field H: Ampere's law in magnetized materials, a deceptive parallel, boundary conditions, Linear and nonlinear media: Magnetic susceptibility and permeability, Energy in magnetic fields.

[Griffiths: 6.1: 6.1.1 – 6.1.4, 6.2: 6.2.1 – 6.2.3, 6.3: 6.3.1 – 6.3.3, 6.4: 6.4.1 – 6.4.2, 7.2.4]

3. Microscopic Theory of Magnetism **[4 h]**

Molecular field inside matter, origin of diamagnetism, origin of paramagnetism, theory of ferromagnetism, ferromagnetic domains, ferrites

[Reitz: 10.1 – 10.2]

UNIT III: Maxwell's Equations and Propagation of Electromagnetic Waves **[15 h]**

4. Maxwell's Equations **[5 h]**

Generalization of Ampere's law, displacement current, Maxwell's equations and their empirical basis, electromagnetic energy, Poynting theorem.

[Reitz: 16.1 – 16.3]

5. Propagation of Electromagnetic Waves **[10 h]**

The wave equation, plane monochromatic waves in non-conducting media, polarization, plane monochromatic waves in conducting media, reflection and refraction at the boundary of two non-conducting media: normal incidence and oblique incidence, Brewster's angle, critical angle.

[Reitz: 16.4, 17.1, 17.2, 17.4, 18.1, 18.2]

Experiments: (Minimum Six)

1. Hysteresis by magnetometer.
2. B-H curve in a hard magnetic material and in a soft ferrite.
3. Core losses and copper losses in a transformer.
4. Measurement of mutual inductance using ballistic galvanometer.
5. Calibration of lock-in-amplifier and determination of mutual inductance.
6. Determination of magnetic susceptibility of $FeCl_3$ by Quincke's method.
7. M/C using ballistic galvanometer
8. Helmholtz coils.

References:

1. Griffiths D. J., 2011, *Introduction to Electrodynamics,*3rd Ed. , Prentice Hall of India.

2. Reitz J. R., Milford F. J., Christy R. W., 1979, *Foundations of Electromagnetic Theory*,3rd Ed., Addison-Wesley Publishing Company.

Additional Reference:

Mukherji U., 2008, *Electromagnetic Field Theory and Wave Propagation*, Narosa Publishing House.

Web References:

1. https://nptel.ac.in/courses/115101005/
2. https://swayam.gov.in/nd1_noc19_ph08/preview
3. https://ocw.mit.edu/courses/physics/8-07-electromagnetism-ii-fall-2012/lecture-notes/
4. https://www.feynmanlectures.caltech.edu/II_toc.html
5. http://galileo.phys.virginia.edu/classes/109N/more_stuff/Maxwell_Eq.html

Course Title **: Solid State Physics**

Course Code **: PHY-E9**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Pre-requisites **: Quantum Mechanics (PHY-IV.C-6)**

Course Objective: This course deals with crystalline solids and is intended to provide students with basic physical concepts and mathematical tools used to describe solids. The course broadly deals with the topics related to structural aspects and the various physical properties of crystalline solids.

Course Outcomes: After completion of this course, students will be able to
CO1: Identify bonding types in crystalline solids and correlate the nature of bonding of solid to some of the physical properties associated with it.
CO2: Identify different crystal systems and determine structural parameters like unit cell of crystal lattices, translation vectors, atomic packing, crystal planes and directions with help of Miller Indices.
CO3: Derive and apply Bragg's law to determine crystal structure.
CO4: Derive and apply classical free electron theory of metals to study electrical conductivity
CO5: Derive and apply density of energy states to estimate density of free electrons, Fermi energy and mean energy of electron gas at absolute zero
CO6: Derive and apply Fermi Free electron gas model in 3 dimensions to study electrical properties of metals.
CO7: Apply Kronig-Penney Model and Bloch theory to interpret energy band structures in solids, in particular knowing effective mass and E v/s k relationship.
CO8: Differentiate materials with respect to their magnetic properties.
CO9: Apply the knowledge gained to solve problems in solid state physics using relevant mathematical tools.

Theory:

Unit-I Bonding in Solids and Crystal Structures **[20 h]**

I.1: Bonding in Solids [5h]

Introduction, Bonding in Solids, Cohesive energy, Ionic bonding, Calculation of Cohesive energy of ionic solids, Covalent bonding, Metallic bonding, Hydrogen bonding, Van der Waals (Molecular) bonding.

[Pillai: Ch-3.I – 3.IX, 3.XII – 3.XXIV]

I.2: Crystal Structure [11h]

Introduction, Space Lattice, Unit cell, Lattice Parameter of unit cell, Bravais lattices, Crystal Symmetry, Stacking sequences in metallic crystal structure, SC, BCC, FCC and HCP structures, Crystal structures- NaCl, diamond, CsCl, ZnS, Directions in crystals, Planes in crystals- Miller indices, Distances of Separation between Successive (*hkl*) Planes.

[Pillai: Ch-4.I – 4.VIII, 4.XIV – 4.XXII]

I.3: Diffraction of X-rays by Crystals [4h]

Introduction, Bragg's law, Bragg's X-ray Spectrometer, Powder Crystal method (Debye Scherrer method), Rotating Crystal method.

[Pillai: Ch-5.VII – 5.XI]

Unit-II Electrical Properties of Metals [20 h]

Introduction, Classical Theory of Electric Conduction, Drawbacks of Classical theory, Revision of particle in a rectangular three-dimensional box, Fermi-Dirac Statistics and Electronic distribution in Solids, Fermi distribution function, Density of energy states and Fermi energy, Mean energy of electron gas at absolute zero, Electrical conductivity from Quantum mechanical consideration, Sources of electrical resistance in metals, Thermal conductivity in metals, Joule's law, Thermionic emission, Failure of Sommerfeld's free electron model, Band theory of Solids, Brillouin Zones, Motion of electrons in one-dimensional periodic potential, Distinction between metals, insulators and semiconductors.

[Pillai: Ch-6.II – IV, 6.XIV – 6.XVIII, 6.XX – 6.XXII, 6.XXV, 6.XXIX, 6.XXXI, 6.XXXV – 6.XXXXI]

Unit-III Magnetic Materials and Magnetic Properties [5 h]

Introduction, Classification of magnetic materials, The quantum numbers, Origin of magnetic moment, Ferromagnetism, Ferromagnetic domains, Hysteresis, Hard and soft materials.

[Palanisamy: 8.1, 8.2, 8.3, 8.4, 8.7, 8.7.3, 8.7.5, 8.7.6]

Experiments: (Minimum Six)

1. Energy band gap of a semiconductor using a diode.
2. Energy band gap of a semiconductor using LEDs
3. Energy band gap of a thermistor.
4. To determine value of Planck's constant using LEDs of at least 4 different colours.
5. Fermi energy of Copper
6. Measurement of Hysteresis loss using CRO
7. Calculation of lattice constant by of Copper – X-ray diffraction pattern is given and student calculates: d-spacing, miller indices and lattice constant.
8. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four-probe method (room temperature to 150 °C) and to determine its band gap
9. Investigating crystal structure using Vesta software.

References:

1. Pillai S. O., 2018, *Solid State Physics,* 8th Multi Colour Edition, New Age International Publisher.
2. Palanisamy P. K., 2004, *Solid State Physics*, Scitech Publications (India) Pvt. Ltd.

Additional References:

1. Kittel C., 2004*, Introduction to Solid State Physics*, 8th Edition,John Wiley and Sons.
2. Dekker A. J., 1998, *Solid State Physics*, Macmillan India Ltd. Publisher.

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1. https://www.youtube.com/watch?v=RImqF8z91fU&list=PLtTPtV8SRcxi91n9Mni2xcQX4KhjX91xp
2. https://www.classcentral.com/course/swayam-introduction-to-solid-state-physics-13045
3. https://www.classcentral.com/course/swayam-solid-state-physics-14298
4. https://www.youtube.com/playlist?list=PLaNkJORnlhZnC6E3z1-i7WERkferhQDzq
5. https://www.youtube.com/playlist?list=PL0jxQTuSuktJd7Gbelcg9R0f3oYYeMbRs

Course Title : **Thermodynamics and Statistical Mechanics**

Course Code : **PHY-E10**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Pre-requisite : **Heat and Thermodynamics (PHY-II.C-3)**

Course Objectives : This course will introduce kinetic theory, classical thermodynamics, probability and statistical methods.

Learning Outcome : After completion of this course, students will be able to:
CO1 : Understand basics of kinetic theory of gases and thermodynamic potentials.
CO2 : Understand Maxwell-Boltzmann, Fermi-Dirac, and Bose-Einstein statistics and its application to the classical gas, electrons in a metal and blackbody radiation
CO3 : Understand the specific heat of solids by invoking statistical mechanics.

Theory

Unit 1 : Kinetic theory of Gases and Thermodynamic Potentials. **[15 h]**

1. **Kinetic theory of Gases:** [9 h]
   Basic assumptions, Equation of State of an Ideal Gas, Collisions with a moving wall, the principle of equi-partition of energy, classical theory of specific heat capacity, specific heat capacity of a solid.
   [Sears and Salinger: 9.1, 9.2, 9.4 – 9.8]

2. **Thermodynamic Potentials** [6 h]
   The Helmholtz function and Gibbs function, Thermodynamic Potentials, Maxwell Relations.
   [Sears and Salinger: 7.1-7.3]

Unit 2: Statistical Thermodynamics and Quantum Statistics **[20 h]**

1. **Statistical Thermodynamics** [10 h]
   Phase space, Probability of distribution, The most probable distribution, Maxwell Boltzmann Statistics. Molecular speeds: mean, most probable and r. m. s. speeds. Experimental verification of Maxwell Boltzmann statistics.
   [Beiser: 15.1 – 15.5]

2. **Quantum Statistics** [10 h]

   Bose Einstein statistics, Blackbody Radiation, Rayleigh Jeans formula, Plank radiation formula, Fermi Dirac statistics.
   [Beiser: 16.1 – 16.6]

Unit III : Specific Heats of Solids **[10 h]**

1. **Lattice Vibrations and Specific Heats of Solids** [10 h]
   Thermal Vibrations: Frequencies. Thermal Vibrations: Amplitudes. Normal Modes of a Lattice. Phonons. Specific Heats of Solids. The Einstein's theory. The Debye Theory. Fermi energy, Electron energy distribution.
   [Beiser: 19.1 – 19.7, Kachhava: 2.5, 2.6. 2.13]

Experiments: (Minimum Six)

1. Specific heat of Graphite
2. Study the temperature dependence of resistivity.
3. OPAMP as a bridge amplifier and its application in temperature measurement.
4. Determination of Boltzmann constant.
5. Study of Stefan's Law.
6. Determination of Stefan's constant
7. Thermal conductivity of poor conductor by LEE's method.
8. Tutorial on Maxwell Equation and Free energy
9. Tutorial on Statistical Thermodynamics
10. Tutorial on Statistical Thermodynamics

References:

1. Beiser A., 1995, *Perspectives of modern physics*, 5th edition, McGraw hill.
2. Sears F. and Salinger G., 1998, *Thermodynamics, Kinetic Theory and Statistical Thermodynamics*, 3^{rd} Edition, Narosa.
3. Kachhava C. M., 2003, *Solid State Physics Solid State Devices and electronics*, New Age International (P) Limited.

Additional References:

1. Garg S., Bansal R.and Ghosh C., 1993, *Thermal Physics*, Tata McGraw Hill.
2. Zemansky M. and Ditman R., 1997, Heat *and Thermodynamics*, McGraw Hill.
3. Reif F., 1965, *Fundamentals of Statistical and Thermal Physics*, Mc Graw Hill
4. Brijlal, Subrahmanyam N., 2008, *Heat thermodynamics and Statistical Physics*, S Chand Company Ltd.
5. Laud B., 2003, *Introduction to Statistical Mechanics*, New Age International.
6. Saha M. and Shrivastava B., 1965, *Treatise on heat*, The Indian Press.

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1. https://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring-2008/
2. https://nptel.ac.in/courses/113106039/
3. https://www.youtube.com/watch?v=ef54OnrZBg4&list=PLclocfvsabE1j2OcBdWfVhzNJNnbQ3YM7
4. https://aptv.org/Education/khan/topic.php?topic=thermodynamics
5. https://www.youtube.com/watch?v=Th-LQz5bBJA

Course Title **: Electronics-II**

Course Code **: PHY-E11**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Pre-requisite **: Electronics-I (PHY-E5)**

Course Objectives **:** This course aims at introducing students to analog and digital circuits.

Course Outcomes **:** At the end of this course, students will be able to:
CO1 : Analyse AC circuits and apply the techniques in designing circuits.
CO2: Generate different kinds of waves using OP-Amp
CO3: Understand the basic concepts of 555 timer.
CO4: Develop the ideas of monolithic linear regulators and understand different types of voltage regulators in LM series
CO5: Apply binary operations to different digital circuits
CO6: Understand the clocked digital electronics and its applications in different types of counters

Theory

UNIT – I : [15 h]

1. **AC Models (BJT)** **[4 h]**
   Base-Biased amplifier, Emitter-Biased amplifier, Small signal operation, analyzing an amplifier.
   [Ref.# 1 Article 9.1 to 9.7]

2. **Transistor Multivibrators** **[4 h]**
   Transistor as a switch, switching times, Multivibrators – Astable, Monostable, Bistable and Schmitt Trigger.
   [Ref.# 3 Article 18.1 to 18.5]

3. **FET's and MOSFET's** **[7 h]**
   Basic structure of the JFET, Principles of operation, Characteristic curves and parameters, Common source amplifiers, Common gate amplifier,
   MOSFET: Depletion Mode and Enhancement mode, Dual-Gate MOSFET.
   FET Phase shift oscillator, FET as VVR and its applications in Attenuator, AGC and Voltmeter circuits.
   [Ref.# 1 Article 13.1 to 13.9, 14.1 to 14.5]

UNIT – II: [15 h]

4. **OPAMP Applications** **[5 h]**
   Active diode circuits, Comparator, Window comparator, Schmitt Trigger, Waveform generator –Square wave, Triangular and Ramp Generator and monostable.
   [Ref. #1 Article 22.7, 22.8]

5. **Timers** **[5 h]**
   The 555 Timer, Basic concept, 555 block diagram, Monostable, Astable, Bistable, Schmitt Trigger and Voltage controlled oscillator (VCO) using 555 timer.
   [Ref.# 1 Article 23.7, 23.8]

6. **Monolithic Linear Regulators** **[5 h]**
   Basic type of IC regulator, Load and line regulation,LM7800 series, Current Boosters, LM -317 or LM7812 as a voltage regulator.
   [Ref#4 24.4,24.5]

UNIT – III [15 h]

7. **Digital Circuits** **[7 h]**
   Binary number system, Binary to Decimal and Decimal to Binary conversion, Basic logic gates, AND, OR, NOT(realization using Diodes and Transistor), NAND, NOR as universal building blocks in logic circuits, EX-OR and Ex-NOR gates.
   Boolean Algebra:De Morgan's Law's, Boolean Laws, NAND and NOR gates, Sum of Products methods and Product of Sum methods of representation of logical functions.
   Half adder and Full adder,
   Data Processing Circuits: Multiplexer and Demultiplexer, Encoders and decoders.
   [Ref. # 2 Article5.1 to 5.8.1, 6.1, and 6.2]

8. **Sequential Circuits** **[8 h]**
   Basic RS FF, Clocked RS FF, JK FF, D-type and T-type FF, Master Slave Concept.
   Shift Registers:Serial-in-Serial-Out, Serial-in-Parallel-out, Parallel-in-Serial-out, Parallel-in-Parallel-out Shift registers (upto 4 bits)
   Counters:Applications of FF's in counters, binary ripple counter, Modulus of counter (3,5) BCD Decade Counter, Cascade BCD Decade counters.
   [Ref.# 2 Article7.1 to7.9, 8.1, 8.2, 8.4]

Experiments (Minimum Six):

1. Astable Multivibrator
2. Monostable Multivibrator
3. Bistable Multivibrator
4. Schmitt Trigger
5. F.E.T Characteristics

6. IC LM 317 Voltage Regulator
7. IC 555 Timer as Astable Multivibrator and its use as Voltage Controlled Oscillator
8. IC 555 Timer as Monostable Multivibrator
9. Digital Multiplexer
10. Verification of De Morgan's Theorems and Boolean Identities
11. NAND and NOR Gates as Universal Building Blocks
12. Binary Addition –Half Adder and Full Adder Using Gates
13. JFET as a common source amplifier.

References :

1. Malvino A.,1996, *Electronic Principles*, 5th edition,Tata McGraw Hill.
2. Jain R. P. 2003, *Digital Electronics*, 3rd edition, Tata McGraw Hill.
3. Mottershed A. 1997, *Electronics Devices and Circuits an Introduction*, PHI
4. Malvino A. and Bates D.J., 2007, *Electronic Principles*, 7th edition, Tata McGraw Hill

Additional References:

1. Malvino A. and Leach D. 1986, *Digital Principles and Applications,*4th edition Tata McGraw Hill.
2. Millman J. and Halkias C., 1972, *Integrated Electronics*, Tata McGraw Hill.
3. Millman J. and Halkais C., 1967, *Electronic Devices and Circuits,* Mc Graw Hill.
4. Mehta V.K., 2003, *Principles of Electronics,* 8th edition, S. Chand & Company.

Web References:

1. https://nptel.ac.in/courses/117/107/117107094/
2. https://www.electronics-tutorials.ws
3. https://www.electronicshub.org/
4. https://nptel.ac.in/courses/108/105/108105132/
5. https://www.khanacademy.org/science/electrical-engineering

Course Title : **Mathematical Physics**

Course Code : **PHY-E12**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Pre-requisite : **Introduction to Mathematical Physics (PHY-I.C-1)**

Course Objectives : To acquaint students with mathematical skills which are required to study various concepts of Physics.

Course Outcomes : At the end of this course, students will be able to:
CO1 : Comprehend the functions of complex variables.
CO2 : Apply mathematical techniques such as: calculus of residues to evaluate definite integrals.
CO3: Apply solutions of Legendre, Bessel and Hermite equations, Fourier transforms of different functions in solving various Physics problems.
CO3 : Able to solve higher order problems in Physics**.**

Theory:

UNIT I: Functions of a Complex Variables and Calculus of Residues [15 h]

1. Functions of a Complex Variables [8 h]

Introduction, complex variables and representations: algebraic operations, Argand diagram: vector representation, complex conjugate, Euler's formula, De Moivre's theorem, the n^{th} root or power of a complex number, analytic functions of a complex variable: the derivative of f(z) and analyticity, harmonic functions, contour integrals, Cauchy's integral theorem, Cauchy's integral formula.
[Harper: 3.1, 3.2: 3.2.1 – 3.2.6, 3.3: 3.3.1 – 3.3.5]

2. Calculus of Residues [7 h]

Zeroes, isolated singular points, evaluation of residues: m^{th} order pole, simple pole, the Cauchy residue theorem, the Cauchy principal value, evaluation of some definite integrals.
[Harper: 4.1 – 4.3: 4.3.1 – 4.3.2, 4.4 – 4.6: 4.6.1-4.6.4]

UNIT II: Partial Differential Equations and Special Functions of Mathematical Physics [15 h]

3. Partial Differential Equations and Special Functions of Mathematical Physics [15 h]

Introduction,Some important partial differential equations in physics, an illustration of the method of direct integration, method of seperation of variables, the Hermite polynomials: basic equations of motion in mechanics, one-dimensional linear harmonic oscillator, solution of Hermite's differential equation, Legendre and associate Legendre polynomials: spherical harmonics, the azimuthal equation, Legendre polynomials, Bessel function: introduction:

solution of Bessel's equation, analysis of various solutions of Bessel's equation, characteristics of Bessel functions.

[Harper: 6.1 – 6.5: 6.5.1 – 6.5.3, 6.5.8]

UNIT III: Fourier Series and Fourier Transforms [15 h]

4. Fourier Series [7 h]

Introduction: The Fourier cosine and sine series, change of interval, Fourier integral, complex form of Fourier series, generalized Fourier series and Dirac-delta function, summation of the Fourier series.

[Harper: 7.1 – 7.3]

5. Fourier Transforms [8 h]

Introduction, theory of Fourier transforms: formal development of the complex Fourier transform, cosine and sine transforms, multiple-dimensional Fourier transforms, the transforms of derivatives, the convolution theorem, Parseval's relation, the wave packet in quantum mechanics: origin of the problem - quantization of energy, the development of a new quantum theory, a wave equation for particles - the wave packet.

[Harper: 8.1 – 8.3]

Experiments: (Minimum Six)

1. Generating and plotting Legendre Polynomials.
2. Generating and plotting Bessel function.
3. Generating and plotting Hermite Polynomials.
4. Using spherical polar co-ordinates obtain an expression for divergence and curl of a vector function, operate gradient and Laplacean operator on a scalar function.
5. Using cylindrical co-ordinates obtain an expression for divergence and curl of a vector function, operate gradient and Laplacean operator on a scalar function.
6. Fourier series: programme to sum:$\sum_{n=1}^{\infty}(0.2)^n$, and to evaluate Fourier co-efficients of a given periodic functions.
7. Compute the n^{th} roots of unity for n = 2, 3, and 4.

References:

1. Harper, C., 1993, *Introduction to Mathematical Physics,* 5th Ed., Prentice Hall of India,.
2. Arfken G., 2005, *Mathematical Methods for Physicists*, Elsevier.
3. Spiegel, M.R., 2004, *Fourier Analysis*, Tata McGraw-Hill.

Additional References:

1. Riley K. F., Hobson M. P., Bence S. J., 1998, *Mathematical Methods for Physics and Engineering,* Cambridge University Press
2. Boas M. L., 2013, *Mathematical Methods in Physical Sciences,* John Wiley and Sons, 3rd Ed.
3. Lipschutz S., 1974, *Schaum Outline of Theory and Problems of Complex Variables*, Mc Graw Hill.

Web References:

1. https://nptel.ac.in/courses/115106086/
2. https://www.maths.ed.ac.uk/~jmf/Teaching/MT3/ComplexAnalysis.pdf
3. https://www-thphys.physics.ox.ac.uk/people/FrancescoHautmann/ComplexVariable/s1_12_sl8.pdf
4. https://nptel.ac.in/courses/111/106/111106100/
5. https://nptel.ac.in/courses/115/105/115105097/

Course Title : **Solid State Devices**

Course Code : **PHY-E6**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1(Practical)**

Pre-requisite : **Nil**

Course Objectives : The objectives are to provide a clear explanation of the operation of most commonly used solid state devices.

Course Outcomes : At the end of this course, the students will be able to:
CO1 : Comprehend the p-n junction theory and analyse the effect of heat and light on the performance of the semiconductor devices.
CO2: Understand different types of special diodes and their uses in various electronics applications.
CO3 : Understand different types of optoelectronic devices and their uses in various electronics applications.
CO4: Design, construct and study the performance of circuits based on breakdown devices.
CO5 : Corelate the theory to understand the working of these devices.

Theory:

UNIT – I: Basic Semiconductor and pn-Junction Theory and Special Diodes [15 h]

1. Basic Semiconductor and pn-Junction Theory: [10 h]

The Atom, Electron Orbit and Energy Levels, Energy Bands, Conduction in Solids, Conventional Current and Electron Flow, Bonding Forces between Atoms, Classification of Solids, Intrinsic Semiconductor, Conduction of Electrons and Holes, *p*-Type and *n*-Type Semiconductors, Effect of Heat and Light, Drift Current and Diffusion Current, The *pn*-Junction, Reverse-biased Junction, Forward-biased Junction, Temperature Effect, Mobility and Conductivity, Hall Effect and Hall Coefficient.

[Ref.1: Chapter 1 and Ref.2: Chapter 1: 1.8 and1.9]

2. Special Diodes: [5 h]

Zener Diode, Use of Zener Diode as voltage regulator and as Peak Clipper, Meter Protection, Tunneling Effect, Tunnel Diode, Tunnel Diode as Oscillator, Varactor, PIN Diode, Schottky Diode, Step Recovery Diode.

[Ref.3: Chapter 15]

UNIT II: Optoelectronic Devices and Industrial Devices **[20 h]**

3. Optoelectronic Devices: **[8 h]**

Light Units, Photomultiplier tube, Photoconductive Cell, Photovoltaic Cell, Photodiode, Solar Cell, Phototransistor, PhotoFET, Spectral response of Human eye, Light Emitting Diode(LED), Liquid Crystal Display(LCD), Optoelectronic Couplers, Laser Diode, Light Dependent Resistor (LDR).

[Ref.1: Chapter 19: 19-1 to 19-7, 19-9, 19-11, 19-12 and Ref.3: 16.1 to 16.3]

4. Industrial Devices: **[12 h]**

Silicon Controlled Rectifier(SCR), SCR Characteristic and Parameters, Simple applications of SCR: HWR, Battery-charging regulator and Temperature Controller, Silicon Controlled Switch (SCS), Gate Turn Off switch (GTO), Light Activated SCR (LASCR), Shockley Diode, The TRIAC and DIAC, Typical Diac-Triac Phase control circuit, The Unijunction Transistor(UJT), UJT Characteristics, UJT Parameter and Specification, UJT Relaxation Oscillator, UJT Control of SCR, Programmable Unijunction Transistor.

[Ref.1: Chapter 18: 18-1, 18-2, 18-4, 18-6 to 18-11; Ref.4: Chapter 21: 21.6 to 21.10 and Ref.5: Chapter 28: 28-4]

UNIT – III: Field Effect Transistors **[10 h]**

5. Field Effect Transistors: **[10 h]**

Advantage and Disadvantage of The FET, Basic Construction of JFET, Characteristics curves of The JFET, Principle of operation of The JFET, Effect of V_{DS} on Channel Conductivity, Channel Ohmic Region and Pinch-Off Region, Characteristic Parameters of The FET, Effect of Temperature on FET Parameters, The MOSFET, The Depletion MOSFET, The Enhancement MOSFET, The difference between JFETs and MOSFETs, Dual Gate MOSFET, FET used in Phase-Shift Oscillator Circuit, Applications of FET in its Channel Ohmic Region, FET as a VVR in Voltage controlled Attenuator and in an Automatic Gain Controlled Circuit, Field-Effect Diode and its use as CRD, Power MOSFETs.

[Ref.5: Chapter 21: 21-1 to 21-8, Chapter 22: 22-1 to 22-5, 22-9, 22-10;

Ref.1: Chapter 8: 8-9]

Experiments: **(Minimum six)**

1. Energy Gap of a Semiconductor
2. Energy Gap of a LED.
3. Zener Diode Characteristics and Voltage regulation
4. LDR Characteristics

5. LED VI Characteristics
6. Phototransistor
7. SCR characteristics and gate controlled ac half wave rectifier
8. UJT Characteristics and its use in relaxation oscillator
9. FET Characteristics
10. Solar Cell.
11. SCR, Diac, Triac Characteristics.

References:

1. Bell David A., Electronics Devices and Circuits, Prentice-Hall of India Pvt. Ltd., New Delhi, 3rd Edition (2000).
2. Singh Kamal and Singh S. P., Solid State Devices and Electronics, S. Chand & Company Ltd., New Delhi, 1st Edition (2007).
3. Theraja B. L., Basic Electronics (Solid State), S. Chand and Company Ltd., New Delhi, 1st Multicolour Edition (2005).
4. Boylestad Robert and Nashelsky Louis, Electronic Devices and Circuit Theory, Prentice-Hall of India Pvt. Ltd., New Delhi, 6th Edition (2000).
5. Mottershead Allen, Electronics Devices and Circuits An Introduction, Prentice-Hall of India Pvt. Ltd., New Delhi, 23rd Printing, (2000).

Web References:

1. https://nptel.ac.in/courses/117106091/
2. https://www.elprocus.com/types-of-diodes-and-applications/
3. https://www.electronicshub.org/types-of-diodes/
4. https://www.electronicshub.org/thyristor-basics/
5. https://gradeup.co/field-effect-transistor-study-notes-i-96d9d1d0-79ad-11e7-bf36-f08a68dca14c

Annexure II

Course codes for courses offered as General elective

Semester	Course Code for regular Course	Course Title	Course code when offered as Generic Elective Course
I	PHY-I.C-1	Mechanics I	PHY-GEC-1
II	PHY-I.C-3	Heat and Thermodynamics	PHY-GEC-2
III	PHY-E3	Oscillations, Waves and Sound	PHY-GEC-3
IV	PHY-E4	Properties of Matter and Acoustics	PHY-GEC-4

DEPARTMENT OF PHYSICS

COURSE STURUCTURE [2020-2021 onwards]

SEMESTER	CORE		ELECTIVE				
I	PHY-I.C-1 Introduction to Mathematical Physics	PHY-I.C-2 Mechanics-I	-------	-------	-------	-------	-------
II	PHY-II.C-3 Heat and Thermodynamics	PHY-II.C-4 Electricity and Magnetism	-------	-------	-------	-------	-------
III	PHY-III.C-5 Electromagnetic Theory-I	-------	PHY-E1 *Optics	PHY-E2 Modern Physics	PHY-E3 Oscillations, Waves and Sound	PHY-E17 Introduction to Astronomy and Astrophysics	PHY-E8 Instrumentation
IV	PHY-IV.C-6 Quantum Mechanics	-------	PHY-E5 *Electronics-I	PHY-E18 Introduction to Error Analysis	PHY-E4 Properties of Matter and Acoustics	PHY-E7 Computational Physics	-------
V	PHY-V.C-7 Electromagnetic Theory-II	-------	PHY-E9 *Solid State Physics	PHY-E10 Thermodynamics and Statistical Mechanics	PHY-E11 Electronics-II	PHY-E12 Mathematical Physics	PHY-E6 Solid State Devices
VI	PHY-VI.C-8 Atomic and Molecular Physics	-------	PHY-E13 *Mechanics II	PHY-E14 Nuclear and Elementary Particle Physics	PHY-E15 Introduction to Special Theory of Relativity	PHY-E16 Introduction to Material Science	

* BoS Physics recommends these elective courses to be taken by students as a prerequisite to the M.Sc. (Physics) Program.

COURSES FOR STUDENTS OPTING PHYSICS AS MINOR SUBJECT

[2020-2021 onwards]

Semester	Course
I	Mechanics-I
II	Electricity and Magnetism Or Heat and Thermodynamics
III	Modern Physics Or Electromagnetic theory -I
IV	Computational Physics Or Quantum Mechanics
V	Thermodynamics and Statistical Mechanics Or Electromagnetic theory -II
VI	Mechanics II Or Introduction to Materials Science

COURSES OFFERED AS GENERIC ELECTIVE COURSES

[2020-2021 onwards]

Semester	Course Title	Course code when offered as Generic Elective Course
I	Mechanics I	PHY-GEC-1
II	Heat and Thermodynamics	PHY-GEC-2
III	Oscillations, Waves and Sound	PHY-GEC-3
IV	Properties of Matter and Acoustics	PHY-GEC-4

ANNEXURE A

(Summary of changes incorporated in the syllabus)

Semester	Course Title	Existing (Indicate only the unit where the change is proposed)	Changes Proposed	Specify the reason for the change
I	Introduction to Mathematical Physics	Matrices	Added the topic Vector Algebra and Vector Analysis	As suggested by BoS members Vector Algebra and Vector Analysis has more relevance than Matrices
III	Optics	List of Experiments	Added new experiment Malus's Law using LASER source	New apparatus is procured using which this additional experiment can be done
III	Modern Physics	List of Experiments	Added following new experiments 1. I-V Characteristics of LASER 2. Optical fibre: Numerical aperture 3. Bending loss in optical fibre	New apparatus is procured using which these additional experiments can be done
III	Oscillations, Waves and Sound	Unit II	Introduced the topic: Coupled Oscillations [5 hours]	Contents of existing topics in Unit II is too less for 15 hours
III	Instrumentation	List of Experiments	Introduced Application of Pt 100 as a temperature sensor.	Theory of temperature sensors is covered in the topic on Transducers
V	Solid State Physics	**Unit II: Electron Theory of Metals [20 h]** Introduction, Classical free electron theory, Quantum theory of free	**Unit-II Electrical Properties of Metals** **[20 h]** Introduction, Classical Theory of Electric Conduction, Drawbacks of Classical theory,	Subtopics added because the contents of existing Unit II is too less for 20 hours.

		electrons, Fermi distribution function, Density of energy states, Sources of electrical resistance, Electrons in a periodic potentials, Energy bands in Solids.	Revision of particle in a rectangular three-dimensional box, Fermi-Dirac Statistics and Electronic distribution in Solids, Fermi distribution function, Density of energy states and Fermi energy, Mean energy of electron gas at absolute zero, Electrical conductivity from Quantum mechanical consideration, Sources of electrical resistance in metals, Thermal conductivity in metals, Joule's law, Thermionic emission, Failure of Sommerfeld's free electron model, Band theory of Solids, Brillouin Zones, Motion of electrons in one- dimensional periodic potential, Distinction between metals, insulators and semiconductors.	
V	Thermodynamics and Statistical mechanics	**Unit – III: Specific Heats of Solids [10 h]** Thermal Vibrations: Frequencies. Thermal Vibrations: Amplitudes. Specific Heats of Solids. The Einstein's theory. The Debye Theory. Fermi energy, Electron energy distribution.	**Lattice Vibrations and Specific Heats of Solids** [10 h] Thermal Vibrations: Frequencies. Thermal Vibrations: Amplitudes. Normal Modes of a Lattice. Phonons. Specific Heats of Solids. The Einstein's theory. The Debye Theory. Fermi energy, Electron energy distribution.	Introduced the concept of Normal modes of lattice and phonons for better understanding of specific heats of solids
V	Thermodynamics and Statistical mechanics	List of experiments	Introduced the experiment: Thermal conductivity of poor conductor by LEE's method	To replace one of the tutorials.
V	Electronics II	List of experiments	Introduced the experiment: JFET as	Theory of JFET as a common source is covered.

			a common source amplifier	
v	Solid State Devices	Unit 2: Topic 4	Breakdown Devices is renamed as Industrial Devices.	As suggested by the BoS members

STATISTICS

Course Structure for Statistics

	Core	Core	Elective	Elective	Elective	Elective
SEM - I	Basic Analysis	Combinatorics -I				
SEM – II	Mathematical Analysis	Probability theory				
			Elective-I	**Elective-II**	**Elective-III**	**Elective-IV**
SEM – III		Linear Algebra	Applications of Probability Distributions	Statistical Estimation.	Numerical Methods	
SEM – IV		Testing of hypothesis	Design of experiments	Decision Theory.	Operations Research	
SEM – V		Graph Theory	Logistic Regression	Statistical inferences	Python/Octave	
SEM - VI		Statistical Graph Theory	GIS	Consumer Finance	Computers for Statistics (On Line.)	

STATISTICS SYLLABUS

Course Title: **Applications of Probability Distributions**

Course Credit: 04

Max Marks: 100

Course Objectives: To learn indepth properties of theoretical distributions.

Learning Outcome: The student will be able recognize the correct distribution to be used to analyse given data.

Unit 0: Strong law of large numbers. Domain of attraction for different distributions. (4 Hrs.)

Unit 1:

Joint Probability and conditional distribution: mass function for discrete random variables, Joint Probability density function for continuous random variables, their properties, Marginal and conditional Distributions, Independence of Random Variables, Conditional Expectation & Variance.

Implication to Bayesian: Prior and posterior distribution (10 Hrs.)

Unit 2 :

Standard Continuous Probability Distributions: Rectangular, Exponential, Gamma, Beta (Type I & Type II).

The following aspects of the above distributions (wherever applicable) to be discussed: Mean, Median, Mode & Standard deviation. Moment Generating Function, Additive property, cumulants Generating Function, Interrelation between the distributions. (8 Hrs.)

Unit 3 :

Normal Distribution: Mean, Median, Mode, Standard deviation, Moment Generating function, cumulant Generating function. Recurrence relation for central moments, , Distribution of linear function of independent Normal variables. Fitting of Normal Distribution, Central Limit theorem for independent identical distribution of random variables.

Log Normal Distribution: Derivation of mean & variance (15 Hrs.)

Unit 4 :

Chi-Square Distribution: Concept of degrees of freedom. Mean, Median, Mode & Standard deviation, moment generating function, cumulant generating function, additive property, Distribution of the sum of squares of independent Standard Normal variables, goodness-fit, contingency table and test of independence.

t-distribution: Mean, Median, Mode & Standard deviation. Distribution of ratio of a Standard Normal variable to the square root of an independent Chi-square divided by its degrees of freedom. Asymptotic properties. Student's t.

F-distribution: Mean, Mode & Standard deviation. Distribution of : Reciprocal of an F-variate, Ratio of two independent Chi-squares divided by their respective degrees of freedom. Interrelationship of F with: t-distribution, Chi-square distribution & Normal distribution.

(13 Hrs.)

CART and CHAID, its usage in Artificial Intelligence , Multi Layer , Nueral Network,

(10 Hrs.)

References:

1. Robert V. Hogg etel. Introduction to Mathematical Statistics, Pearson Education Ltd.
2. Thomas Hall , Paul Lewicki, Statistics : Methods and Applications, StaSoft.
3. S.C.Gupta, V.K.Kapoor, Fundamentals of Mathematical Statistics, S. Chand & Sons.

Statistical Estimation.

Course Credit: 04

Max Marks: 100

Course Objectives: Introduse different methods of estimations.

Learning Outcome: The student will be able to use different models depending on the need.

Unit 1 :

POINT ESTIMATION AND PROPERTIES OF ESTIMATOR: Notion of a parameter and parameter space. Problem of Estimation, Definitions of Statistic, Estimator and Estimate. Properties of a good estimator: (a) **Unbiasedness:** Definition of an unbiased estimator, biased estimator, positive and negative bias, illustrations and examples (these should include unbiased and biased estimators for the same parameters). (b**) Consistency:** Definition, Proof of the following theorem: An estimator is consistent if its bias and variance both tend to zero as the sample size tends to infinity. (c) **Sufficiency:** Concept and definition of Sufficiency, Neymann Factorization Theorem (without proof). Exponential family of probability distributions and Sufficient statistic. (d) **Relative efficiency of an estimator**. Illustrative examples.

Methods of Estimation a) Method of Maximum Likelihood Estimation (M.L.E.), Definition of likelihood as a function of unknown parameter, for a random sample from i) discrete distribution ii) continuous distribution. Derivation of Maximum Likelihood Estimator (M.L.E.) for parameters of standard distributions (case of one and two unknown parameters).

b) Method of Moments, Derivation of moment estimators for standard distributions (case of one and two unknown parameters). Illustrations of situations where M.L.E. and Moment Estimators are distinct and their comparison using Mean Square Error. (18 Hrs.)

Unit 2 :

Simple linear regression model (i) Review of simple linear regression model: Y = +X + ε, where ε is a continuous random variable with E(ε) =0, V(ε) = σ2 . Estimation of and , by the method of least squares. (ii) Properties of estimators of and (iii) Estimation of σ2 (iv) Assumption of normality of ε . (v) Interval estimation in simple linear regression mode (vi) Coefficient of determination (vii) Residual analysis.

Multiple linear regressionmodel (i) Review of multiple linear regression model Y = + X1 + . . . + Xp + ε , where ε is a continuous random variable with E(ε) =0, V(ε) = σ2 . Estimation of regression parameters by the method of least squares, obtaining normal equations, solutions of normal equations. (ii) Estimation of σ2. (iii) Assumption of normality of ε . (iv) Interval estimation (v) Variable selection and model building. (vi) Residual diagnostics and corrective measures. (17 Hrs.)

Unit 3:

Introduction to simulation: merits, demerits, limitations. Pseudo random number. Model sample from normal distribution (using Box- Muller transformation), uniform distribution, exponential distribution. Monte Carlo method of simulation: Statistical applications of simulation in numerical integration such as computation of probabilities of events related to gamma, beta and bivariate normal distribution. (15 Hrs.)

Resampling technique : Bootstrap and Jackknife. (10 Hrs.)

References:

1. Robert V. Hogg etel. Introduction to Mathematical Statistics, Pearson Education Ltd.
2. S.C.Gupta, V.K.Kapoor, Fundamentals of Mathematical Statistics, S. Chand & Sons
3. ManojKumar Srivastava etal., Statistical Inference : Theory of Estimation, PHI (EEE)

Testing of hypotheses

Course Credit: 04

Max Marks: 100

Course Objectives: Introdusing Testing , confidence limits , clustering and their relations..

Learning Outcome: The student will be comfortable in using all these testing techniques.

Unit 1: Parametric Tests

Statistical hypothesis, problem of testing of hypotheses. Definition and illustrations of (1) simple hypothesis, (2) composite hypothesis, (3) test of hypothesis, (4) critical region, (5) type I and type II errors. probabilities of type I error and type II error. Problem of controlling the probabilities of errors of two kinds. Definition and illustrations of (i) level of significance, (ii) observed level of significance (p-value), (iii) size of a test, (iv) power of a test.

Definition of most powerful (M.P.) level α test of simple null hypothesis against simple alternative. Statement of Neyman - Pearson (N-P) lemma for constructing the most powerful level α test of simple null hypothesis against simple alternative hypothesis. Illustrations.

Power function of a test, power curve, definition of uniformly most powerful (UMP) level α test for one sided alternative. Illustrations. (18 Hrs.)

Unit 2: Likelihood ratio tests

Notion of likelihood ratio test (LRT), λ (x)=Sup L(θ0|x) / Sup L(θ|x) Construction of LRT for H0 : θ = θ0 against H1: θ ≠ θ0 for the mean of normal distribution for i) known σ2 ii) unknown σ2 (one sided and two sided alternatives). LRT for variance of normal distribution for i) known μ ii) unknown μ (one sided and two sided alternatives hypotheses).

LRT for parameters of binomial and exponential distribution for two sided alternatives only. LRT as a function of sufficient statistics, statement of asymptotic distribution of -2 loge λ (x).

(Relate to support vector machine (SVM)) (18 Hrs.)

Unit 3: Sequential Tests

Sequential test procedure for simple null hypothesis against simple alternative hypothesis and its comparison with fixed sample size N-P test procedure. Definition of Wald's SPRT of strength (α, β). Illustration for standard distributions like Bernoulli, Poisson, Normal and Exponential. SPRT as a function of sufficient statistics. Graphical representation of SPRT. (8 Hrs.)

Unit 4: Non-parametric Tests

Concept of non- parametric tests. Distinction between a parametric and a nonparametric Tests.One tailed and two tailed test procedure of (i) Sign test, ii) Wilcoxon signed rank test (iii) Mann- Whitney U test, (iii) Run test, one sample and two samples problems 4.2 Empirical distribution function Sn (x). Properties of Sn (x) as estimator of F (.). Kolmogorov – Smirnov test for completely specified univariate distribution (one Sample problem only) for two sided alternative hypotheses. Comparison with chi-square test.
(16 Hrs.)

References:

1. Erich Lehmann & Joseph Romano, Testing Statistical Hypotheses, Springer Texts in Statistics .
2. S.C.Gupta, V.K.Kapoor, Fundamentals of Mathematical Statistics, S. Chand & Sons
3. Richard Rossi, Mathematical Statistics: An Introduction to Likelihood Based Inference, Wiley.

Design of Experiments

Course Credit: 04

Max Marks: 100

Course Objectives: To introduce and familiarise student with different methods of designing statistical experiments.

Learning Outcome: The students will be able to designe experiments as required.

Unit 1

Types of sampling (Simple Random Sampling (SRS),Stratified Sampling, Cluster Sampling, Systematic Sampling, Multistage Sampling.) and their significance in testing. (10 Hrs.)

Unit 2

- Analysis of variance (ANOVA): concept and technique.
- Basic terms of design of experiments: Experimental unit, treatment, and layout of a experiment.
- Basic principles of design of experiments: Replication, randomization and local control. Choice of size and shape of a plot for uniformity trials, the empirical formula for the variance per unit area of plots.
- Completely Randomized Design (CRD) : Application of the principles of design of experiment in CRD, Layout, Model: $X_{ij} = \mu + \alpha_i + \varepsilon_{ij}$ i= 1,2, ...t. j = 1,2,.........., n_i assumptions and interpretations. Testing normality graphically. Breakup of total sum of squares into components. Estimation of parameters, expected values of mean sums of squares, components of variance, preparation of (ANOVA) table, testing equality of treatment effects, Hypothesis to be tested $H_0 : \alpha_1= \alpha_2 = ... = \alpha_t = 0$. Comparison of treatment means using box plot techniques. Statement of Cochran's theorem. F test for testing H_0 with justification (independence of chi- square is to be assumed), test for equality of two specified treatment effects using critical difference (C.D).
- Randomized Block Design (RBD) : Application of the principles of design of experiments in RBD, layout Model: $X_{ij} = \mu + \alpha_i + \beta_j +\varepsilon_{ij}$ i= 1,2, ...t. j = 1,2,.......... b, Assumptions and interpretations. Breakup of total sum of squares into components. Estimation of parameters, expected values of mean sums of squares, components of variance, preparation of analysis of variance table, Hypotheses to be tested $H_{01}:\alpha_1=\alpha_2=\alpha_3=...=\alpha_t=0$ $H_{02}:\beta_1=\beta_2=\beta_3=...=\beta_b=0$Ftestfor testing H_{01} and H_{02} with justification (independence of chi- squares is to be assumed), test for equality of two specified treatment effects using critical difference (CD).
- Latin Square Design (LSD): Application of the principles of design of experiments in LSD, layout, Model : $X_{ij(k)} = \mu + \alpha_i + \beta_j +\gamma_k+\varepsilon_{ij(k)}$ i = 1,2, ···m, j = 1,2···,m, k=1,2···,m. Assumptions and interpretations. Breakup of total sum of squares into components. Estimation of parameters, expected values of mean sums of squares, components of variance, preparation of analysis of variance table,

Hypothesestobe tested :- H01:α1=α2=···=αm=0 H02:β1=β2= ···=βm=0 H03 : γ1= γ 2 = ··· = γ m= 0 and their interpretation. Justification of F test for H01, H02 and H03 (independence of chi- square is to be assumed). Preparation of ANOVA table and F test for H01, H02 and H03 testing for equality of two specified treatment effects, comparison of treatment effects using critical difference, linear treatment contrast and testing its significance.

- Linear treatment contrasts, orthogonal contrasts. Scheffe's method for comparing contrasts, Tuckey's procedure for comparing pairs of treatment means (applicable to C.R.D., R.B.D. and L.S.D.) Identification of real life situations where the above designs are used. (20 Hrs.)
-
- **Unit 3**

- Analysis of non- normal data using. Kruskal Wallis test.

1.1.1.1.1.1.1.1 Efficiency of Design: Concept and definition of efficiency of a design. Efficiency of RBD over CRD. 2.3 Efficiency of LSD over (i) CRD (ii) RBD. (10 Hrs.)

-
- **Unit 4**
- Factorial Experiments: General description of mn factorial experiment, Definitions of main effects and interaction effects in 2^2 and 2^3 factorial experiments. Yate's procedure, preparation of ANOVA table, test for main effects and interaction effects.
- General idea of confounding in factorial experiments Construction of layouts in total confounding and partial confounding in 2^2 and 2^3 factorial experiments.
- Total confounding (confounding only one interaction) ANOVA table, testing main effects and interaction effects.
- Partial confounding (confounding only one interaction per replicate); ANOVA table, testing main effects and interaction effects. (20 Hrs.)

References:

- 1.D.R.Cox & Nancy Raid, The theory of the design of experiments, Chapman & Hall/CRC.
- 2. S.C.Gupta, V.K.Kapoor, Fundamentals of Mathematical Statistics, S. Chand & Sons
- 3. Richard Rossi, Mathematical Statistics: An Introduction to Likelihood Based Inference, Wiley.

Course Structure for Statistics

	Core	**Core**				
SEM - I	Basic Analysis	Combinatorics - I				
SEM – II	Mathematical Analysis	Probability theory				
			Elective-I	**Elective-II**	**Elective-III**	**Elective-IV**
SEM – III		Testing of hypothesis	Applications of Probability Distributions	Statistical Estimation.	Numerical Methods	
SEM – IV		Linear Algebra	Design of experiments and sampling	Decision theory and anova	Operations Research	
SEM – V		Graph Theory	Stochastic Process	Applied GIS	Statistical Learning and Data Mining	
SEM - VI		Statistical Graph Theory	Demography and Indian Official Statistics	Consumer Finance	Computers for Statistics (On Line.)	

Syllabus

Course Title:GRAPH THEORY

Course Code: STAT-V.C-5

Marks: 100

Credits: 4

Course Pre Requisites: Basic set theory, Principle of counting, Principles of Mathematical Induction

Course objective: To introduce the concept of discrete graphs, trees and some of their applications in real world problems.

Course contents:

Chapter 1. Graphs (8 hours)

- The Konigsberg 7 bridges problem and Euler's solution to it.
- definition of graph
- examples and types of graphs: complete, directed, bipartite, multi graph, etc
- degree of a vertex
- Adjacency matrix , incidence matrix
- operations on graphs: subgraphs, union, intersection and Cartesian product
- isomorphisms in graphs
- special graphs: self-complimentary graphs, Petersen and Herschel's Graph

Chapter 2. Walks paths and cycles (12 hours)

- walks, paths and cycle definition
- distance and weighted distance
- radius and diameter of a graph
- eccentricity of a vertex
- Euler walks
- Hamiltonian cycles
- application: travelling salesman problem

Chapter 3. Connectivity (8 hours)

- Cut-points
- blocks
- connectivity

Chapter 4. Trees (12 hours)

- definition of tree

- results on trees
- spanning trees
- application: minimum spanning trees and Kruskal's algorithm.
- Breadth First Search Algorithm and its use in the Chinese postman problem
- Dijkstra's Algorithm for shortest path.

Chapter 5. Coloring (10 hours)

- vertex coloring
- chromatic number of a graph and simple relations
- chromatic polynomial and its properties
- edge colorings

Chapter 6. Planarity (10 hours)

- representations and crossing number of graphs
- Euler's formula
- maps and planar graphs
- proof of five color theorem for planar graphs

One in six lectures should be used only for problem solving. Emphasis should be given in conducting problem solving home assignments rather conducting written exams.

References:

- W.D. Wallis, A Beginners Guide to Graph Theory, Birkhauser
- Robin J. Wilson Introduction to Graph Theory, Longman Group Ltd.
- J.A. Bondy, U.S.R Murthy, Graph Theory, Springer
- D.B. West, Introduction to Graph Theory, second edition, Prentice Hall of India.
- F Harary, Graph Theory, Narosa
- V.K. Balakrisnan, Graph Theory (Schaum series), Mc Graw Hill India

Course Title:STOCHASTIC PROCESS

Course Code: STAT-V.E-7

Marks: 100

Credits: 4

Course Pre Requisites: Basic of probability theory, Principle of counting, Principles of Mathematical Induction

Course objective: To introduce the concept of stochastic process, branching process etc.

Course contents:

Unit I **(20 hrs)**

Notion of stochastic processes, Markov chain, one step transition probabilities, Chapman-Kolmogorov equations, evaluation of higher step transition probabilities, classification of states, periodicity of a Markov chain, concept of closed class, minimal closed class, stationary distribution. Some examples such as gamblers ruin problem and one dimensional random walk. Concept of absorption probabilities, Use of these to compute probability of winning the game by a gambler having initial capital 'a'

Unit II **(20 hrs)**

Branching process, classification of states, identification of criticality parameter, extinction probability, relationship between criticality parameter and extinction probability of the process, Expression for mean and variance of the process.

Extinction probability, Some epidemiological applications, Introduction to Markov chain in continuous time, concept of intensity rate, relationship between intensity matrix and transition probability matrix. Kolmogorov's forward and backward equations

Unit III **(20 hrs)**

Introduction to birth process, birth and death process, linear birth and death process, Growth model with immigration and related results, Expression for mean and variance of a birth process and, birth and death process, Applications of these processes.

References

Sidney I. Resnick (1992) Adventures in Stochastic Processes *Birkhauser* ISBN 0817635912

S. Ross (2008) Stochastic processes Second Edition Wiley India Pvt. Ltd ISBN: 9788126517572

J. Medhi (2009) Stochastic processes New Age Science Ltd; 3rd Revised edition edition

Course Title:APPLIED GIS

Course Code: STAT-V.E-8

Marks: 100

Credits: 4

Course Requisite : Basics of Geography(Cartography, Geographical positioning and Spatial analysis), Matrices and Linear algebra.

Course outcome : Students will get an idea about geo informatics systems

Course Objectives: This Course introduces various recent application of GIS in business, society, transportation and spatial planning. Learning outcomes: At the end of this course students will be able to correlate knowledge of GIS in the day to days life problems.

Course contents:

Unit I (20 hrs)

I Geobusiness Retail Application of Spatial Modelling to Solve: Retail Location Problems, Location Based Services for Mobile Applications Mass Appraisal Model, Lifestyle Segmentation Profiles, Neighbourhood Model, Housing Price Mass Appraisal Model.

Unit II (20 hrs)

Social Application: Assessing Clusters of Deprivation in City Regions, GIS for Joined up Government Spatial Statistical Methods to the Detection of Geographical Patterns of Crime Transport and Location: Demand Responsive Passenger Transport Services, Strategic Land Use / Transportation Model, Relocation of Facilities. Probability Based GIS Model.

Unit III (20 hrs)

Spatial Planning Modelling Migration, Modeling Regional Economic Growth, Carrying Capacity, Planning Network of Site, Assessing Service Provision,

References

-Abbot, J., Chambers, R., Dunn, C., Harris, T., Merode, E. d., Porter, G., Townsend, J.,Weiner, D., de Merode, E., (1998). ‘Participatory GIS: opportunity or oxymoron?’ PLA Notes33. IIED: Londo

-Elwood, Sarah (2006) Participatory GIS and Community Planning: Restructuring Technologies, Social Processes, and Future Research in PPGIS Collaborative Geographic Information Systems edited by Shivanand Balram and Suzana Dragicevic, Idea Group Inc. University of Arizona, USA

-Elwood, Sarah (2006), Critical Issues in Participatory GIS: Deconstructions, Reconstructions, and New Research Directions Transactions in GIS, 10(5): 693–708

-McCall, Michael K. (2004) Can Participatory-GIS Strengthen Local-level Spatial Planning? Suggestions for Better Practice. Dept. of Urban & Regional Planning and GeoInformation Management ITC. Course prepared for: GISDECO 2004 Skudai, Johor, Malaysia, 10-12 May (2004)

Course Title:STATISTICAL LEARNING AND DATA MINING
Course Code: STAT-V.E-9
Marks: 100
Credits: 4

Prerequisite Courses : Statistical distributions, Domain of attraction, Statistical Testing, Graph theory.

Course Objectives : To provide skills of data analysis using Python/Octave programming language

Learning Outcome: Students will learn the basic applications of statistical theory in data analysis using machine language.

Unit 0
This unit is to re-visit the distributions withspecial emphases on domain of attraction, statistical testing, and statistical analysis of data.
(10 hrs)

Unit I
Supervised Learning:
K - nearest neighbourhood algorithm, Decision trees, Naïve Bayes and Bayesian networks.
(12 hrs)

Unit II
Support-Vector Machines and Kernel Methods, Optimal Separating Hyperplane, Soft-Margin Classifier, SVM Criterion as Loss Plus Penalty, Computations and the Kernel Trick, Function Fitting Using Kernels, Kernel Smoothing and Local Regression, Model evaluation techniques, Cost-Benefit analysis using data driven costs
(14 hrs)

Unit III
Unsupervised Learning: Hierarchical and k-means clustering, Kohonen networks, BIRCH clustering, Measuring cluster goodness Graphical evaluation of classification, Association rules, Genetic algorithms, Imputation of missing data.
(14 hrs)

Unit IV
Neural Networks and the Handwritten Digit Problem, Fitting a Neural Network, Autoencoders, Deep Learning, Learning a Deep Network
(10 hrs)

References

1. Alpaydin, E. (2014), Introduction to Machine Learning, 3rd Ed. MIT Press.

2. Breiman, L., Friedman, J.H., Olshen, R.A. and Stone, C.J. (1984). Classification and Regression Trees. Wadsworth and Brooks.

3. Hastie T., Tibshirani R. and Friedman J. H., (2008). The Elements of Statistical Learning: Data Mining, Inference and Prediction. Springer.

4. James G., Witten, D., Hastie, T. Tibshirani, R. (2013). An Introduction to Statistical Learning: With Applications in R, Springer

5. Larose, D. T. and Laros, C. (2015). Data Mining and Predictive Analytics. Wiley.

6. Mohammad J. Zaki and Wagner Meira. (2014). Data Mining and Analysis. Fundamental Concepts and Algorithms. Cambridge University Press, New York.

7. Ripley,B. D. (1996). Pattern Recognition and Neural Networks. Cambridge University Press 8.Shmueli, G., Patel, N. Bruce, P. (2010). Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XL Miner, Wiley.

ZOOLOGY

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
(Autonomous)
PROGRAMME BSC ZOOLOGY
CORE AND ELECTIVES COURSES

SEMESTER	COURSE CODE	CORE COURSES	COURSE CODE	ELECTIVE COURSES
I	ZOO-I.C-1	Animal Diversity : Non Chordates		
	ZOO-I.C-2	Cell and Molecular Biology		
II	ZOO-II.C-3	Diversity and Biological Systems of Chordates		
	ZOO-II.C-4	Fundamentals of Animal and Human Genetics		
III	ZOO-III.C-5	Human Physiology	ZOO-III.E-1	Vertebrate Endocrinology
			ZOO-III.E-2	Basic microbiology and Fundamentals of Animal Biotechnology
			ZOO-III.E-3	Environmental Toxicology
			ZOO-III.E-4	Parasitology
IV	ZOO-IV.C-6	Biochemistry and Metabolic Regulation	ZOO-IV.E-5	Animal cell culture and Applications
			ZOO-IV.E-6	Aquaculture and Fisheries
			ZOO-IV.E-7	Immunology
			ZOO-IV.E-8	Evolutionary Biology
V	ZOO-V.C-7	Developmental Biology	ZOO-V.E-9	Molecular Genetics and Forensic Science
			ZOO-V.E-10	Economic Zoology
			ZOO-V.E-11	Ecology and Ethology
			ZOO-V.E-12	Fish Preservation and Processing
VI	ZOO-VI.C-8	Wildlife Biology	ZOO-VI.E-13	Health and Nutrition
			ZOO-VI.E-14	Basic and Applied Entomology
			ZOO-VI.E-15	Laboratory Techniques in Pathology
			ZOO-VI.E-16	Bio Entrepreneurship

PROGRAMME: BSC ZOOLOGY
CORE COURSES

CORE COURSES FOR ZOOLOGY SINGLE MAJOR / DOUBLE MAJOR		
SEMESTER	**COURSE CODE**	**COURSE TITLE**
1	ZOO-I.C-1	Animal Diversity : Non Chordates
1	ZOO-I.C-2	Cell and Molecular Biology
2	ZOO-II.C-3	Diversity and Biological Systems of Chordates
2	ZOO-I.C-4	Fundamentals of Animal and Human Genetics
3	ZOO-III.C-5	Human Physiology
4	ZOO-IV.C-6	Biochemistry and Metabolic Regulation
5	ZOO-V.C-7	Developmental Biology
6	ZOO-VI.C-8	Wildlife Biology

CORE COURSES FOR ZOOLOGY MAJOR - MINOR		
SEMESTER	**COURSE CODE**	**COURSE TITLE**
1	ZOO-I.C-1	Animal Diversity : Non Chordates
2	ZOO-II.C-3	Diversity and Biological Systems of Chordates
3	ZOO-III.C-5	Human Physiology
4	ZOO-IV.C-6	Biochemistry and Metabolic Regulation
5	ZOO-V.C-7	Developmental Biology
6	ZOO-VI.C-8	Wildlife Biology

PROGRAMME: BSC ZOOLOGY
ELECTIVE COURSES

ELECTIVE COURSES FOR BSc ZOOLOGY		
SEMESTER	**COURSE CODE**	**COURSE TITLE**
Odd semester	ZOO-III.E-1	Vertebrate Endocrinology
	ZOO-III.E-2	Basic microbiology and Fundamentals of Animal Biotechnology
	ZOO-III.E-3	Environmental Toxicology
	ZOO-III.E-4	Parasitology
	ZOO-V.E-9	Molecular Genetics and Forensic Science
	ZOO-V.E-10	Economic Zoology
	ZOO-V.E-11	Ecology and Ethology
	ZOO-V.E-12	Fish Preservation and Processing
Even semester	ZOO-IV.E-5	Animal cell culture and Applications
	ZOO-IV.E-6	Aquaculture and Fisheries
	ZOO-IV.E-7	Immunology
	ZOO-IV.E-8	Evolutionary Biology
	ZOO-VI.E-13	Health and Nutrition
	ZOO-VI.E-14	Basic and Applied Entomology
	ZOO-VI.E-15	Laboratory Techniques in Pathology
	ZOO-VI.E-16	Bio Entrepreneurship

COURSE STRUCTURE FOR PROGRAMME: BSC ZOOLOGY

<table>
<tr><th colspan="2">STRUCTURE</th><th>CREDITS</th><th>SUBJECTS &PAPERS</th><th>CC Major + Project</th><th>CC Minor</th><th>Elective</th></tr>
<tr><td rowspan="8">Component A (84Credits)</td><td rowspan="2">CHOICE – 1 Single Major</td><td>32+4</td><td>8 Core Papers (Major) + Project Paper</td><td>8 + 1</td><td></td><td></td></tr>
<tr><td>48</td><td>12 Elective Papers (Major)</td><td></td><td>--</td><td>12</td></tr>
<tr><td rowspan="3">CHOICE – 2 Major and Minor</td><td>32+4</td><td>8 Core Papers (Major) + Project Paper</td><td>8 + 1</td><td></td><td></td></tr>
<tr><td>24</td><td>6 Core Papers (Minor)</td><td></td><td>6</td><td></td></tr>
<tr><td>24</td><td>6 Elective Papers (Major)</td><td></td><td></td><td>6</td></tr>
<tr><td rowspan="3">CHOICE – 3 Double Majors</td><td>32+4</td><td>8 Core Papers (Major 1) + Project Paper</td><td>8 + 1</td><td>--</td><td></td></tr>
<tr><td>32</td><td>8 Core Papers (Major 2)</td><td>8</td><td>--</td><td></td></tr>
<tr><td>16</td><td>2+2 Elective Papers(Major 1 / Major 2)</td><td></td><td></td><td>4</td></tr>
<tr><th colspan="2">STRUCTURE</th><th>CREDITS</th><th>GENERAL SUBJECTS & PAPERS</th><td colspan="2">Compulsory</td><td>Elective</td></tr>
<tr><td rowspan="5">Component B (36 Credits)</td><td rowspan="5">Compulsory Subjects</td><td>8</td><td>A. Languages (Two Papers of 4 Credits each)</td><td colspan="2">2</td><td></td></tr>
<tr><td>8</td><td>B. (1) Academic Writing (2) Cyber Security</td><td colspan="2">2</td><td></td></tr>
<tr><td>2 + 2</td><td>C. EVS (Two papers of 2 Credits each)</td><td colspan="2">2</td><td></td></tr>
<tr><td>8</td><td>D. (1) Statistical Methods (2) Research Writing</td><td colspan="2">2</td><td></td></tr>
<tr><td>8</td><td>E. Interdisciplinary (Arts / Science) (Two Papers of 4 Credits each)</td><td colspan="2"></td><td>2</td></tr>
<tr><td rowspan="3">Component C (6 Credits)</td><td rowspan="3">Extra-curricular</td><td>2</td><td>Music, Arts (2 Credits)</td><td colspan="2"></td><td>1</td></tr>
<tr><td>2</td><td>Sports (2 Credits)</td><td colspan="2"></td><td>1</td></tr>
<tr><td>2</td><td>NCC, NSS (2 Credits)</td><td colspan="2"></td><td>1</td></tr>
<tr><td>Component D (4 Credits)</td><td>Internship</td><td>4</td><td>Internship (Minimum 1 Month)</td><td colspan="2">1</td><td></td></tr>
<tr><td colspan="2">Abbreviations:</td><td colspan="5">CC – Core Compulsory CE – Core Electives CP – Core Project CM – Core Minor GC – General Compulsory GE – General Electives I – Internship</td></tr>
</table>

COURSE DISTRIBUTION
FOR PROGRAMME: BSC ZOOLOGY

Distribution of courses (Single Major)						
Semesters	I	II	III	IV	V	VI
Courses	2CC	2CC	CC	CC	CC	CC
	GC - B	GC - B	3CE	3CE	3CE	3CE
	LANG	LANG	GC - D	GC - D	GC - E	GC - E
	EVS	EVS			PROJ	PROJ
Total	4.5	4.5	5	5	5.5	5.5

Distribution of Courses (Major - Minor)						
Semesters	I	II	III	IV	V	VI
Courses	2CC	2CC	CC	CC	CC	CC
	GC - B	GC - B	CE	CE	2CE	2CE
	LANG	LANG	GC - D	GC - D	GC - E	GC - E
	CCm	CCm	CCm	CCm	CCm	CCm
			EVS	EVS	PROJ	PROJ
Total	5	5	4.5	4.5	5.5	5.5

Distribution of Courses (Double Majors)						
Semesters	I	II	III	IV	V	VI
Courses	2CC - 1	2CC - 1	CC - 1	CC - 1	CC - 1	CC - 1
			CE	CE	CE	CE
	LANG	LANG	2GC - B, D	2GC - B, D	GC - E	GC - E
	2CC - 2	2CC - 2	CC - 2	CC - 2	CC - 2	CC – 2
					EVS	EVS
					PROJ	PROJ
Total	5	5	5	5	5	5

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PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
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PROGRAMME BSC ZOOLOGY
COURSE CURRICULUM - CORE COURSES

SEMESTER	**COURSE CODE**	**CORE COURSES**
I	ZOO-I.C-1	Animal Diversity : Non Chordates
	ZOO-I.C-2	Cell and Molecular Biology
II	ZOO-II.C-3	Diversity and Biological Systems of Chordates
	ZOO-II.C-4	Fundamentals of Animal and Human Genetics
III	ZOO-III.C-5	Human Physiology
IV	ZOO-IV.C-6	Biochemistry and Metabolic Regulation
V	ZOO-V.C-7	Developmental Biology
VI	ZOO-VI.C-8	Wildlife Biology

SEMESTER –I:

CORE COURSE : ANIMAL DIVERSITY: NON CHORDATES	
COURSE CODE:	ZOO-I.C-1
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To be familiar with the different non-chordate phyla. • To know the general and distinguishing characters of each of them. • To study how the different systems evolved in their complexity. • To compare and contrasts the life processes in different phyla.
LEARNING OUTCOME:	At the end of the course, the students will be familiar with the non-chordate world that surrounds us. They will be able to appreciate the process of evolution and see how it progressed from simple, unicellular cells to complex, multicellular organisms. Students will be able to identify the invertebrates and classify them upto the class level. Students will understand the basis of life processes in the non-chordates.

ZOO-I.C-1: ANIMAL DIVERSITY: NON CHORDATES		
MODULE	**TOPICS**	**CONTACT HOURS**
Module 1: Evolution of Animal Diversity and Diversity of lower non chordates	1.1 Non chordate evolution and diversity 1.2 Taxonomy and phylogeny of animals 1.3 Invertebrate cladogram 1.4 Protista Classification and general characters upto class for the following phyla: 1.5 Porifera 1.6 Cnidaria 1.7 Platyhelminthes 1.8 Aschelminthes 1.9 Annelida	15
Module 2: Diversity of higher Non Chordates And Biological systems of non chordates 1	Classification and general characters upto class for the following phyla: 3.1:Onycophora 3.2: Arthropoda 3.3: Mollusca 3.4: Echinodermata 3.5: Hemichordata Comparison of life processes such as nutrition, sensory and neural control and coordination, sense organs	15
Module 3: Biological systems of Non Chordates 2	Comparison of life processes (Phylum Porifera to hemichordate)such as: • blood vascular system, • exoskeleton, • endoskeleton, • locomotion and muscular system, • respiration, • excretion, • Reproduction and development.	15

PRACTICAL COMPONENT OF ZOO-I.C-1: ANIMAL DIVERSITY: NON CHORDATES (DURATION -02 HRS /WEEK)		
Sr. No	Practical	No. of Practicals
1.	Identification of organisms from phylum protozoa to phylum Hemichordata	06
2.	Observation of permanent slides	03
3.	Mountings: Cockroach mouth parts, prawn appendages	02
4.	Field trip to terrestrial environment to study the invertebrates in their natural habitats	01

REFERENCE BOOKS:

1. Barnes R.D. (2000). Invertebrate Zoology.Hall Saunders International Edition, London.
2. Barrington E.J.W. 1979. Invertebrate structure and Function.John Wiley and Sons Inc.
3. Jordan, E. L. and Verma, P.S. (2000). Invertebrate Zoology. S. Chand & Co. Pvt. Ltd. New Delhi.
4. Marshall A.J.and W.D. Williams. 1974. Textbook of Zoology. Macmillan.
5. Pechenik J.A.(2002). Biology of the invertebrates. Tata McGraw hill Publishing company limited, New Delhi .

REFERENCE BOOKS FOR PRACTICALS:

1) Ziser. W.S (2014) Biology 1413 Introductory Zoology Lab Manual.Morton Publishing Co. Austin Community College.
2) Lal S.S. (2004) A textbook of practical zoology vertebrate. Rastogi publications, Meerut India.

Z00-I.C-2 : CELL AND MOLECULAR BIOLOGY

CORE COURSE : CELL AND MOLECULAR BIOLOGY

COURSE CODE:	ZOO-I.C-2
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	This course will give firm and rigorous foundation in the principles of modern molecular and cellular biology. It discusses the fundamental processes that enable cells to grow, move and communicate and will cover topics such as cell architecture, cell chemistry, cell division, functions and cell cycle. Students will also learn current molecular biological techniques that are used to study cell biology. Laboratories will focus both on exercises that help illustrate cellular phenomena, as well as on the introduction of techniques and procedures commonly utilized in modern cell and molecular biology research.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: • Develop deeper understanding of what life is and how it functions at cellular level. • Describe cellular membrane structure and function, fine structure and function of cell organelles. • Perform a variety of molecular and cellular biology techniques.

MODULE	TOPICS	CONTACT HOURS
MODULE 1: TECHNIQUES OF CELL STUDY AND CELL CHEMISTRY (15 Hrs)	Unit 1: MICROSCOPY • Light Microscopy • Electron Microscopy (SEM, TEM, IEM,STEM).	04
	Unit 2: CELL STUDY METHODS • Cell Fractionation, Chromatography and electrophoresis • X-ray diffraction and NMR spectroscopy • Radioisotope tracer technique, Autoradiography, intracellular electrodes	04
	Unit 3: MOLECULES IN CELL. • Micromolecules in cells: Sugars, Fatty acids, aminoacids, Nucleotides. • Macromolecules in cells: Nucleic acids, proteins, Polysaccharides, glycogen, fats.	05
	Unit 4: CHEMICAL BONDS IN BIOMOLECULES • covalent bonds, ionic bonds, noncovalent interactions	02
MODULE 2: CELL ARCHITECTURE (15 Hrs)	Unit 5: MEMBRANE STRUCTURE AND MEMBRANE PROTEINS • lipid bilayer – composition and structural organization (amphipathic phospholipids, Fluidity of cell membrane) • Membrane Proteins –structure and function (transmembrane proteins, peripheral membrane proteins) • Phospholipids, sphingolipids, Cholesterol in cell membrane.	06
	Unit 6: MOLECULAR STRUCTURE AND FUNCTION • Plasma Membrane • Cell matrix: Physical nature and Properties. • Nucleus: Ultra Structure and function • Mitochondria: Ultra Structure and functions • Endoplasmic Reticulum: ultra structure, modifications, functions	06
	UNIT 7: MOLECULAR STRUCTURE AND FUNCTION • Golgi Complex: detailed structure and function • Ribosomes- Structure and function • Microsomes: Lysosome-morphology and function,Microbodies • Cytoskeleton – Microtubules, Microfilaments, intermediate filaments	03
MODULE 3: CELLULAR TRANSPORT OF PROTEINS AND VESICLES (15 Hrs)	Unit 8: TRANSPORT ACROSS CELLL MEMBRANES • Principle of transmembrane transport (transporters and channels, active and passive transport, osmosis) • Transporters and their function- passive transporters, Pumps (Na^+, K^+, Ca^{++}), functions of transporters. • Ion Channels - ion channels activities, regulation of opening and closing of channels. • Protein transport into organelles (nucleus, mitochondria,ER).	10
	Unit 9: VESICULAR TRANSPORT. • Vesicular transport – transport of soluble proteins, vesicle budding, vesicle docking, endocytic pathways • General principles of cell signaling, G-Protein coupled receptors, enzyme coupled receptors	05

PRACTICAL COMPONENT OF ZOO-I.C-2: CELL AND MOLECULAR BIOLOGY (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1)	Introduction to Lab techniques – Pipetting, preparation of buffers and solutions, Lab equipments (use and maintenance), acquaintance with general laboratory practices	02
2)	Cytochemistry: Localisation of Proteins, Carbohydrates & fats using different stains.	03
3)	Comparison of membrane permeability – Cellophane and Chick intestine.	01
4)	Osmotic studies – Using Human Red blood cells.	01
5)	Permament slides: - Mitotic stages - Meiotic stages (mounting from grasshopper testes) - Histology - Study of different cell types (animal cells)	03
6)	Technique of Agarose gel electrophoresis (Observation of technique)	01
7)	Protein study – SDS-PAGE (Observation of technique)	01

REFERENCE BOOKS:

Essential books:

1) *Alberts B, Hopkins, Lewis J, Raff M, Robertis K, Walter P (2014): Essential Cell Biology, Fourth Edition, Graland Science Taylor & Francis Group, UK.*
2) *Lodish H, Berk A, Kaiser CA, Krienger M, Scott MP, Anthony, Bretscher A, Amon A. Scott MP (2013): Molecular Cell Biology, Seventh Edition, W. H. Freeman and Company New York.*

Supplementary Reading:

3) *Gupta PK (2003): Cell and Molecular Biology, Second Edition, Rakesh Kumar Rastogi for Rastogi Publications, Meerut, New Delhi, India.*
4) *Bolsover SR, Shephard EA, Hugh AW, Hyams JS (2011): Cell Biology, Third Edition, Wiley Blackwell, A John Wiley & Sons, Inc., Publications.*
5) *Verma PS and Agarwal VK (2007): Cell Biology Genetics Molecular Biology Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.*

REFERENCE BOOKS FOR PRACTICALS:

1) *Alberts B, Hopkins, Lewis J, Raff M, Robertis K, Walter P (2014): Essential Cell Biology, Fourth Edition, Graland Science Taylor & Francis Group, UK.*
2) *Bolsover SR, Shephard EA, Hugh AW, Hyams JS (2011): Cell Biology, Third Edition, Wiley Blackwell, A John Wiley & Sons, Inc., Publications.*
3) *Verma PS and Agarwal VK (2007): Cell Biology Genetics Molecular Biology Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.*
4) *Alberts B, Johnson A, Lewis J, Raff M, Robertis K, Walter P (2008): Molecular Biology of the Cell, Fifth Edition, Published by Garland Science, Taylor & Francis Group, UK.*

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SEMESTER – II

CORE COURSE: DIVERSITY AND BIOLOGICAL SYSTEMS OF CHORDATES	
COURSE CODE:	ZOO-II.C-3
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To be familiar with the different Chordate phyla. • To know the general and distinguishing characters of each of them. • To compare and contrast the major biological systems amongst them.
LEARNING OUTCOME:	At the end of the course, the students will be familiar with the chordate world that surrounds us. They would be able to identify the different chordates upto the order. They will understand the functioning and mechanism of the various biological systems in the chordates.

ZOO-II.C-3: DIVERSITY AND BIOLOGICAL SYSTEMS OF CHORDATES		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Diversity of chordates(upto order)	1.1: Chardata: General plan of organization and Outline classification 1.2: General characters and classification of Protochordates 1.3: General characters and classification of Agnatha 1.4: General characters and classification of Pisces 1.5: General characters and classification of Amphibia 1.6: General characters and classification of Reptilia 1.7: General characters and classification of Aves 1.8: General characters and classification of Mammalia	**15**
MODULE 2: Biological Systems I	3.1: Integument: Pisces, Amphibia, Reptilia, Aves, Mammalia 3.2:Locomotory apparatus: Pisces , Amphibia, Reptilia , Aves, Mammalia 3.3: Digestive system: Pisces , Amphibia, Reptilia , Aves, Mammalia 3.4: Respiratory system: Pisces , Lungs in Amphibia, Reptilia , Aves, Mammalia	**15**
MODULE 3: Biological systems - II	3.1: Circulatory system: Pisces , Amphibia, Reptilia , Aves, Mammalia 3.2: Brain and cranial nerves: Pisces , Amphibia, Reptilia , Aves, Mammalia 3.3: Reproductive system: Pisces , Amphibia, Reptilia , Aves, Mammalia	**15**

PRACTICAL COMPONENT OF ZOO-II.C-3: DIVERSITY OF CHORDATES (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1.	Identification and Systematic classification of organisms from protochordates to mammalia	05
2.	Mounting of scales and chromatophores in fishes	01
3.	Observation of general viscera of chordate phyla	01
4.	Observation and study of nests of birds- crow, baya weaver, munia, sun bird (any three)	01
5.	Identification of Indian venomous and non venomous snakes with the help of keys provided (four each)	01
6.	Mounting of pectin of eye (chick)	01
7.	Mounting of hyoid apparatus of chick; observation of hyoid apparatus of reptiles and mammals	01
8.	Overview of skull from fish to mammals	01
9.	Observation of permanent slides (amphioxus, doliolum, salpa)	01
10.	Field trip to fish landing site and wild life sanctuary	02

REFERENCE BOOKS:

1. Cleveland Hickman Jr., Roberts Larry, Susan Keen, Allan Larson and Eisenhour D (2014). Animal Diversity. McGraw Hill Science.
2. Kardong K(2011). Vertebrates: Comparative anatomy, evolution, function. McGraw-Hill Higher Education.
3. Kent G.C. and Carr R.K. (2000). Comparative anatomy of the vertebrates. McGraw-Hill Higher Education.
4. Young J.Z. (2006). The life of vertebrates. Radha Press Delhi, Indian Edition.

REFERENCE BOOKS FOR PRACTICALS:

1) Ziser. W.S (2014) Biology 1413 Introductory Zoology Lab Manual. Morton Publishing Co. Austin Community College.
2) Lal S.S. (2004) A textbook of practical zoology vertebrate. Rastogi publications, Meerut India.

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ZOO-II.C-4: FUNDAMENTALS OF ANIMAL AND HUMAN GENETICS

FUNDAMENTALS OF ANIMAL AND HUMAN GENETICS

COURSE CODE:	ZOO-II.C-4
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	This course is intended to provide solid understanding of concepts and principles of genetics as it applies to animals and humans. Students will receive good foundation of chromosome structure, its aberrations and inheritance patterns of traits and disease which will help one to develop conceptual skills to address questions in genetic research.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: • Describe the basic structure of genes and chromosomes. • Relate an organism's genotype and phenotype and explain the role of genes in inheritance. • Understand the reason why a given genotype does not always result in the same phenotype • Demonstrate knowledge of genetic principles and their application in society • Construct and analyze pedigrees to determine mode of inheritance of disorders and traits.

MODULE	TOPICS	CONTACT HOURS
MODULE 1: TRANSMISSION GENETICS	UNIT 1: MODES OF INHERITANCE • Mendels laws of inheritance , test cross, back cross • Gene interactions: 9:3:3:1/12:3:1 / 9:3:4 /9:6:1 / 9:7 / 15:1 / 13:3. lethal genes, penetrance. • Inheritance of Multiple Alleles and Multiple genes	06
	UNIT 2: PATTERN OF INHERITANCE BY PEDIGREES • Construction of Pedigrees • Analysis of Pedigree analysis : autosomal dominant, autosomal recessive, X-Linked dominant, X-linked recessive, Y-linked, Mitochondrial inheritance • Sex limited and Sex influenced and multifactorial inheritance disorders in humans	09
MODULE 2: CHROMOSOME STRUCTURE AND ABNORMALITIES	UNIT 3: CHROMOSOME STRUCTURE • Chromosome morphology- chromatid, Centromere, secondary constriction, chromomere • Heterochromatin and euchromatin • Chromosome structure and organization. • Human chromosomes and karyotype.	06
	UNIT 4: CHROMOSOMAL ABERRATION • Numerical aberrations: Types- Aneuploidies and Euploidies, Mosaicism, Numerical aberrations in humans • Structural Abnormalities: Types-Deletions, inversions, Translocations, duplications. Structural aberrations in humans.	09
MODULE 3: GENE MUTATIONS, SEX DETERMINATION.	UNIT 5: GENETIC MUTATIONS. • characteristics of mutations • classification of mutations (Spontaneous, Induced) molecular basis of mutations • Mutagens – physical and chemical	08
	UNIT 6: SEX DETERMINATION. • Environmental Sex Determination – hormonal, egg size, incubation temperature. • Chromosomal sex determination - XX♀and XO♂, XO ♀ and XX ♂, ZW♀ and ZZ♂, XX♀and XY♂, Diploid female and Haploid male, single gene effect. • Molecular basis of sex determination: Geneic imbalance, Sex index, Intersex and gynandomorphs, X/A Ratio. • Sex determination by Y linked genes, Dosage compensation, X-inactivation	07

PRACTICAL COMPONENT OF ZOO-II.C-4: FUNDAMENTALS OF ANIMAL AND HUMAN GENETICS. DURATION - 02 HRS /WEEK		
Sr. No	Practical	No. of Practicals
1)	Verification of Mendel's laws - monohybrid cross	01
2)	Verification of Mendel's laws - dihybrid cross	01
3)	Manual Karyotyping of human chromosome plates: 1) Normal Male and Female 2) Downs syndrome 3) Turners Syndrome	04
4)	Drosophila Culture technique	01
5)	Study of Mutants of Drosophila	01
6)	Exercises for Multiple alleles and Multiple genes	02
7)	Construction of pedigrees	01
8)	Analysis and interpretation of Pedigrees	01

REFERENCE BOOKS FOR THEORY:

1) Gardner EJ, Simmons MJ and Snustad DP (2013): Principles of Genetics, Eighth Edition, John Wiley Publication, Singapore.
2) De Robertis EDP, De Robertis EMF (2012): Cell and Molecular Biology, Eigth Edition. Wolter Kluwer Publication, Philadelphia.
3) Singh BD (2014): Fundamentals of Genetics. Second Edition, Kalyani Publishers, New Delhi.
4) Lewis R (2009): Human Genetics, Concepts and Applications, Seventh Edition. McGraw-Hill International Edition, New York.
5) Gangane SD (2009): Human genetics, Third Edition, Reed Elsevier India Pvt Ltd., Haryana India.
6) Gardner A, Davies T (2010): Human Geentics, Second Edition, Scion Publishing Ltd, UK.
7) Marcus A(2011): Genetics, MJP Publishers, Chennai.
8) Verma PS and Agarwal VK (2014): Cell Biology Genetics Molecular Biology Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.
9) Kothari ML, Mehta L, Roychoudhury SS (2009): Essentials of Human Genetics, Fifth edition, University Press Pvt. Ltd. Hyderabad.

REFERENCE BOOKS FOR PRACTICALS:

1) Gangane SD (2009): Human genetics, Third Edition, Reed Elsevier India Pvt Ltd., Haryana India.
2) Marcus A(2011): Genetics, MJP Publishers, Chennai.
3) Gardner A, Davies T (2010): Human Genetics, Second Edition, Scion Publishing Ltd, UK.
4) Lewis R (2009): Human Genetics, Concepts and Applications, Seventh Edition. McGraw-Hill International Edition, New York.

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SEMESTER –III

CORE COURSE :HUMAN PHYSIOLOGY	
COURSE CODE:	ZOO-III.C-5
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	The primary goal of this course is to offer an in-depth presentation of the function of the major organs and organ systems of the human body. The course is designed to expand physiological concepts presented in prerequisite courses.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: • describe and explain the normal function of the cells, tissues, organs, and organ systems of the human body • develop understanding of the functional relationships of anatomical structures to one another

ZOO-III.C-5: HUMAN PHYSIOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: PHYSIOLOGY OF DIGESTION AND RESPIRATION (15 Hrs	UNIT 1: *DIGESTIVE SYSTEM* • Structural organization, histology and functions of gastrointestinal tract and its associated glands; • Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins. • Role of gastrointestinal hormones on the secretion and control of enzymes of Gastrointestinal tract	08
	UNIT 2: *RESPIRATORY SYSTEM* • Histology of trachea and lung; • Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; • Transport of oxygen in the blood oxygen- hemoglobin & myoglobin , dissociation curve and the factors influencing it Carbon monoxide poisoning; Carbon dioxide transport in the blood; • Buffering action of blood and haemoglobin Control of respiration	07
MODULE 2: PHYSIOLOGY OF EXCRETION AND CIRCULATION (15 Hrs)	UNIT 3: *EXCRETORY SYSTEM* • Structure of kidney and its histological details, Renal blood supply; Mechanism urine • Formation and its regulation, Regulation of acid-base balance.	05
	UNIT 4: *CIRCULATORY SYSTEM* • An outline structure of heart; Coronary circulation; structure of conducting and working • Myocardial fibers. Origin and conduction of cardiac impulses functions of AV node; Cardiac cycle; Cardiac output and its regulation-Frank-Starling Law of the heart, nervous and chemical regulation of heart rate; Blood pressure and its regulation; Electrocardiogram • Components of blood and their functions; Structure and functions of haemoglobin; Haemopoiesis; Haemostasis and Coagulation of blood; Disorders of blood.	10
MODULE 3: PHYSIOLOGY OF NERVOUS SYSTEM, MUSCLES AND REPRODUCTIVE SYSTEM (15 hrs)	UNIT 5: *NERVOUS SYSTEM* • Structure of neuron, resting membrane potential , Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; • types of synapsis, Synaptic transmission and, Neuromuscular junction; Reflex action & its types -reflex arc • Physiology of hearing and vision	06
	UNIT 6: *MUSCLE* • Histology of different types of muscle; • Ultra structure of skeletal muscle; • Molecular and chemical basis of muscle contraction; • Characteristics of muscle twitch; Motor Unit, summation & tetanus	04
	UNIT 7: *REPRODUCTIVE SYSTEM* • Histology of male and female reproductive systems. • Puberty, Physiology of male and female reproduction.	05

PRACTICAL COMPONENT OF ZOO-III.C-5: HUMAN PHYSIOLOGY (DURATION -02 HRS /WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1)	Enumeration of red blood cells / WBC using haemocytometer	02
2)	Estimation of haemoglobin using Sahli's haemoglobinometer	01
3)	Determination of activities of digestive enzymes (Amylase, Pepsin, Trypsin and Lipase)	02
4)	Temporary preparation of Striated muscle fibers and nerve cells.	02
5)	Urine analysis (for organic, inorganic and abnormal components)	03
6)	Examination of sections of mammalian tissues: Lung, Kidney, Gonads, Intestine, Muscles, Spinal cord, Bone and cartilage	02

REFERENCE BOOKS:

Essential books:

1. *Singh HD(2011):Textbook of Human Physiology, S Chand Publishers, New Delhi.*
2. *Widmaier, Raff, & Strang(2008), Vander's Human Physiology: The Mechanisms of Body Function, 12thedition, McGraw Hill,. ISBN 978-0-07-337810-7*
3. *Tortara G J and Derrickson BH(2009). Principles of Anatomy and physiology, 12th Edition. John Wiley & sons, Inc.*
4. *Guyton Ac and Hall JE(2011). Testbook of Medical Physiology, 12th Edition, Harcourt Asia Pvt Ltd, WB Saunders Company.*

Supplementary Reading:

5. *Openstax College (2013). Anatomy and Physiology. Vol II. Mainstreet MS, Houston Texas(Ebook)*
6. *Forciea B (2012). An eText of Human Anatomy and Physiology(Ebook).*
7. *Wingerd B(2008). The Human Body, Essential Anatomy and Physiology. University Readers, SanDiego CA.*

REFERENCE BOOKS FOR PRACTICALS:

1. *Openstax College (2013). Anatomy and Physiology. Vol II. Mainstreet MS, Houston Texas(Ebook*
2. *Forciea B (2012). An eText of Human Anatomy and Physiology(Ebook).*
3. *Wingerd B(2008). The Human Body, Essential Anatomy and Physiology. University Readers, SanDiego CA.*

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SEMESTER - IV

CORE COURSE: BIOCHEMISTRY AND METABOLIC REGULATION	
COURSE CODE:	ZOO-IV.C-6
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To understand the basic principles that govern the functioning of living systems • To know the structure of biomolecules and the role they play in governing life processes through the pathways • To be familiar with enzymes and their activities
LEARNING OUTCOME:	At the end of the course, the students will be able to understand better the chemical basis in life. They will appreciate better the interactions between the biological molecules.

ZOO-IV.C-6: BIOCHEMISTRY AND METABOLIC REGULATION		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: **Fundamentals of biochemistry and Carbohydrate metabolism**	1.1 Principles of pH, buffer, thermodynamics 1.2Enzymes: classification, properties of enzyme, enzyme kinetics, MichaelisMenten Equation, enzyme inhibition 1.3 Carbohydrate structure, aerobic and anaerobic glycolysis, Citric acid cycle, glycogenesis, glycogenolysis, Pentose phosphate pathway, 1.4 Diabetes mellitus	**15**
MODULE 2: **Lipid and Protein metabolism**	2.1: Lipid: -structure and classification, -fatty acid synthesis -fatty acidoxidation(saturated and unsaturated), - metabolism of glycerophospholipids, sphingolipids, cholesterol - disorders: fatty liver types (NAFL, AFL) 2.2 Protein: - structure(primary, secondary, tertiary) and classification -amino acid biosynthesis, nucleotide biosynthesis, - amino acid catabolism, urea cycle, Fate of carbamoyl P, - Hyper uricemia	**15**
MODULE 3: **Nucleotide metabolism and integration of metabolism**	3.1Biosynthesis of purine and pyrimidine (de novo and salvage pathway) 3.2 Degrdation of purine and pyrimidine 3.3 Interconversions between the three principal components 3.4 Metabolism in starvation: Carbohydrate, lipid, proteins (The feed/fast cycle)	**15**

PRACTICAL COMPONENT OF ZOO-IV.C-6: BIOCHEMISTRY AND METABOLIC REGULATION (DURATION -02 HRS /WEEK)		
Sr. No	Practical	No. of Practicals
1)	Principle and working of spectrophotometer	01
2)	Estimation of reducing sugars DNSA method	01
3)	Estimation of protein – Folin Lowry's method	01
4)	Estimation of fatty acids by titration method	01
5)	Separation of lipids by thin layer chromatography	02
6)	Colorimetric estimation of liver glycogen of chick by Anthrone method	02
7)	Effect of substrate concentration on amylase activity	01
8)	Estimation of DNA by DPA method	01
9)	Isolation of lecithin and cholesterol from yolk	02

REFERENCE BOOKS:

1. David, L.N. and Cox, M. Michael (2008) Lehninger principles of biochemistry. W.H. Freeman and Company, New York.
2. Delvin, T.M. (1997). Textbook of biochemistry with clinical correlations. Wiley liss.
3. Harvey, A.R. and Ferrier, D. (2011). Lippincott's Illustrated Reviews Biochemistry. Wolters Kluwer, Lippincott Williams and Wilkins. 5th Edition.
4. Pratt, W.C. and K. Cornely 2003 Essential Biochemistry Wiley Publications third edition.

REFERENCE BOOKS FOR PRACTICALS:

Plummer, M. and D.T. Plummer (1988) Introduction to practical biochemistry.Tata McGraw Hill Education ,UK.

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SEMESTER – V

CORE COURSE:DEVELOPMENTAL BIOLOGY	
COURSE CODE:	ZOO-V.C-7
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To understand the processes of fertilization, polyspermy and activation of egg metabolism • To know the basics of animal development, specifically in sea urchin and chick • To be familiar with the processes that help in the establishment of basic plan of development
LEARNING OUTCOME:	• At the end of the course, the students will be able to understand the basic plan of animal development. They will be familiar with the processes which occur during the course of development in invertebrates and vertebrates. This paper will provide the basic knowledge of developmental biology.

ZOO-V.C-7: CORE COURSE:DEVELOPMENTAL BIOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Early embryonic development and early development of model organism: sea urchin	1.1: Introduction to cell division: mitosis and meiosis 1.2: Fertilization: structure of the gametes 1.3: Species recognition specificity of egg and sperm 1.4: Gamete fusion and the prevention of polyspermy 1.5: The activation of egg metabolism 1.6: Fusion of the genetic material 1.7: Rearrangement of the egg cytoplasm 1.8: Sea Urchin: cleavage, gastrulation, blastula formation 1.9: Fate maps and the determination of sea urchin blastomeres, gastrulation 1.10: Embryonic stem cells: Pluripotency and tutipotency	05 04 06
MODULE 2: Early development of model organism: chick	2.1: Chick: cleavage, gastrulation, primitive streak, epiboly 2.2: Axis formation in the chick embryo 2.3: Development upto three days of incubation 2.4: Extra embryonic membranes of chick development, structure and functions of yolk sac, amnion, chorion and allantois	05 07 03
MODULE 3: Growth and regeneration	3.1: Nuclear transplantations and embryonic inductions 3.2: Size and proportion, aging, theories of ageing, postnatal disorders of growth and differentiation 3.3: Distribution of regenerative capacity, Planarian regeneration, regeneration of limb and tail in vertebrates 3.4: Hejmadi Mohanty's experiment	04 06 05

PRACTICAL COMPONENT OF ZOO-V.C-7 (DURATION -02 HRS /WEEK)		
SR. NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1)	Observation of developmental stages of sea urchin: cleavage, blastula, gastrula (permanent slides)	01
2)	Study of morphogenetic movement *in vivo* in hens egg using vital staining technique by preparing window opening	01
3)	*In vitro* observation of different extra embryonic membrane in a six days old chick embryo	01
4)	Preparation of permanent slides of chick embryo: 24 hours, 36 hours,48 hours, 72 hours	06
5)	Effect of retinoic acid on regeneration of fin in fish	01
6)	Mounting of eye vesicles and limb buds of six day old chick embryo	01
7)	Effect of lead acetate / mercuric chloride on the neural tube development of chick embryo	01

REFERENCE BOOKS:

1. *Gilberts, S.F. (2013). Developmental Biology, Sinauer Associates, Sunderland.*
2. *Jain, P.C. (2013). Elements of developmental biology, Vishal Publications, Jalandhar*
3. *Slack, J.M.W. (2006). Essential developmental biology. Blackwell Publishing, U.K.*

REFERENCE BOOKS FOR PRACTICALS:

1. *Beffa – Mari, M. And J. Knight (2005) Key experiments in practical developmental biology. Cambridge University Press.*
2. *Tyler, M.S. (2000) Developmental biology, a guide for experimental study. Sinauer Associates, Inc. Publishers, Sunderland, MA.*

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SEMESTER – VI

CORE COURSE: WILDLIFE BIOLOGY	
COURSE CODE	**ZOO-VI-C-8**
MARKS	100 [75 –Theory ; 25- Practical]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES	This course is designed to enable students to understand the basics of wildlife status, conservation, assessment and management.
LEARNING OUTCOME	Upon successful completion of the course, students will be able to: ▪ Know the techniques used in assessment and monitoring of wildlife. ▪ Know about the diversity, extent, range of wildlife population dynamics.

ZOO-VI-C-8: WILDLIFE BIOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: INTRODUCTION TO WILDLIFE	UNIT 1: Introduction to wildlife • Values of wildlife - Conservation ethics, Importance of conservation, Causes of depletion, World conservation strategies. UNIT 2: Evaluation and management of wildlife • Habitat analyses, Physical parameters: Topography, Geology, Soil and water. • Biological Parameters: food, cover, forage, browse and ground cover estimation. • Standard evaluation procedures: remote sensing and GIS.	15
MODULE 2: POPULATION ESTIMATION AND PROTECTED AREAS	UNIT 3: Population estimation • Population density, natality, mortality, fertility schedules and sex ratio computation. • Analysis of scat and dropping of ungulates and carnivores. • Trichotaxonomy, pug marks and census method based on indirect evidences. UNIT 4: Protected areas • Protected Area network (PAN): National parks and wildlife sanctuaries. • Biogeographical features of important features of protected areas in India (any 3). • Tiger conservation - tiger reserves in India, challenges and management of tiger reserves.	15
MODULE 3: MANAGEMENT OF WILDLIFE	UNIT 5: Management of habitats • Setting back succession, grazing logging, mechanical treatment, advancing the succession process, artificial feeding grounds. • Cover construction, preservation of general genetic diversity, restoration of degraded habitats, UNIT 6: Management planning of wildlife in protected areas • Habitat carrying capacity, visitors carrying capacity, eco tourism / wild life tourism, concept of climax persistence, ecology of perturbance. • Role of national / state statutory bodies on governing wildlife (NBWL, IUCN, CITES, state wildlife boards and forest department). UNIT 8: Management ofcritical population • Radio- telemetry, care of injured and diseased animal, quarantine, common diseases of wild animals, capture and translocation of wildlife. • Captive management – a brief idea.	15

PRACTICAL COMPONENT OF WILDLIFE BIOLOGY ZOO-VI-C-8: (DURATION: 30 HOURS – 02hrs/WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1)	Study of butterflies and their host plants on the campus / molluscs/ ants/ spiders / birds	02
2)	Acquainting oneself with basic equipment needed in wildlife studies; use, care and maintenance (compass, binoculars, spotting scope, range finders, Global Positioning System, various types of cameras and lenses)	02
3)	Familiarization and study of species specific evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers, feathers, etc. – case study	02
4)	Demonstration of various field techniques for flora and fauna: PCQ, Ten tree method, Circular, Square and rectangular plots, Parker's 2 Step and other methods for ground cover assessment, Tree canopy cover assessment, Shrub cover assessment	03
5)	Trail / transect-quadrate monitoring for abundance and diversity estimation of mammals and birds (direct and indirect evidences) (on campus or fieldtrip)	03

REFERENCE BOOKS:

1. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
2. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence. Cambridge University.
3. Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5th edition. The Wildlife Society, Allen Press.
4. Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences
5. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.

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PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
(Autonomous)
PROGRAMME BSC ZOOLOGY
COURSE CURRICULUM - ELECTIVE COURSES

<table>
<tr><th></th><th>SEMESTE R</th><th>COURSE CODE</th><th>CORE COURSES</th></tr>
<tr><td rowspan="8">ODD SEMESTER</td><td rowspan="4">III</td><td>ZOO-III.E-1</td><td>Vertebrate Endocrinology</td></tr>
<tr><td>ZOO-III.E-2</td><td>Basic microbiology and Fundamentals of Animal Biotechnology</td></tr>
<tr><td>ZOO-III.E-3</td><td>Environmental Toxicology</td></tr>
<tr><td>ZOO-III.E-4</td><td>Parasitology</td></tr>
<tr><td rowspan="4">V</td><td>ZOO-V.E-9</td><td>Molecular Genetics and Forensic Science</td></tr>
<tr><td>ZOO-V.E-10</td><td>Economic Zoology</td></tr>
<tr><td>ZOO-V.E-11</td><td>Ecology and Ethology</td></tr>
<tr><td>ZOO-V.E-12</td><td>Fish Preservation and Processing</td></tr>
<tr><td rowspan="8">EVEN SEMESTER</td><td rowspan="4">IV</td><td>ZOO-IV.E-5</td><td>Animal cell culture and Applications</td></tr>
<tr><td>ZOO-IV.E-6</td><td>Aquaculture and Fisheries</td></tr>
<tr><td>ZOO-IV.E-7</td><td>Immunology</td></tr>
<tr><td>ZOO-IV.E-8</td><td>Evolutionary Biology</td></tr>
<tr><td rowspan="4">VI</td><td>ZOO-VI.E-13</td><td>Health and Nutrition</td></tr>
<tr><td>ZOO-VI.E-14</td><td>Basic and Applied Entomology</td></tr>
<tr><td>ZOO-VI.E-15</td><td>Laboratory Techniques in Pathology</td></tr>
<tr><td>ZOO-VI.E-16</td><td>Bio Entrepreneurship</td></tr>
</table>

ODD SEMESTER

SEMESTER – III

ELECTIVE COURSE: ENDOCRINOLOGY	
COURSE CODE:	ZOO-III.E-1
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To study the endocrine organs of vertebrates • To understand the underlying principles of hormone functions • To gain an insight into the current and important issues in endocrinology
LEARNING OUTCOME:	At the end of the course, the students will be familiar with all the endocrine organs and their functions in body growth, metabolism, reproduction and development. They will be able to appreciate better the contemporary issues in endocrinology.

ZOO-III.E-1: ENDOCRINOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: **Anatomy and histology**	Unit 1: 1.1 Aim and scope of endocrinology, 1.2 techniques in endocrinology - histology, histochemistry, immunocytochemistry, in situ hybridisation, radio immune assay, surgical techniques, 1.3 regulation of hormone secretion: feedback mechanisms - positive, negative, short loop, long loop	15
	Unit 2: 2.1 Anatomy and histology of endocrine glands- Pituitary, Pineal gland, Thyroid, Parathyroid, Thymus, Adrenal, Endocrine pancreas, GI tract, Endocrine hypothalamus, Gonads, Placenta	
MODULE 2: **Hormones**	Unit 3: 3.1 Classification of hormones 3.2 Hormone structure 3.3 Biological actions of hormones	15
	Unit 4: 4.1 Mechanisms of hormone action 4.2 Receptor and it regulation 4.3 Steroid and peptide hormones actions	
	Unit 5: 5.1 Hormones and Homeostasis - Calcium and glucose	
MODULE 3: **Pathological conditions**	Unit 6: 6.1 Biosynthesis and secretion of hormones - steroid hormones, thyroid hormones	15
	Unit 7: 7.1 Growth factors - neurotropic growth factors, hematopoietic growth factors, other peptide growth factors	
	Unit 8: 8.1 Endocrine disorders - goitre, gigantism, dwarfism, cretinism, diabetes mellitus, insepidus	

PRACTICAL COMPONENT OF ZOO-II.C-3: Vertebrate Endocrinology (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1)	Histological slides ofEndocrine hypothalamus, Gonads, Placenta pituitary, Pineal gland, thyroid gland, Parathyroid,Thymus, adrenal gland, pancreas, ovary, testis	04
2)	Display of Pituitary and gonads in fishes/chick	03
3)	Preparation of histological slides using microtomy	05

REFERENCE BOOKS:

1. David, N.O. and J.A. Carr (2013) Vertebrate Endocrinology. Academic press publications 5th edition.
2. Hadley, M. and Levine, J (2006) Endocrinology. Benjamin Cummings 6th edition.
3. Kovacs, J.W. and S.R. Ojeda (2011) Textbook of endocrine physiology 6th edition. Oxford university press.
4. Yadav, P.R. (2004) Endocrinology. Discovery Publishing House, New Delhi.

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ELECTIVE COURSE: BASIC MICROBIOLOGY AND FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY	
COURSE CODE:	ZOO-III-E-2
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	To provide a comprehensive survey of microbiology with basic information on bacteria and learn the fundamentals of biotechnological techniques.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: • Gain working knowledge of basic bacterial laboratory techniques, as well as the foundations of biotechnological tools. • Students will also master the basic laboratory skills and techniques necessary to work efficiently in a microbiology laboratory and perform techniques of gene insertion and selection of recombinant plasmids.

ZOO-III-E-2: BASIC MICROBIOLOGY AND FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Microbiology (15 hrs)	1: Introduction to Microorganisms-Bacteria o Structure and Identification of bacteria(morphological types) o Nutritional types o Nutritional requirements	08
	2: Isolation and Culture of Bacteria: o Cultivation of bacteria o Different methods of isolation and maintenance of pure cultures o Culture characteristics	04
	3: Use of microorganisms in biotechnology-An overview: o Production of valuable substances o Fuel Production, recovery of minerals and oils o Microorganisms in bioassays o Food and agriculture sector o Medicine and health	03
MODULE 2: Tools in Biotechnology (15 hrs)	4: Scope and importance of Biotechnology o Definition o Contribution and importance of biotechnology	03
	5: Nucleic Acid Enzymology: o Restriction enzymes, Ligases, Alkaline phosphatase o Polynucleotide kinase, Terminal Transferases, S1 Nuclease o Polymerases, Reverse transcriptase	07
	6: Gene Cloning vectors: o Plasmids, Bacteriophage, cosmids o Shuttle and expression vectors	05
MODULE 3: Genetic Engineering (15 hrs)	7: Techniques in genetic engineering: o Gene transfer methods o Methods of Labeling Nucleic acids o Nucleic acid Hybridization o Polymerase chain reaction	05
	8: Recombinant DNA technology: o Procedure / Technique	04
	9: Blotting Techniques: o Southern Blotting o Northern Blotting o Western Blotting	03
	10: DNA sequencing techniques: o Chemical Degradation method o Chain termination method o Automated Sequencing	03

PRACTICAL COMPONENT OF ZOO-III-E-2: DURATION - 02 HRS /WEEK BASIC MICROBIOLOGY & FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1)	Preparation of culture media for bacteria (Plates, Slants, deeps, Broth).	02
2)	Staining of Microorganisms (Gram staining, negative staining).	02
3)	Isolation of pure colonies of Bacteria (streak plate method – 3 Quadrant And 5 Quadrant methods)	02
4)	Identification of Products of metabolic pathways of microbial cells.	01
5)	Bacteriological testing of Milk.	01
6)	DNA sequencing - Analysis of prints.	01
7)	Isolation of Plasmid DNA (Demonstration)	02
8)	Transformation of bacteria (Selection by blue-white colony method – demonstration practical	02

REFERENCE BOOKS:

Essential books:

1) *Pelczar MJ, Chan ECS, Krieg NR(2009). Microbiology. Tata Mc Graw Hill, New York.*
2) *Dubey RC and Maheshwari DK (2012). A test book of Microbiology. S Chand Publishers, New Delhi.*
3) *Prave P, Faust U, Sittig W and Sukatsh DA(2004). Fundamentals of Biotechnolgy.*
4) *Purohit SS(2008). BiotechnologyFundamentals and applications. Agrobios, Jodhpur India.*
5) *Ranga MM(2012): Animal Biotechnology. Agrobios, Jodhpur India.*

Supplementary reading:

6) *Black JG(2005). Microbiology principles and explorations. John Wiley and sons Inc.*
7) *Sullia SB and Shantharam S(2006). General Microbiology. Oxford and IBH Publishing Co Pvt Ltd, NewDelhi.*

REFERENCE BOOKS FOR PRACTICALS*:*

1) *Gunasekaran P(2009). Lab Manual in Microbiology. New Age International Ltd. Publishers, New Delhi.*

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ELECTIVE COURSE: ENVIRONMENTAL TOXICOLOGY	
COURSE CODE:	ZOO-III-E-3
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To study the different environmental pollutants and their toxicity. • To know the physiological effects of toxicant exposure.
LEARNING OUTCOME:	After completion of the course students are expected to be able to: • Distinguish,classify and characterize a variety of environmental pollutants based on their biological and physical properties. • Identify the main sources and types of environmental pollutants and assess their potential environmental fate. • Will learn mechanisms of detoxification of various varieties of toxicants. • Will learn bio-indicators of exposure to specific environmental contaminants. • Identify potential solutions to anthropogenic pollution

ZOO-III-E-3: ENVIRONMENTAL TOXICOLOGY		
MODULE	**TOPIC**	**CONTACT HOURS**
MODULE 1: INTRODUCTION TO TOXICOLOGY	**1.1Introduction To Toxicology:** o Definition and History of Toxicology and Toxicity o Disciplines of Toxicology o Biouptake,Bioaccumulation,Biotransfer and Biological Magnification, Relationship to Other Sciences, Scope and importance of Toxicology **1.2: Classes Of Toxicant:** • Define Toxicant and Toxins, their classification • Toxicants in Air, Water and Soil • Toxicants in Domestic and Occupational Settings • Synthetic drugs: Solvents; Therapeutic drugs, Drugs of abuse,Combustion products,Cosmetics • Movement and fate of Toxicants in the environment	**15**
MODULE 2: ENVIRONMENTAL IMPACT MITIGATION	**2.1: Toxicity Of Heavy Metals:** • Toxicity of Arsenic, Lead, Mercury, • Cadmium,Copper, Zinc, Aluminium,Iron and Manganese; Sources and portals of heavy metal pollutants; Toxicity of substances on Human and Animals **2.2: Agro-Chemical Pesticides And Their Environmental Impact Mitigation** • Definition and Classification • Organochlorine Insecticides, Organophosphate Insecticides, Carbamates, Pyrethroid Insecticides, Dinitrophenols, Herbicides, Fungicide • Control of Pesticide Pollution; Integrated Pest management	**15**
MODULE 3: TOXINS AND FOOD ADDITIVES	**3.1:Toxins:** • History, Classes of Toxicants: Microbial, Mycotoxins, Algaltoxins, Planttoxins, Animaltoxins, **3.2: Food Additives:** • General account of Food Additives: • Incidental or Indirect additives • Intentional or Direct additives: **a.**Antioxidants b. Emulsifiers c. Enzymes d. Flavouring agents e. Colour and preservatives f. Artificial sweetening agents i)Saccharine ii)Urea derivatives	**15**

PRACTICAL COMPONENT OF ZOO-III.E-3:ENVIRONMENTAL TOXICOLOGY (DURATION-02 HRS/WEEK)		
Sr.No.	**Practical**	**No.of Practicals**
1.	To determine the effect of temperature on the toxicity of a pollutant	01
2.	To determine the effect of pH on the toxicity of a pollutant.	01
3.	To Separate and analyse the residues of carbamate pesticides by thin layer chromatography.	01
4.	To evaluate qualitatively the presence of pesticide residues in vegetable samples.	01
5.	Estimation of total dissolved solids in given water sample.	01
6.	To determine Lc^{50} of a pollutant on mosquito larvae .	02
7.	Effect of pesticides on Oxygen consumption in fish	01
8.	Estimation of Phosphorus in given water sample by Spectrophotometer	01
9.	Estimation of Boron from given water/soil sample by spectrophotometer	01
10.	Estimation of Primary Productivity by Light and Dark bottle method.	02
11.	Estimation of Fluorides in given water sample	01
12.	Determination of Nitrates from given water sample.	**01**

REFERENCE BOOKS FOR THEORY:

1. Ernst Hodgson(2004) A Text Book of Modern Toxicology ,A John Wiley and sons Inc,Publication.
2. Gupta P.K.(2010) Modern Toxicology, Pharma Med Press, Hyderabad.
3. Omkar(2007) Concepts of Toxicology ,Vishal Publishing Co, Jalandhar
4. Pandey K,Shukla J.P. and Trivedi S.P. (2011)Fundamentals of Toxicology,New Central Book Agency(P) Ltd.
5. P.D.Sharma (2011)Environmental Biology and Toxicology (Third edition),Rastogi Publications,Meerut-250002.

REFERENCE BOOKS FOR PRACTICALS:

1. Adam Wooley (2008) A Guide to PracticaL Toxicology:Evaluation,Prediction,and Risk IInd Edition,Informa Healthcare U.S.A.,Inc. New York.
2. Rao K.S. (1998) Practical Ecology,Anmol Publications Pvt. Ltd. New Delhi.

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ELECTIVE COURSE: PARASITOLOGY	
PAPER CODE:	ZOO-III.E-4
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To be familiar with the parasite host interactions. • To gain knowledge on diagnosis of parasite infections and also to learn about the preventive measures.
LEARNING OUTCOME:	At the end of the course the learner will be acquainted with dimensions of public health viz a viz parasitic diversity, epidemiology and community prophylaxis

ZOO-III.E-4: PARASITOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: **Basic Principles of Parasitology and parasitic protozoans**	1.1 Parasite systematics, Ecology and Evolution 1.2 Immunology and Pathology 1.3 Symbiosis and parasitism 1.4 Parasite host interactions Form, function, classification, life cycle, diagnosis and preventive measures *1.5 Trypanosomagambiens* 1.6 Amoebas -*Entamoebahistolytica* *1.7* Malaria organisms - *Plasmodium vivax* 1.8 Sexually transmitted parasite - *Trichomonasvaginalis*	**15**
MODULE 2: Parasitic Platyhelmithes and Nematodes	Form, function, classification, life cycle, diagnosis and preventive measures 2.1 Trematoda(liver fluke - *Fasciola hepatica*, intestinal fluke - *Fasciolopsisbuski*, lung fluke - *Paragonimuswestermani*); 2.2 Cestoda (Tape worm - *Taeniasolium*) 2.3 Hook worms- *Ancyclostoma duodena* 2.4Guinea worm- *Dracanculusmedinensis* 2.5Round worm*Ascarislumbricoids, Enterobiasvermicularis* 2.6 *Wuchereriabancrofti*	**15**
MODULE 3: Parasitic arthropods and Parasites of domestic livestock	Form, function, classification , life cycle, diagnosis and preventive measures: Copepods, Barnacles, Amphipods, Isopods, Flea, Ticks, Mites, Head and pubic lice	**15**

PRACTICAL COMPONENT OF ZOO-III.E-4: PARASITOLOGY (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1)	Study of*Trypanosomagambiens, Entamoebahistolytica, Plasmodiumvivax, Trichomonasvaginalis, Fasciola hepatica,Taeniasolium, Ancyclostoma duodena, Dracanculusmedinensis, Ascarislumbricoids, Wuchereriabancrofti*, copepod, barnacle, amphipod, isopod from permanent slides with respect to parasitic adaptations.	06
2)	Preparation of peripheral blood smear from the perspective of detection of haemoparasites	01
3)	Study of parasites of domestic livestock(parasite, pathogenicity)	04
4)	Study of fish parasites	01

REFERENCE BOOKS:

1. Chatterjee, K.D. (2009) Parasitology (Protozoology and Helminthology) with two hundred fourteen illustrations. CBS, 13th edition.
2. Dey, N.C., Dey, T.K. and D.M. Sinha (1995) Medical Parasitology. New Central book agency private limited, Calcutta.
3. Paniker, J.C.K. (2007) Textbook of medical parasitology. Jaypee Brothers, New Delhi.
4. Schmidt, G.D. (1990) Essentials of Parassitology. Universal Book Stall, New Delhi.

REFERENCE BOOK FOR PRACTICALS:

1. Halton, D.W., Behnke, J.M. and I. Marshall (2005) Practical exercises in parasitology. Cambridge University Press.

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SEMESTER – V

ELECTIVE COURSE: MOLECULAR GENETICS AND FORENSIC SCIENCE	
COURSE CODE	ZOO-V.E-9
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	This course will ellucidate the functional aspects of the genetic material at molecular level, focusing on gene expression and gene regulation. It will also expose students to the basics of forensic science and understand diagnostic genetics.
LEARNING OUTCOME	Upon successful completion of the course, students will be able to understand: ▪ The process of replication, transcription and translation ▪ Difference between the gene expression in prokaryotes and eukaryotes ▪ Branches of forensic science ▪ The molecular tools used in genetic diagnosis

ZOO-V.E-9: MOLECULAR GENETICS AND FORENSIC SCIENCE		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1 : Gene Expression and Gene Regulation	1.1 : DNA Replication: DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication 1.2: Transcription: transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors 1.3 : Translation: Genetic code, Process of protein synthesis, Difference between prokaryotic and eukaryotic translation, Post Transcriptional Modifications and Processing of Eukaryotic RNA 1.4: Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac-operon and trp-operon; Transcription regulation in eukaryotes: Activators,repressors, enhancers, silencers elements; Gene silencing	2 5 4 4
MODULE 2 : Basics of Forensic Science	2.1 : Definition, overview of Disciplines of Forensic science 2.2: Crime and Crime Scene management: Types of crime scenes – indoor and outdoor. Securing and isolating the crime scene. Crime scene search methods. Safety measures at crime scenes. Legal considerations at crime scenes. Documentation of crime scenes – photography, videography, sketching and recording notes. 2.3: Forms of forensic evidences: -Biological evidence: Bloodstains, hair, semen, DNA -Physical and trace evidence –pattern of blood stains, fingerprints, fibres, weapons - Documents- types of forensic documents (genuine /forged),methods of detecting forged documents(handwriting analysis, Analysis of paper and inks)	3 6 6
MODULE 3 : Diagnostic Genetics	3.1 : Cytogenetics/ Molecular Cytogenetics/ Biochemical/ Molecular methods of detecting genetic disorders - Adult and Newborn screening 3.2: Cytogenetics/ Molecular Cytogenetics/ Molecular methods of detecting genetic disorders – Prenatal and Preimplantation screening 3.3: Forensic testing - DNA fingerprinting, paternity testing, personal /individual identification	6 5 4

PRACTICAL COMPONENT OF ZOO–V.E-9: MOLECULAR GENETICS AND FORENSIC SCIENCE (DURATION -02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Isolation of DNA from peripheral blood/tissue (chick liver).	01
2	Microscopic examination of Hair a. Human scalp Hair b. Animal Hair	02
3	Sketching and Photography of various type of crime scene.	02
4	Presumptive Tests for Blood a. Phenolphthalin Assay b. Benzidine c. Leucomalachite Green (L.M.G.) d. Luminol Test	02
5	Examination of ink by TLC method	01
6	To perform ridge tracings and ridge counting	01
7	Analysis of DNA fingerprints	03

REFERENCE BOOKS :

1) *J. Prahlow (2010); Forensic Pathology for Police, Death Investigators, Attorneys, 17 and Forensic Scientists, DOI 10.1007/978-1-59745-404-9_2, C Springer Science + Business Media, LLC (Ebook available)*
2) *Robert Schleif (1993). Genetics and Molecular Biology. S E C O N D E D I T I O N. Department of Biology,The Johns Hopkins University, Baltimore, Maryland. The Johns Hopkins University Press 2715 North Charles Street Baltimore, Maryland 21218-4319, The Johns Hopkins Press Ltd., London (Ebook available)*
3) *Richard Saferstein (2011); Forensic Science,II Edition, Prentice Hall publishers, Sanfrancisco*
4) *Griffith A, Wesseler S, Lewontin R Gelbart W, Suzuki D and Miller J(2000). Introduction to Genetic Analysis. Eigth Edition.(Ebook available)*
5) *Tom Strachan and Read A (2010): Human Molecular Genetics. Fourth Edition. Garland Science Publisher, New York, NY 10017*

REFERENCES BOOKS FOR PRACTICALS:

1) *Hikmet Geckil ().Molecular Biology Lab manual. UMBC. (Ebook available).*
2) *J. Prahlow (2010); Forensic Pathology for Police, Death Investigators, Attorneys, 17 and Forensic Scientists, DOI 10.1007/978-1-59745-404-9_2, C Springer Science+Business Media, LLC (Ebook available.)*

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ELECTIVE COURSE: ECONOMIC ZOOLOGY	
COURSE CODE	ZOO-V.E-10
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	To study the various aspects of economic zoology To study the species of economic importance, classification To gain an insight whether own business can be started based on studying the zoological species and their products
LEARNING OUTCOME	How zoological species contribute to economic sources can be learned. Students will learn the techniques of rearing and maintenance of the species, harvesting their products and selling of species and the products

ZOO-V.E- 10 : ECONOMIC ZOOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1 : Scope of Economic Zoology	1.1 : Economic Zoology, History, Scope, 1.2 : Species of bionomic importance (Honey bee, Silkworm, lac insect, mackerel, domestic fowl, goat, sheep, cow, buffalo, pig, rats, mice) 1.3 : Source, properties, constituents and nutritive value of products of bionomic importance: eggs of poultry, milk, meat, honey, medicinal value of synthetic insulin (recombinant), significance of wool, silk, lac 1.4 : Organizations and their functions: agricultural and processed food products export development authority (APEDA), the marine products exports developmental authority (MPEDA), central silk board (CSB), central bee research and training institute (CBRTI), pharmaceutical and biotechnology industries (Lupin) and contract research organizations (Intox), and research institutes (NIN, Hyderabad)	3 3 5 4
MODULE 2 : Models in Economic Zoology	2.1 : Insects, products and applications : lac insects, honey bees, silkworms 2.2 : Vermiculture: Rearing and maintenance of earthworms 2.3 : Aquaculture : rearing and maintenance of prawns,oysters, edible and ornamental fishes 2.4 : Poultry : rearing and maintenance of domestic fowl, applications and products 2.5 : Business models of apiculture, sericulture, aquaculture and poultry	3 2 3 3 4
MODULE 3 : Pharma products and biological control	3.1 : Pharmaceuticals from animals and their Applications (antiserum), from transgenic animals (malaria vaccine, alpha 1 antitrypsin, lactoferrin, fibrinogen) 3.2 : Species used in biological control : *Casnoidea indica*, Trichogramma, *Poecilia reticulata / Gambusia affinis* 3.3 : Maintenance and breeding of animals for research: mice, rats, guinea pigs, rabbits, marmosets, guidelines given by committee for the purpose of control and supervision of experiments on animals (CPCSEA)	5 5 5

PRACTICAL COMPONENT OF ZOO-V.E-10 (DURATION - 02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Vermicomposting	05
2	Preparation of dairy products from milk : cheese and butter	02
3	Laboratory observations of insects – Honeybee, Silk moth, Lac insect	01
4	Visit to dairy industry/poultry/ piggery/apiary/silk industry/ biotechnology industry/pharmaceutical industry/research institute	04

REFERENCE BOOKS :

1) *G. S. Shukla, V. B. Upadhyay (2008) Economic Zoology, Rastogi Publications, Meerut*
2) *H. Osborn (1908) Economic Zoology an introductory text book in zoology with special reference to its applications in agriculture, commerce and medicine The Macmillan Company*
3) *K. P. Shrivastava, Gs Dhaliwal (2015) Text Book of Applied Entomology Kalyani Publishers*
4) *P. K. Gupta (2011) Vermicomposting for Sustainable Agriculture, Agrobios India Ltd*
5) *S. Singh (1962) Bee-Keeping in India ICAR New Delhi p. 214*

REFERENCE BOOKS FOR PRACTICALS:

1) *A. K. Tripathi* ***(2009)*** *Mulberry Sericulture: Problems And Prospects Aph Publishing Corporation*
2) *C.L. Metcalf and W.P Flint (1962) Destructive and Useful Insects New York, N.Y. : McGraw-Hill*

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ELECTIVE COURSE: ECOLOGY AND ETHOLOGY	
COURSE CODE	ZOO-V.E-11
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	• To study the distribution of organisms, their interrelations in populations and communities and interactions between biotic and abiotic components • To study impact of anthropogenic activities on ecosystem and study behaviour of organisms under natural conditions
LEARNING OUTCOME	• The student will gain better understanding in ecology and ethology • This course also has applied value towards conservation of biodiversity and sustainable development

ZOO-V.E- 11 : ECOLOGY AND ETHOLOGY

MODULE	TOPICS	CONTACT HOURS
MODULE 1 : Basic Ecology	1.1 :Introduction to Ecology : What is Ecology? History of ecology, ecology today, scope of ecology, objective of study,subdivisions of ecology 1.2 : Ecosystem Ecology:kinds of ecosystem (marine, fresh water, terrestrial),Gaia hypothesis, deep ecology, energy flow within the Ecosystem,food chains and energy flow,ecological pyramids, ecological niche nutrient and Cycling of trace elements: Cobalt (Co), Molybdenum (Mo) and Lead. 1.3: Population Ecology:population density,natality, mortality,survivorship curve and life tables,age distribution,biotic potential of population, growth models, population dispersal, regulation of population, co-operative and disoperative coactions and carrying capacity,predator –prey relationships,symbiosis	03 06 06
MODULE 2 : Conservation Ecology and Basic Ethology	2.1: Community Ecology:characters of a community, classification of a community,community periodism, community stratification,community succession 2.2: Biodiversity and conservation: application of ecology inbiodiversity conservation 2.3:Introduction to Ethology: the history of ethology,approaches to study of behavior, types of behavior – instinct and learning,economic andsocial aspect of behaviour, ethologists and their work – Lorenz, Tinbergen, Goodall, M.K. Chandrashekar, animal behaviour :an evolutionary approach 2.4: Concept of Ethology:stimuluous –response concept,reflexes, innate releasing mechanisms,fixed action pattern,ethogram releaser,motivation or drive with respect to hunger and sexual behaviour	03 04 04 04
MODULE 3 : Advanced Ethology	3.1 : Approaches to studying behaviour, methods associated with neurophysiological approach,psychological and ethological approach. 3.2: Pheromones :introduction,types of pheromones,the primer pheromones,the imprinting pheromones 3.3:Hormones: effect of hormones on sexual behaviour,maternal behaviour,territorial marking, learning and memory 3.4:Patterns of behavior :feeding, aggressive and reproductive behavior, biological clocks 3.5:Communication behavior :introduction,communication signals,communication among bees: Honeybee dances	03 03 03 03 03

PRACTICAL COMPONENT OF ZOO–V.E-11: ECOLOGY AND ETHOLOGY (DURATION -02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Determination of population density in a natural/hypothetical community by Quadrats method and calculation of Shannon-Weiner diversity Index for the same community	02
2	Study of an aquatic/mangrove ecosystem: Mmeasurement of the area,temperature,turbidity,determination of pH,and dissolved oxygen content (Winkler's method),and free CO_2	04
3	To study the habituation to light stimulus in earthworm/crabs/snails/ spider web	01
4	To demonstrate photactic and geotactic responses of the animal provided earthworm/crabs	01
5	Study of Life Tables and plotting of surviourship curves of different types from the hypothetical/real data provided.	01
6	Report on a visit to National Parks/Biodiversity Parks/Wild life sanctuary	03

REFERENCE BOOKS :

1. *Arora, Mohan. P. (2004) : Ecology , Himalaya Publishing House*
2. *Aubrey Manning and stamp Dawkins (1997) : An Introduction to Animal behaviour (fourth edition), Cambridge University Press.*
3. *Dash M. C. (2001) : Fundamental of Ecology , Tata Mc Graw – Hill publishing Company Limited New Delhi*
4. *Felicity Huntingford (1984) : The study of Animal behaviour , Chapman and Hall.*
5. *Hoshang S. Gundevia and Hare Govind Singh (2006) : A Text Book of Animal Behaviour, S. Chand & Company LTD. New Delhi-110055.*
6. *Juneja Kavita (2002) : Ecology , Anmol Publications PVT. LTD. New Delhi-110002 (India)*
7. *Mathur Reena (1994) : Animal Behaviour, Rastogi and Company, Meerut-250002 India.*
8. *Rana, S. V. S.(2003) : Essentials of Ecology and Environmental Science ,Prentice- Hall of India Private Limited , New Delhi-110001*
9. *Ranga, M. M.(2002) : Animal Behaviour Second Enlarged Edition , Agrobios (India)*
10. *Robert A. Wallace (1938) : Animal Behaviour Its Development, Ecology and Evolution , Goodyear Publishing Company, Inc. Santa Monica, California.*
11. *Sharma P.D.(2014-15) : Ecology and Environment, Rastogi Publications. Meerut (12^{th} revised edition) -25002.*
12. *W.H. Thorpe (1979) : The Origins and rise of Ethology, Praeger Publishers.*

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ELECTIVE COURSE: FISH PRESERVATION AND PROCESSING	
COURSE CODE	ZOO-V.E-12
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	• To familiarize the students with different methods of fish preservation and processing • To acquaint them with techniques and precautions for hygienic fish handling • The course content is locally relevant and prepares students for entrepreneurship and self employment
LEARNING OUTCOME	By the end of the course, the students will be familiar with the economic benefits of fishes. They will also be able to understand the nutritional values of the fishes and to identify some of the fish pathogens

ZOO-V.E- 12 : FISH PRESERVATION AND PROCESSING		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Fishery Development	1.1 : Status of Development of the fishery and seafood processing industry. 1.2: Empowerment through Aquatic Products: (Background,Nutritionalsecurity,Role ofFisheries Fisheries Sector,Role of Tifac in Fisheries Sector,Objectives,Integrated Fisheries Project(IFP),Indian national centre for ocean information services (INCOIS), Catch per unit effort (CPUE), Maximum sustainable yield (MSY)	05 10
MODULE 2: Fish Handling and preservation	2.1: Recent Scenario: Quality Changes and Shelf life of Chilled Fish,Theeffect of Hygiene duringhandling 2.2: Fish Handling Methods: Organoleptic test, Assessment of Fish Quality,Quality assessment of Fresh Fish,Quality Assessment of Fish Products,Physical methods,Assurance of Fresh Fish Quality, Post harvest Changes in Fish,How does a Fish Lose its Quality, fish as vectors of zoonotic diseases 2.3: Fish Preservation: Reasons for Spoilage of Fishes,Methods of Fish.	04 08 03
MODULE 3: Value of Fish	3.1:Economic Importance of Fish:Food value,Fish By-Products, surimi, Goan fish para, balchao 3.2: Postmortem changesin Fish,Bacteriological Changes, Lipid Oxidation and Hydrolysis, Chemical Composition,Lipids,Proteins,N- containing Extractives,Vitamins and Minerals, 3.3: Aquatic Resources and their utilization, value added product: chitin	05 05 05

PRACTICAL COMPONENT OF ZOO-V.E-12: FISH PRESERVATION AND PROCESSING (DURATION -02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Estimation of Proteins and Lipids form fish tissue	02
2	Determination of moisture and ash content from the fish	01
3	Preparation of fish Fillet	01
4	Study of Fish Parasites – ectoparasites (gills); endoparasites (gut)	02
5	Method of fish preservation (salting, pickling)	02
6	Visit to Fish Processing Centre/Fishing Co-operative Society /Fishery Institute/Fishery survey of India, Vasco (FSI)	04

REFERENCE BOOKS :

1) Braj Kishore Singh (2008) Applied Fisheries and Aquaculture Swastik Publishers and Distributers Delhi,India

2) Pandey and Shukla (2015) Fish and Fisheries, IIIrd Revised Edition, Rastogi Publications Meerut, India

REFERENCE BOOKS FOR PRACTICALS:

1) Braj Kishore Singh (2008) Applied Fisheries and Aquaculture Swastik Publishers and Distributers Delhi,India

2) Pandey and Shukla (2015) Fish and Fisheries, IIIrd Revised Edition, Rastogi Publications Meerut, India

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EVEN SEMESTER

SEMESTER – IV

ELECTIVE COURSE: ANIMAL CELL CULTURE AND APPLICATIONS	
COURSE CODE:	ZOO-IV-E-5
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	This course is an introduction to the theory, standard practices, and methodologies of animal cell culture. The laboratory emphasizes the principles and practices of initiation, cultivation, maintenance of cell lines.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: ▪ operate, calibrate, and maintain standard equipment found in an animal cell culture laboratory; ▪ Prepare and sterilize media and solutions used in cell culture. ▪ Demonstrate an understanding of the concepts and applications of mammalian cell culture. ▪ Recognize and employ biosafety guidelines and practices.

ZOO-IV-E-5: ANIMAL CELL CULTURE AND APPLICATIONS		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: LAB REQUIREMENTS FOR CELL CULTURE (15 hrs)	1: Historical background of Cell culture:	01
	2: Biology of cells in culture: Origin and characteristics, Differentiation, kinetics of cell growth, Genetics of Cultured cells, Problems associated with cell culture	04
	3: Lab requirements for animal cell culture: o Lab facilities and setup for cell culture o Major and minor equipments o Environmental conditions o Substrates for Culturing and sub culturing	05
	4: Animal tissue culture media o Natural media – biological fluids, tissue extracts o Chemically defined media- characteristic and composition o Media supplements – L Glutamine, serum. Advantages and disadvantages of serum in media / serum free media	05
MODULE 2: CELL CULTURE TECHNIQUES(15 hrs)	5: Primary cell culture: o Mechanical disaggregation o Enzymatic disaggregation o Protocol for primary cell culture	06
	6: Secondary cell culture/ Sub culturing: o Protocol for sub culturing of suspension culture o Protocol for sub culturing of adherent o Established cell lines	06
	7: Scale up of animal cell culture: o Techniques of Scale up of suspension cultures o Techniques of Scale up of Monolayer cultures	03
MODULE 3: CELL CULTURE APPLICATIONS(15 hrs)	8: Cell Hybridoma Technology : o Steps of cell Hybridoma technology o Procedure o Production of monoclonal antibodies o Applications of monoclonal antibodies	05
	9: Valuable Products through cultured cells: Production of Tissue plasminogen, growth factor, Erythropoietin, Factor VIII, Interferons.	05
	10: Other Application: Vaccines through cultured cells, Cytotoxicity testing, Fluorescent In-Situ Hybridization for disease detection, Cell culture in biomedical research.	05

PRACTICAL COMPONENT OF ZOO-IV-E-5: DURATION -02 HRS /WEEK ANIMAL CELL CULTURE AND APPLICATIONS		
Sr. No	**Practical**	**No. of Practicals**
4)	Packing and sterilization of glass and plastic wares for cell culture & Lab Precautions and Biosafety measures	02
5)	Preparation of reagents and media for cell culture. ▪ Reagents ▪ Media / Buffers	02
6)	Quantification of cells (Viable cell count) by trypan blue exclusion dye.	01
7)	Methods used for cell disaggregation – Mechanical and Enzymatic	02
8)	Setting up of primary cell culture ▪ Suspension culture ▪ Adherent cell culture	02
9)	Setting up of chicken embryo fibroblast culture (cold trypsinization / warm trypsinisation)	02
10)	Biological waste disposal methods	01

REFERENCE BOOKS:

1) *Ranga MM(2012). Animal Biotechnology. Agrobios India Ltd. Jodhpur.*
2) *Mathur S(2006). Animal Cell and Tissue Culture. Agrobios India Ltd. Jodhpur.*
3) *Masters W(2005). Animal Cell Culture. Oxford University Press Inc., NewYork*
4) *Gangal S(2010). Principles and practices of Animal Tissue Culture. Second Edition. University Press PVT. LTD., Hyderabad India.*
5) *Freshney I R(2007). Culture of animal Cells: A manual of Basic Techniques. 5th edition, John Wiley & Sons Inc Pte Ltd*

REFERENCE BOOKS FOR PRACTICALS:

1) *E Book- Fletcher L, Goss E. Phelps P and Wheeler A(2014). Introduction to Biotechnology – Laboratory Manual.*
2) *Harisson M A and Rae IF(1997):General Techniques of Cell Culture Handbook in Practical animal cell biology. Cambridge University Press.*
3) *Ebook- Cell Culture basics. From www.invitrogen.com/ cellculture basics.*

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ELECTIVE COURSE : AQUACULTURE AND FISHERIES	
COURSE CODE:	ZOO-IV.E-6
MARKS:	100[75- Theory; 25- Practicals]
CREDITS:	04 [03-Theory;01- Practical)
CONTACT HOURS	**:** Theory :45 Hours(03 LEC/WEEK) Practicals: 30 Hours(01 PRACTICAL/WEEK)
COURSE OBJECTIVES:	• To improve the understanding of conservation and sustainability of living resources • To improve the social and economic benefits derived from aquaculture and fisheries. • To study the role of aquaculture in rural development in solving nutritional security and unemployment. • Empowerment of fishery and entrepreneurship development
LEARNING OUTCOMES:	• The student may become future aqua culturist, entrepreneur who will provide employment to others. • Optimum utilization of unutilized and underutilized aquatic resources for fisheries and aquaculture, enhance the fish production, employment generation and even to earn the foreign exchange.

ZOO-IV.E-6: AQUACULTURE AND FISHERIES		
MODULE	**TOPIC**	**CONTACT HOURS**
MODULE 1:	**1.1:Inland Fisheries:** • fisheries: Fisheries of Ganga and Brahmputra river system • Reservoir fisheries • Lakesterine fisheries: Cat fish, Murrels, Mullets, Major carps • Cold water fisheries: Mahaseer fishery **1.2: Marine Fisheries:** • Estuarine fisheries:The catadromous fishes (*Polynemous indicus,P.tetradactylus*) and anadromous fishes(*Hilsa ilisha,Pama pama,Polynemous paradiseus*) • Coastal fisheries or Inshore fisheries: Elasmobrach fishery and Teleost fishery • Offshore and Deep sea fisheries: Pomfrets(*Pampus,Stromateus) Eleutheronema tetradactylus*(rava),*Polydactylus indicus*(dara), ghol(*Pseudosciaena diacanthus*),*scianids*(Kurtus) **1.3: Crustacean And Molluscan Fisheries:** • Prawn fisheries in Goa: Penaeid and Palaemonid groups. • Crab fisheries in Goa • Edible oyster fisheries in Goa • Mussel fisheries in Goa **1.4 :Fishing Methods In India**: • Marine Fishing Crafts and Gears used in Goa • Inland Fishing Crafts and Gears used in Goa	**15**
MODULE 2:	**2.1: Integrated Fish Farming Systems:** • Principle of integrated Fish farming • Integration with animal husbandry • Integration with farming systems. **2.2:Induced Breeding:** • Selection of site • Design and Layout of fish farm • Freshwater and brackish water pond • construction • Pond maintenance • Prevention of fish diseases • Control of aquatic weeds • Control of predatory and Weed fishes • Control of Aquatic insect • Harvesting	**15**

<table>
<tr><td>MODULE 3:</td><td>3.1: Fish Culture System:
• Mono culture, polyculture, composite culture, raceway culture, extensive, semi intensive, intensive, zero water exchange
• Objective of fish culture
• Pond preparation
• Selection of species
• Stocking of seed
• Feed and feeding
• Harvesting
• Bionomics of fish culture
3.2: Cage And Pen Culture:
• Advantage of Fish culture in cages
• Selection of species for cage culture
• Installation of cage - shape ,size and types of cages
• Pen culture
• Maintenance of cage and pen
3.3: Preservation And Processing:
• Fish marketing
• Transportation
• Reasons for spoilage of Fishes
• Methods of fish preservation-Freeze-drying,
• Salting, Refrigeration, Deep Freezing,</td><td>15</td></tr>
</table>

<table>
<tr><th colspan="3">PRACTICAL COMPONENT OF ZOO-IV.E-6: AQUACULTURE AND FISHERIES (DURATION – 02 HRS/ WEEK)</th></tr>
<tr><th>Sr. No.</th><th>Practical</th><th>No. of Practicals</th></tr>
<tr><td>1.</td><td>Morphometric and Meristic study : a key for fish Identification</td><td>03</td></tr>
<tr><td>2.</td><td>Identification of important edible shrimps and crabs(any two)</td><td>01</td></tr>
<tr><td>3.</td><td>Identification of important Freshwater and Marine edible fishes (five fishes each from different families)</td><td>02</td></tr>
<tr><td>4.</td><td>Methods of Measuring gonosomatic index of Fish</td><td>01</td></tr>
<tr><td>5.</td><td>Estimation of Fecundity by Frequency Polygon method from a Marine Fish</td><td>01</td></tr>
<tr><td>6.</td><td>Food and Feeding of Fish by analysis of gut content</td><td>01</td></tr>
<tr><td>7.</td><td>Visit to a Fish Landing Center to study different Types of Gear and Craft</td><td>01</td></tr>
<tr><td>8.</td><td>Visit to Fish breeding Center to study Induced Breeding in Indian Carps</td><td>01</td></tr>
<tr><td>9.</td><td>Visit to ICAR/NIMR(National Institute of Malaria Research) Old Goa for Study of Aquarium and Larvivorous Fishes</td><td>01</td></tr>
</table>

REFERENCE BOOKS FOR THEORY:

1. Bal D.V.,RaoVirbhadra,K (1984) Marine Fisheries, Tata McGraw- Hill Publishing Company Ltd.New Delhi.
2. Cushing D.H. (1975) Marine Ecology and Fisheries , Cambridge University Press.
3. Day,F. (1889) The Fauna of British India including Ceylon and Burma. Fishes. 2Vols., Taylor and Francis London.
4. Khanna S.S.(1984) An Introduction to Fishes, Central Book Depot Allahabad.
5. Pandey K and Shukla J.P.(2015) Fish and Fisheries. Rastogi Publications Meerut-250002
6. Sakhare B. Viswas (2007) Applied Fisheries.Daya Publishing House Delhi-110035
7. Santhanam R (1990) Fisheries Science,Daya Publishing House Delhi.
8. SanthanamR,Ramanathan N and Jagatheesan G(1990) Coastal Aquaculture in India,CBS Publishers and distributers,Delhi.
9. Shrivastava C.B.L.(1996) A Text Book of Fishery Science and Indian Fisheries. KitabMahal22 A,S.N.Marg, Allahabad.
10. Singh B.K.(2008) Applied Fisheries and Aquaculture.Swastik Publishers and distributers,Delhi.

REFERENCE BOOKS FOR PRACTICALS:

1. Chandy.M (1970) Fishes,National Book Trust,India,New Delhi.
2. Day.F. (1889) The Fauna of British India including Ceylon and Burma. Fishes. 2Vols.,Taylor and Francis London.
3. R.J.Ranjit Daniels (2002) Freshwater Fishes of Peninsular India, Universities Press (India)Pvt.Ltd. Hyderabad.
4. SakhareViswasB. (2007) Applied Fisheries ,Daya Publishing House Delhi.
5. Sharma U and S.P.Grover (1982) An Introduction to Indian Fisheries,Dehradun India.
6. Srivasava C.B.L.(1986) A Text Book of Fishery Science and Indian Fisheries ,KitabMahal Allahabad.

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ELECTIVE COURSE: IMMUNOLOGY	
COURSE CODE:	ZOO-IV.E-7
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	Familiarize students and make them learn about the structural features of the components of the immune system as well as their functions, and understand the mechanisms involved in immune system development and responsiveness.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: • Understand the components of the immune system and their function. • Be able to explain the mechanisms of immune response. • Perform immunoassays to detect the presence of antigens or antibodies(disease detection).

ZOO-IV-E-7: IMMUNOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: INTRODUCTION TO IMMUNOLOGY	1: OVERVIEW OF IMMUNE SYSTEM: • Basic concepts in immunology • Components of the immune system	05
	2: INNATE AND ADAPTIVE IMMUNITY. • Innate immunity-Anatomical barriers/ layers of defense, cells and molecules involved in innate immunity • Adaptive immunity-cell mediated and humoral immunity, passive immunity (artificial and natural), Active(artificial and natural), Immune dysfunction	10
MODULE 2: ANTIGENS AND IMMUNOGLOBULINS	3: ANTIGENS. • Antigenicity and immunogenicity, Immunogens, adjuvants and haptens • Factors influencing immunogenicity • B and T cell epitopes	05
	4: IMMUNOGLOBULINS • Structure and function of different classes of Immunoglobulin. • Antigen-Antibody interactions • Immunoassays, monoclonal & polyclonal antibodies	07
	5: MAJOR HISTOCOMPATIBILITY COMPLEX. • Structure and function of endogenous and exogenous pathways of antigen presentation	03
MODULE 3: IMMUNE RESPONSE	6: CYTOKINES AND COMPLEMENT SYSTEM • Properties and functions of cytokines, cytokine based therapies • Components and pathways of complement activation	05
	7: HYPERSENSITIVITIES, AUTOIMMUNITY AND TRANSPLANTATION • Gell and coombs' classification, types of hypersensitivities(overview) • Autoimmune responses against self antigens (SLEs), responses to alloantigens and transplant rejection (graft rejection, types and mechanisms of transplant rejection	07
	8: VACCINES • Types of vaccines -inactivated, attenuated, toxoid, subunit, conjugate, experimental (DNA and recombinant vaccine), monovalent/polyvalent vaccines	03

PRACTICAL COMPONENT OF ZOO-IV-E-7: IMMUNOLOGY (DURATION -02 hrs/WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1	Preparation of serum from goat blood.	02
2	Slide Agglutination Reaction(blood groups – A / AB / O with Rh)	02
3	Differential count of leukocytes	01
4	Detection of presence of antigen / antibody - Simple immunodiffusion	01
5	Antibody Titre determination - Ouchterlony immunodiffusion	02
5	Antigen –antibody reaction by immunoelectrophoresis	02
6	Elisa TEST- pregnancy test	01
7	Phagocytosis – WBC (demonstration)	01

REFERENCE BOOKS:

Essential books:

1) *Abbas KA, Lechtman HA(2007). Basic Immunology, Updated Edition 2006-2007: with STUDENT CONSULT. Access (Paperback).*
2) *David M, Jonathan B, David RB and Ivan R(2006). Immunology. VII Edition, Mosby, Elsevier Publication.*
3) *Abbas KA, Lechtman HA(2003). Cellular and Molecular Immunology. Saunders Publication.*
4) *Kindt TJ, Goldsby RA, Osborne BA and Kuby J(2006). Immunology. VI edition. W H Freeman and company.*

Ebooks:

5) *Frank SA(2002).Immunology and evolution of infectious diseases. Princeton University Press, Princeton and Oxford.*
6) *Zabriskie JB(2009). Essential Clinical Immunology. Cambridge University Press.*

REFERENCE BOOKS FOR PRACTICALS:

1) *Talwar GP and Gupta SK(2012).A handbook of practical and Clinical Immunology, CBS publishers.*

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ELECTIVE COURSE : EVOLUTIONARY BIOLOGY	
COURSE CODE:	ZOO-IV.E-8
MARKS:	100 [75-Theory; 25 –Practicals]
CREDITS:	04[03 – Theory; 01 – Practical
CONTACT HOUR :	Theory : 45 Hours(03 Lec./Week) Practicals: 30 Hours(01Practical/Week)
COURSE OBJECTIVE:	• The study aims to discover the history of life and the causes of the diversity and characteristics of organisms. • To show the important contributions of evolutionary biology to other biological disciplines such as medicine
LEARNING OUTCOME:	• The study will give detail knowledge about many unsolved hypothetical issues to solve it. • The student will learn that evolution is not a speculation , but a thoroughly supported hypothesis that explains the process of evolution

ZOO-IV.E-8: EVOLUTIONARY BIOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1:	**1.1: EVOLUTIONARY BIOLOGY:AN OVERVIEW** • What Is Evolution, History Of Evolutionary Biology, Pre Darwinian, Darwin's Evolutionary Theory, Evolutionary Theories After Darwin • Famous contributions to evolutionary Biology: CarlLinneaus,Lamarck,Malthus,Darwin,Thomas Huxley,R.A.Fisher,Haldane,sewall Wright, G.G.Simpson, Dobzanhasky,Ernst Mayr, M.Kimura. **1.2: THE NATURAL SELECTION:** • The Nature of Natural Selection • Postulates of natural selection • Evidences of Natural selection • Types of natural selection(Stabilizing,Directional and Disruptive selection) • Natural Selection in action(Darwin's finches, Endler's guppies examples) • Sexual Selection **1.3: RANDOM PROCESS IN EVOLUTION:** • mutation :types of mutation • genetic drift(bottle neck effect,founder's effect) • gene flow(migration/emmigration **1.4: SYNTHETIC THEORY OF EVOLUTION** • Neo-Darwinis	**20**
MODULE 2:	**2.1: NON- DARWINISM** • Neutral theory of evolution • Molecular polymorphism-nucleic acids and proteins • Molecular clocks **2.2: SPECIATION** • different concepts of speciation • Concept Of Biological Speciation(Allopatric/Sympatric) • Consequence Of Speciation • Factors involved in Biological Speciation(pre and post- zygotic mechanisms) **2.3: POPULATION GENETICS** • Hardy-Weinberg's Law(H-W) • Genes And Genotype Frequencies • Factors Affecting H-W **2.4:ADAPTATIONS :** • Definition and kinds of adaptations with some examples. • Pre , Post adaptations	**10**

	• Coadaptations and Parallel adaptations	
MODULE 3:	**3.1: PATTERNS OF EVOLUTION:** • Sequential and Convergent Evolution • Microevolution • Macroevolution(Adaptive radiation) • Megaevolution • Gradualism And Punctuated Equilibrium **3.2: EVOLUTION AND HUMAN HEALTH AND DISEASES** • Design defects • Defence mechanisms-Allergy,morning sickness • Evolution of antibiotic resistance • Evolution of behaviour,Anxiety,fear and depression.	**15**

PRACTICAL COMPONENT OF ZOO-IV.E-8: EVOLUTIONARY BIOLOGY (DURATION -02 HRS/WEEK)		
Sr.No.	**Practical**	**No.of Practicals**
1.	Study of homology and analogy from suitable specimens	01
2	Serial homology	01
3	Variations are basis for evolution	01
4	To demonstrate the role of Natural Selection in Fixing Favoured Adaptation and Eliminating Maladaptation.	02
5	Problems based on Population Genetics (PTC /blood group)	04
6.	An exercise to illustrate the concepts of Genetic drift	02
7.	Vestigial organs or Vestiges in animals and humans.	01

REFERENCE BOOKS:

1. Bipin Kumar(2001) Organic Evolution; Campus Books International, New Delhi.
2. Charlotte J. Avers (1989)Process and pattern in Evolution ; New York Oxford University Press.
3. Douglas J. Futuyma(2013) Evolution IIIrd edition; Sinaue Associates,Inc.Publishers Sunderland , Massachusetts U.S.A.
4. E.Peter Volpe(1989) Understanding Evolution Vth edition Universal Book Stall.
5. S.Osawa ,T.Honjo(Eds.)(1991) Evolution of life,Springer-Verlag Tokyo .
6. Savage Jay M (1969) Evolution , Amerind Publishing Co-Pvt. Ltd. New Delhi.
7. Veer Bala Rastogi (2004) Organic Evolution ,Eleventh revised edition; Kedarnath Ramnath Delhi.
8. Pranab K. Banerjee (2011) Problems on Genetics,Molecular Genetics and Evolutionary Genetics, New Central Book Agency (P) Ltd. Delhi

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SEMESTER – VI

ELECTIVE COURSE: HEALTH AND NUTRITION	
COURSE CODE	**ZOO-VI-E-13**
MARKS	100 [75 –Theory ; 25- Practical]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES	This course is an introduction to the nutrients, their functions and role in maintaining good health of humans.
LEARNING OUTCOME	Upon successful completion of the course, students will be able to: ▪ Know about nutrients and their function ▪ Understand nutritional biochemistry and role of lifestyle and food habits in causing diseases

ZOO-VI-E-13: HEALTH AND NUTRITION		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: BASIC CONCEPT OF FOOD AND NUTRITION	UNIT 1: Overview of health and nutrition • Definition of health and nutrition • Scope of nutrition, food as a source of nutrients • Nutrients and energy • Adequate, optimum and balanced diet • Malnutrition and health. UNIT 2: Nutritional Biochemistry • Carbohydrates, lipids, proteins - definition, classification, structure and properties • Significance of acid value, iodine value and saponification value of lipids • Essential and non-essential amino acids • Enzymes- definition, classification, properties(overview). • Coenzymes, vitamins (fat soluble and water soluble), structure and properties • Minerals- iron, calcium, phosphorus, iodine, selenium and zinc and their properties	**15**
MODULE 2: NUTRIENTS AND DIETARY PATTERN FOR HUMANS	UNIT 3: Functions of food components of food-nutrients • Biochemical role and dietary sources of macro and micronutrients (carbohydrates, lipids and proteins, fat soluble vitamins-A, D, E and K , water soluble vitamins – thiamin, riboflavin, niacin, pyridoxine, folate, vitamin B12 and vitamin - C Minerals – calcium, iron and iodine). • Changes of nutrient value during cooking of the following food groups: cereals, pulses and vegetables. Nutrient loss - dry, moist, frying and microwave cooking. UNIT 4: Nutrition and dietetics • Physiological considerations, nutrient needs and dietary pattern for various groups- adults, pregnant and nursing mothers, infants, pre-school and school children, adolescents and geriatric nutrition.	**15**

MODULE 3: DIET RELATED DISEASES	UNIT 5:Health and diseases • Major nutritional deficiency diseases- protein energy malnutrition, Vitamin deficiency, iron deficiency anaemia, iodine deficiency disorders, their causes, symptoms, treatment, prevention and government programmes, if any. • Life style related diseases- obesity, hypertension, hyperurecimia, diabetes mellitus, polycystic ovarian disease (PCOD) - their causes and prevention through dietary/lifestyle modifications. • Social health problems: smoking, alcoholism, drug dependence and Acquired Immune Deficiency Syndrome (AIDS); • Common ailments- irritable bowel disease (IBD), constipation: causes and dietary management UNIT 6: Food hygiene • Potable water- sources and methods of purification at consumer level • Food and water borne infections: bacterial infection: cholera, typhoid, dysentery; viral infection: hepatitis, poliomyelitis, protozoan infection: Amoebiasis, Giardiasis; Parasitic infection: Taeniasis and Ascariasis their causative agent, symptoms, transmission and prevention. • Brief account of food spoilage: Causes and preventive measures	**15**

PRACTICAL COMPONENT OF 'HEALTH AND NUTRITION ZOO-VI-E-13: DURATION (30 HOURS – 02hrs/WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICAL S**
11)	To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric	02
12)	To determine absorbed oil content in fried foods	02
13)	Estimation of lactose in milk	02
14)	Ascorbic acid estimation in food by titrimetry	01
15)	Estimation of calcium in foods by titrimetry	01
16)	Observation of any two grain pests	01
17)	Project based: • Identify nutrient rich sources of foods, their seasonal availability and price • Study of nutrition labeling on selected foods	03

REFERENCE BOOKS:

1) Mudambi, SR and Rajagopal, MV. (2007). Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; New Age International Publishers.
2) Srilakshmi B. (2002). Nutrition Science; New Age International (P) Ltd.
3) Srilakshmi B. (2007). Food Science; Fourth Ed; New Age International (P) Ltd.
4) Swaminathan M. (2009). Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.
5) Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; Oxford & IBH Publishing Co. Pvt Ltd.
6) Wardlaw GM, Hampl JS. (2007). Perspectives in Nutrition; Seventh Ed; McGraw Hill.
7) Lakra P, Singh MD. (2008). Textbook of Nutrition and Health; First Ed; Academic Excellence.

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ELECTIVE COURSE: BASIC AND APPLIED ENTOMOLOGY	
COURSE CODE	ZOO-VI.E-14
MARKS	100 [75 -Theory; 25-Practical]
CREDITS	04 [03- Theory; 01- Practical]
CONTACT HOURS	Theory: 45 HOURS [03 Lectures Per Week] Practical: 30 HOURS [01 Practical Per Week]
COURSE OBJECTIVE	• To develop a strong foundation in entomology, including understanding of the importance of insects to the human society. • To review important areas in insect biology such as morphology, physiology, ecology, behaviour, genetics, phylogeny, ontogeny and population biology. • To develop a sufficient background for advanced entomology.
LEARNING OUTCOME	• The students will achieve entrepreneurial opportunities in entomology. • They will gain knowledge on bionomically important insects and their products, insect pests of public health and veterinary importance and their management.

ZOO-VI.E-14: BASIC AND APPLIED ENTOMOLOGY		
MODULE	**TOPIC**	**CONTACT HOURS**
MODULE 1 Fundamentals of Entomology	Unit 1: Class Insecta: • Salient features • Classification of insects up to orders – an overview Unit 2: Morphological studies: • of antenna, • wings, • legs • Mouth parts Unit 3: Techniques: • Collection of insects • Preservation of insects	15
MODULE 2 Bionomics and control of crop pests and medically important pests	Unit 4: Pest of agricultural importance: • Paddy pests, cashew pests, coconut pests, areca nut pests, pulse pests, sugarcane pests, vegetable pests, fruit pests (two pests from each of the above) Unit 5: Insects of medicinal importance: • mosquitoes, housefly, sand fly, cockroaches, human lice, bed bug, rat fleas Unit 6:Termites: • social organization, termitaria and termite control measures	15
MODULE 3 Useful insects and pest management	Unit 7: Useful insects: • Honeybees (Apiculture); Mulberry silk worm(sericulture); lac insects (lac culture) Unit 8: Insect pest control methods: • biological, chemical (attractants, pheromones and hormones), Integrated Pest Management (IPM) Unit 9: Role of insects in ecosystem services	15

PRACTICAL COMPONENT OF BASIC AND APPLIED ENTOMOLOGY ZOO-VI.E-14 PRACTICAL (DURATION: 30 HOURS – 02hrs/WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS (12)**
1.	Collection techniques of Insects – light traps, sweep net, Berlese funnel	02
2.	Identification and study of economically important insects.	02
3.	Field trips to ICAR Old Goa / Govt. of Goa agriculture department/ National Malaria Research Institute (NMRI).	02
4.	Study of insects of college campus dragon fly/ pests of different plants.	03
5.	Study of local insect pests of agriculture.	03

REFERENCE BOOKS:

1) Aitwal, A.S (1993): Agricultural pests of India and South East Asia. Kalyani publication, New Delhi.
2) Awasthi,V.B (2007):Introduction to general and applied entomology ,2nd edition. Scientific publishers India Jodhpur.
3) David, B.V. and Ananthakrishnan, T.N (2006): General and applied entomology, 2nd edition Tata McGraw hill, New Delhi.
4) Reddy,D.S(2010) Applied entomology,2nd edition New Vishal publications

REFERENCE BOOKS FOR PRACTICALS:

1. Fenemore, P.G. and Prakash, A. (1995): Applied Entomology, Wiley Eastern Limited new age international.
2. Varasi, M.S. (1992): Text book of entomology, Himalaya Publishing House, 1st edition.

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ELECTIVE COURSE: LABORATORY TECHNIQUES IN PATHOLOGY	
COURSE CODE	ZOO-VI.E-15
MARKS	100 [75 –Theory; 25- Practical]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC / WEEK) PRACTICAL: 30 HOURS (01 PRACTICAL / WEEK)
COURSE OBJECTIVES	This course is an introduction to the various techniques used in pathological diagnosis.
LEARNING OUTCOME	Upon successful completion of the course, students will be able to: ▪ Know the tests done for disease detection of various body fluids and tissues. ▪ Understand the clinical implication of the pathological tests.

<table>
<tr><th colspan="3">ZOO-VI.E-15: LABORATORY TECHNIQUES IN PATHOLOGY</th></tr>
<tr><th>MODULE</th><th>TOPICS</th><th>CONTACT HOURS</th></tr>
<tr><td>MODULE 1: BLOOD ANALYSIS</td><td>UNIT 1: Introduction to medical lab techniques and its importance
UNIT 2: : Analyses of human Blood:
Ways of obtaining blood samples, precautions and complications.
Methods of estimation and clinical significance of: hemoglobin, Packed Cell Volume (PCV), RBC count, WBC count, Complete Blood Count (CBC), platelets, Erythrocyte Sedimentary Rate (ESR), Differential Leucocyte Count (DLC).</td><td>15</td></tr>
<tr><td>MODULE 2: EVALUATION OF EXCRETORY MATERIAL AND GAMETES</td><td>UNIT 3:.Urine Analyses
Physical characteristics, preservation of urine sample
Gross examination, chemical examination, abnormal constituents and its clinical implications.
Microscopy of urinary sediments
UNIT 4: Stool Analyses
Stool tests for protozoan parasites and helminth eggs.
Clinical significance.
UNIT 5: Semen analyses:
Constituents of semen
Gross and microscopic, cytochemical examination, clinical implications.</td><td>15</td></tr>
<tr><td>MODULE 3: LIVER FUNCTION CYTOLOGY IMAGING</td><td>UNIT 6: Clinical status of liver function -
Function of liver.
Tests of excretion by liver, evaluation of synthesis in liver, evaluation of enzyme activity.
UNIT 7: Clinical cytological studies
Fine Needle Aspiration Cytology (FNAC), Ultrasound guided FNAC, aspiration of intra thoracic masses,
Techniques of preparing cell smears, staining techniques
UNIT 8: Medical imaging
X-Ray, PET, CT Scan, MRI, Dexa Scan, Ultrasound, Doppler's Test (using photographs/reports etc).</td><td>15</td></tr>
</table>

PRACTICAL COMPONENT OF: LABORATORY TECHNIQUES IN PATHOLOGY ZOO-VI.E-15 - (30 HOURS – 02hrs/WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1.	Preparation of blood smears and staining techniques (Leishman's staining, Giemsa staining, Field's staining).	02
2.	Use of different types of anticoagulants, obtaining serum from blood, preparation of cell suspension (blood cells).	01
3.	RBC Count, WBC Count, Differential WBC Count	03
4.	Urine analysis – normal and abnormal constituents	02
5.	Blood sugar estimation using glucometer	01
6.	Estimation of hemoglobin (Sahli's method)	01
7.	Estimation of PCV	01
8.	Estimation of ESR (Wintrobe's / Westergreen method)	01

REFERENCE BOOKS:

1. Sood R (1999). Medical laboratory techniques, Jaypee publishers, New Delhi.
2. Park, K. (2007), Preventive and Social Medicine, B.B. Publishers
3. Godkar P.B. and Godkar D.P (2007). Textbook of Medical Laboratory Technology, II Edition, Bhalani Publishing House.
4. Cheesbrough M (2002)., A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses
5. Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd. New Delhi.

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ELECTIVE COURSE: BIOENTREPRENEURSHIP	
COURSE CODE	ZOO-VI.E- 16
MARKS	100 [75 –Theory; 25- Practical]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC / WEEK) PRACTICAL: 30 HOURS (01 PRACTICAL / WEEK)
COURSE OBJECTIVES	• To help students recognize the opportunities of enterprises in the field of life sciences • To encourage students to think independently and explore new vistas • To familiarise them with the basic skills required for a start-up
LEARNING OUTCOME	At the end of the course, • Students will be exposed to various opportunities available in life science for start-ups. • They will be familiar with the methodologies and regulations required to start an enterprise. • It will also help the student to develop independent thinking skill required at the time of crucial decision making.

ZOO-VI.E- 16: BIOENTREPRENEURSHIP		
UNIT	**TOPICS**	**CONTACT HOURS**
MODULE 1: Entrepreneurship Development	Unit 1: Introduction to entrepreneurship: • entrepreneurial competencies and goal setting, bio entrepreneurship, building a bio-enterprise : balance management, capital, technology Unit 2: Introduction to innovation: • identifying business opportunities Unit 3: Raising funds: public and private	15
MODULE 2: Business plan And Guidelines and regulations for entrepreneurship in life sciences	Unit 4: Business model canvas Unit 5: Guidelines and regulations: • Certification and licensing, acts, regulations and guidelines, marketing and export process, accessing university technology, research and development agencies in India Unit 6:Role of micro, medium and small scale industry sector Unit 7: Innovations in research: • writing project proposals to various funding bodies such as MHRD, UGC, DST, DBT, etc.	15
MODULE 3: Start -up, quality, safety and procedural compliances in a bio enterprise	Unit 8: Intellectual Property Rights and trademark of biological resources Unit 9: quality, safety and procedural compliances • Bio safety and its implementations • Quality control in entrepreneurship • WHO Guidelines for setting up of a contract research organization. • Starting a research laboratory in India – guidelines and permits required	15

PRACTICAL COMPONENT OF BIOENTREPRENEURSHIP ZOO-VI.E-16 (30 HOURS – 02hrs/WEEK)		
SR. NO.	**PRACTICAL**	**NO. OF PRACTICAL**
1.	Exercises on lateral thinking	01
2.	Testing entrepreneurial competencies	01
3.	Online search for patented technologies	01
4.	Identifying Business Opportunities	02
5.	Business Model Canvas	03
6.	Presentation of Business Model Canvas by students	01
7.	Interaction with successful entrepreneur	02
8.	Interaction with Banker/ Angel Investor	01

REFERENCES:

1. Garg, M.C. (2015) Entrepreneurial development. Guset User.
2. Kolchinsky, P. (2004) The entrepreneurs guide to a biotech startup. 4th edition. www.evelexa.com

Additional reading:

1. Simon, S. 2009. Start with why: How great leaders inspire everyone to take action. Penguin Group (USA) Inc .
2. Welch, J. and Byrne, J.A. 2003. Straight from the gut. Business plus publishers.

WEBLIOGRAPHY:

1. http://www.creativeboom.com/resources/10-free-brain-teasing-puzzle-resources-for-team-building-games-and-getting-your-creative-juices-flowing/
2. https://www.scribd.com/document/60183753/39034324-Test-for-Personal-Entrepreneurial-Competencies
3. http://www.wipo.int/edocs/pubdocs/en/patents/434/wipo_pub_l434_02.pdf
4. https://ipindiaonline.gov.in/patentsearch/Granted%20Search%20Engine%20Help%20file.pdf
5. https://canvanizer.com/new/business-model-canvas

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ANNEXURE – I

ACCEPTED CORE AND ELECTIVES PAPERS FOR ZOOLOGY

CORE AND ELECTIVE PAPERS FOR ZOOLOGY MAJOR				
SEMESTER	**SUBJECT CODE CORE PAPERS**	**CORE PAPERS**	**SUBJECT CODE ELECTIVE PAPERS**	**ELECTIVE PAPERS**
Semester 1	**ZOO-I.C-1**	**Animal Diversity : Non Chordates**		
	ZOO-I.C-2	**Cell and Molecular Biology**		
Semester 2	**ZOO-II.C-3**	**Diversity and Biological Systems of Chordates**		
	ZOO-II.C-4	**Fundamentals of Animal and Human Genetics**		
Semester 3	**ZOO-III.C-5**	**Human Physiology**	**ZOO-III.E-1**	**Vertebrate Endocrinology**
			ZOO-III.E-2	**Basic microbiology and Fundamentals of Animal Biotechnology**
			ZOO-III.E-3	**Environmental Toxicology**
			ZOO-III.E-4	**Parasitology**
Semester 4	**ZOO-IV.C-6**	**Biochemistry and Metabolic Regulation**	**ZOO-IV.E-5**	**Animal cell culture and Applications**
			ZOO-IV.E-6	**Aquaculture and Fisheries**
			ZOO-IV.E-7	**Immunology**
			ZOO-IV.E-8	**Evolutionary Biology**
Semester 5	**ZOO-V.C-7**	**Developmental Biology**	**ZOO-V.E-9**	**Molecular Genetics and Forensic Science**
			ZOO-V.E-10	**Economic Zoology**
			ZOO-V.E-11	**Ecology and Ethology**
			ZOO-V.E-12	**Fish Preservation and Processing**
Semester 6	**ZOO-VI.C-8**	**Wildlife Biology**	**ZOO-VI.E-13**	**Health and Nutrition**
			ZOO-VI.E-14	**Basic and Applied Entomology**

			ZOO-VI.E-15	**Laboratory Techniques in Pathology**
			ZOO-VI.E-16	**Bio Entrepreneurship**

CORE PAPERS FOR ZOOLOGY MAJOR - MINOR		
Semester 1	ZOO-I.C-1	Animal Diversity : Non Chordates
Semester 2	ZOO-II.C-3	Diversity and Biological Systems of Chordates
Semester 3	ZOO-III.C-5	Human Physiology
Semester 4	ZOO-IV.C-6	Biochemistry and Metabolic Regulation
Semester 5	ZOO-V.C-7	Developmental Biology
Semester 6	ZOO-VI.C-8	Wildlife Biology

CORE PAPERS FOR ZOOLOGY DOUBLE MAJOR		
Semester 1	ZOO-I.C-1	Animal Diversity : Non Chordates
Semester 1	ZOO-I.C-2	Cell and Molecular Biology
Semester 2	ZOO-II.C-3	Diversity and Biological Systems of Chordates
Semester 2	ZOO-II.C-4	Fundamentals of Animal and Human Genetics
Semester 3	ZOO-III.C-5	Human Physiology
Semester 4	ZOO-IV.C-6	Biochemistry and Metabolic Regulation
Semester 5	ZOO-V.C-7	Developmental Biology
Semester 6	ZOO-VI.C-8	Wildlife Biology

ANNEXURE – II

PAPER TITLE:	**HUMAN PHYSIOLOGY**
PAPER CODE:	**ZOO-III.C-5**
SYLLABUS PREPARED BY:	**DR. NANDINI VAZ FERNANDES**
MARKS:	**100 [75 –Theory ; 25- Practicals]**
CREDITS:	**04 [03 –Theory; 01- Practical]**
CONTACT HOURS:	**THEORY : 45 HOURS (03 LEC/WEEK)** **PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)**
COURSE OBJECTIVES:	**The primary goal of this course is to offer an in-depth presentation of the function of the major organs and organ systems of the human body. The course is designed to expand physiological concepts presented in prerequisite courses.**
LEARNING OUTCOME:	**Upon successful completion of the course, students will be able to:** • **describe and explain the normal function of the cells, tissues, organs, and organ systems of the human body** • **develop understanding of the functional relationships of anatomical structures to one another**

	TOPICS	CONTACT HOURS
UNIT 1: HISTOPHYSIOLOGY OF DIGESTION AND RESPIRATION (15 Hrs)		
	1: ***DIGESTIVE SYSTEM*** • **Structural organization, histology and functions of gastrointestinal tract and its associated glands** • **Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins** • **Role of gastrointestinal hormones on the secretion and control of enzymes of Gastrointestinal tract**	08
	2: ***RESPIRATORY SYSTEM*** • **Histology of trachea and lung** • **Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities** • **Transport of oxygen in the blood oxygen- hemoglobin & myoglobin , dissociation curve and the factors influencing it Carbon monoxide poisoning; Carbon dioxide transport in the blood** • **Buffering action of blood and haemoglobin Control of respiration**	07
UNIT 2: HISTOPHYSIOLOGY OF EXCRETION AND CIRCULATION (15 Hrs)		
	3: ***EXCRETORY SYSTEM*** • **Structure of kidney and its histological details, Renal blood supply; Mechanism urine** • **Formation and its regulation, Regulation of acid-base balance**	05
	4: ***CIRCULATORY SYSTEM*** • **An outline structure of heart; Coronary circulation; structure of conducting and working** • **Myocardial fibers. Origin and conduction of cardiac impulses functions of AV node; Cardiac cycle; Cardiac output and its regulation-Frank-Starling Law of the heart, nervous and chemical regulation of heart rate; Blood pressure and its regulation; Electrocardiogram** • **Components of blood and their functions; Structure and functions of haemoglobin; Haemopoiesis; Haemostasis *(overview and significance)*; Disorders of blood(*nutritional anemia, Leukemia)***	10
UNIT 3: HISTOPHYSIOLOGY OF NERVOUS SYSTEM, MUSCLES AND REPRODUCTIVE SYSTEM (15 hrs)		
	5: ***NERVOUS SYSTEM*** • **Structure of neuron, resting membrane potential , Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers;** • **types of synapsis, Synaptic transmission and, Neuromuscular junction; Reflex action & its types -reflex arc** • **Physiology of hearing and vision**	06
	6: ***MUSCLE*** • **Histology of different types of muscle;** • **Ultra structure of skeletal muscle;** • **Molecular and chemical basis of muscle contraction;** • **Characteristics of muscle twitch; Motor Unit, summation & tetanus**	04
	7: ***REPRODUCTIVE SYSTEM*** • **Histology of male and female gonads.** • **Overview- Physiology of male and female reproduction.**	05

REFERENCE BOOKS:

Essential books:

1. ***Singh HD(2011):Textbook of Human Physiology, S Chand Publishers, New Delhi.***
2. ***Widmaier, Raff, & Strang(2008), Vander's Human Physiology: The Mechanisms of Body Function, 12th edition, McGraw Hill,. ISBN 978-0-07-337810-7***
3. ***Tortara G J and Derrickson BH(2009). Principles of Anatomy and physiology, 12th Edition. John Wiley & sons, Inc.***
4. ***Guyton Ac and Hall JE(2011). Textbook of Medical Physiology, 12th Edition, Harcourt Asia Pvt Ltd, WB Saunders Company***.

Supplementary Reading:

5. ***Openstax College (2013). Anatomy and Physiology. Vol II. Mainstreet MS, Houston Texas(Ebook)***
6. ***Forciea B (2012). An eText of Human Anatomy and Physiology(Ebook).***
7. ***Wingerd B(2008). The Human Body, Essential Anatomy and Physiology. University Readers, SanDiego CA.***

PRACTICAL COMPONENT OF ZOO-III.C-5: (DURATION -02 HRS /WEEK) : HUMAN PHYSIOLOGY		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1.	**Enumeration of red blood cells / WBC using haemocytometer**	**02**
2.	**Estimation of haemoglobin using Sahli's haemoglobinometer**	**01**
3.	**Histochemical localization of digestive enzymes (Amylase, Pepsin, Trypsin and Lipase)**	**02**
4.	**Temporary preparation of Striated muscle fibers and nerve cells.**	**02**
5.	**Urine analysis (for organic, inorganic and abnormal components)**	**03**
6.	**Examination of sections of mammalian tissues:** - **Lung** - **Kidney** - **Gonads** - **Small Intestine** - **Muscles*(Cardiac, Skeletal, Smooth)*** - **Bone and cartilage**	**02**

REFERENCE BOOKS FOR PRACTICALS:

1. ***Openstax College (2013). Anatomy and Physiology. Vol II. Mainstreet MS, Houston Texas(Ebook)***
2. ***Forciea B (2012). An eText of Human Anatomy and Physiology(Ebook).***
3. ***Wingerd B(2008). The Human Body, Essential Anatomy and Physiology. University Readers, SanDiego CA.***

ANNEXURE – III

PAPER TITLE:	**Vertebrate Endocrinology**
PAPER CODE:	**ZOO-III.E-1**
NAME OF FACULTY:	**Dr. SOCORRINHA D'COSTA**
MARKS:	**100 [75 –Theory ; 25- Practicals]**
CREDITS:	**04 [03 –Theory; 01- Practical]**
CONTACT HOURS:	**THEORY : 45 HOURS (03 LEC/WEEK)** **PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)**
COURSE OBJECTIVES:	• **To study the endocrine organs of vertebrates** • **To understand the underlying principles of hormone functions** • **To gain an insight into the current and important issues in endocrinology**
LEARNING OUTCOME:	**At the end of the course, the students will be familiar with all the endocrine organs and their functions in body growth, metabolism, reproduction and development. They will be able to appreciate better the contemporary issues in endocrinology.**

UNIT	TOPICS	CONTACT HOURS
UNIT 1:	Unit 1: 1.1 Aim and scope of endocrinology, 1.2 techniques in endocrinology - histology, histochemistry, immunocytochemistry, in situ hybridisation, radio immune assay, surgical techniques, 1.3 regulation of hormone secretion: feedback mechanisms - positive, negative, short loop, long loop	15
	1.4 Anatomy and histology of endocrine glands- Pituitary, Pineal gland, Thyroid, Parathyroid, Thymus, Adrenal, Endocrine pancreas, GI tract, Endocrine hypothalamus, Gonads, Placenta	
UNIT 2:	2.1 Classification of hormones 2.2 Hormone structure 2.3 Biological actions of hormones	15
	2.4 Mechanisms of hormone action 2.5 Receptor and it regulation 2.6 Steroid and peptide hormones actions	
	2.7 Hormones and Homeostasis - Calcium and glucose	
UNIT 3:	3.1 Biosynthesis and secretion of hormones - steroid hormones, thyroid hormones	15
	3.2 Growth factors - neurotropic growth factors, hematopoietic growth factors, other peptide growth factors	
	3.3 Endocrine disorders - goitre, gigantism, dwarfism, cretinism, diabetes mellitus, insepidus	

REFERENCE BOOKS:

1. David, N.O. and J.A. Carr (2013) Vertebrate Endocrinology. Academic press publications 5th edition.
2. Hadley, M. and Levine, J (2006) Endocrinology. Benjamin Cummings 6th edition.
3. Kovacs, J.W. and S.R. Ojeda (2011) Textbook of endocrine physiology 6th edition. Oxford university press.
4. Yadav, P.R. (2004) Endocrinology. Discovery Publishing House, New Delhi.

PRACTICAL COMPONENT OF ZOO-III.E-1: Vertebrate Endocrinology
(DURATION -02 HRS /WEEK)

Sr. No	Practical	No. of Practicals
1.	Histological slides of Endocrine hypothalamus, Gonads, Placenta pituitary, Pineal gland, thyroid gland, Parathyroid, Thymus, adrenal gland, pancreas, ovary, testis	04
2	Display of Pituitary and gonads in fishes/chick	03
3	Preparation of histological slides using microtomy	05

ANNEXURE IV

PAPER TITLE:	**BASIC MICROBIOLOGY AND FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY**
PAPER CODE:	**ZOO-III-E-2**
NAME OF FACULTY:	**DR. NANDINI VAZ FERNANDES**
MARKS:	**100 [75 –Theory ; 25- Practicals]**
CREDITS:	**04 [03 –Theory; 01- Practical]**
CONTACT HOURS:	**THEORY : 45 HOURS (03 LEC/WEEK)** **PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)**
COURSE OBJECTIVES:	**To provide a comprehensive survey of microbiology with basic information on bacteria and learn the fundamentals of biotechnological techniques.**
LEARNING OUTCOME:	**Upon successful completion of the course, students will be able to:** • **Gain working knowledge of basic bacterial laboratory techniques, as well as the foundations of biotechnological tools.** • **Students will also master the basic laboratory skills and techniques necessary to work efficiently in a microbiology laboratory and perform techniques of gene insertion and selection of recombinant plasmids.**

MODULE	TOPICS	CONTACT HOURS
UNIT 1: Microbiology (15 hrs)		
	1: Introduction to Microorganisms-Bacteria ○ Structure and Identification of bacteria(morphological types) ○ Nutritional types ○ Nutritional requirements	08
	2: Isolation and Culture of Bacteria: ○ Cultivation of bacteria ○ Different methods of isolation and maintenance of pure cultures ○ Culture characteristics	04
	3: Use of microorganisms in biotechnology-An overview: ○ Production of valuable substances ○ Fuel Production, recovery of minerals and oils ○ Microorganisms in bioassays ○ Food and agriculture sector ○ Medicine and health	03
UNIT 2: Tools in Biotechnology (15 hrs)		
	4: Scope and importance of Biotechnology ○ Definition ○ Contribution and importance of biotechnology	03
	5: Nucleic Acid Enzymology: ○ Restriction enzymes, Ligases, Alkaline phosphatase ○ Polynucleotide kinase, Terminal Transferases, S1 Nuclease ○ Polymerases, Reverse transcriptase	07
	6: Gene Cloning vectors: ○ Plasmids, Bacteriophage, cosmids ○ Shuttle and expression vectors	05
UNIT 3: Genetic Engineering (15 hrs)		
	7: Techniques in genetic engineering: ○ Gene transfer methods ○ Methods of Labeling Nucleic acids ○ Nucleic acid Hybridization ○ Polymerase chain reaction	05
	8: Recombinant DNA technology: ○ Procedure / Technique	04
	9: Blotting Techniques: ○ Southern Blotting ○ Northern Blotting ○ Western Blotting	03
	10: DNA sequencing techniques: ○ Chemical Degradation method ○ Chain termination method ○ Automated Sequencing	03

REFERENCE BOOKS:

Essential books:

1) *Pelczar MJ, Chan ECS, Krieg NR(2009). Microbiology. Tata Mc Graw Hill, New York.*
2) *Dubey RC and Maheshwari DK (2012). A test book of Microbiology. S Chand Publishers, New Delhi.*
3) *Prave P, Faust U, Sittig W and Sukatsh DA(2004). Fundamentals of Biotechnolgy.*
4) *Purohit SS(2008). BiotechnologyFundamentals and applications. Agrobios, Jodhpur India.*
5) *Ranga MM(2012): Animal Biotechnology. Agrobios, Jodhpur India.*

Supplementary reading:

6) *Black JG(2005). Microbiology principles and explorations. John Wiley and sons Inc.*
7) *Sullia SB and Shantharam S(2006). General Microbiology. Oxford and IBH Publishing Co Pvt Ltd, NewDelhi.*

PRACTICAL COMPONENT OF ZOO-III-E-2: DURATION - 02 HRS /WEEK BASIC MICROBIOLOGY & FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY		
SR. NO	PRACTICAL	NO. OF PRACTICALS
1.	**Preparation of culture media for bacteria (Plates, Slants, deeps, Broth).**	**02**
2.	**Staining of Microorganisms (Gram staining, negative staining).**	**02**
3.	**Isolation of pure colonies of Bacteria (streak plate method – 3 Quadrant And 5 Quadrant methods)**	**02**
4.	**Identification of Products of metabolic pathways of microbial cells.**	**01**
5.	**Bacteriological testing of Milk.**	**01**
6.	**DNA sequencing - Analysis of prints.**	**01**
7.	**Isolation of Plasmid DNA (Demonstration)**	**02**
8.	**Transformation of bacteria (Selection by blue-white colony method – demonstration practical**	**02**

REFERENCE BOOKS FOR PRACTICALS:

1) *Gunasekaran P(2009). Lab Manual in Microbiology. New Age International Ltd. Publishers, New Delhi.*

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ANNEXURE V

PAPER TITLE:ENVIRONMENTAL TOXICOLOGY

PAPER CODE: ZOO-III.E-3

NAME OF FACULTY:K.N.MISHRA

MARKS :100[75-Theory; 25 – Practical]

CREDITS: 04[3 –Theory; 01 –Practical]

CONTACT HOURS : Theory : 45 Hours (03 Lec./ Week)
Practical :30 Hours (01 Practical/Week)

COURSE OBJECTIVE :

- To study the different environmental pollutants and their toxicity.
- To know the physiological effects of toxicant exposure.

LEARNING OUTCOME:

After completion of the course students are expected to be able to:

- Distinguish, classify and characterize a variety of environmental pollutants based on their biological and physical properties.
- Identify the main sources and types of environmental pollutants and assess their potential environmental fate.
- Will learn mechanisms of detoxification of various varieties of toxicants.
- Will learn bio-indicators of exposure to specific environmental contaminants.
- Identify potential solutions to anthropogenic pollution

	TOPIC	CONTACT HOURS
UNIT1:	**1.1INTRODUCTION TO TOXICOLOGY:** ○ Definition and History of Toxicology and Toxicity ○ Disciplines of Toxicology ○ Biouptake,Bioaccumulation,Biotransfer and Biological Magnification ○ Relationship to Other Sciences. ○ Scope and importance of Toxicology **1.2: CLASSES OF TOXICANT:** • Define Toxicant and Toxins • Toxicants and their classification • Toxicants in Air • Toxicants in Water and Soil • Toxicants in Domestic and • Occupational Settings • Synthetic drugs:Solvents, • Therapeutic drugs, Drugs of abuse, Combustion products,Cosmetics • Movement and fate of Toxicants in the environment	**15**

UNIT2:	**2.1: TOXICITY OF HEAVY METALS:** • Toxicity of Arsenic,Lead,Mercury, • Cadmium,Copper,Zinc,Aluminium,Iron and Manganese • Sources and portals of heavy metal pollutants • Toxicity of substances on Human and Animals **2.2: AGRO-CHEMICAL PESTICIDES AND THEIR ENVIRONMENTAL IMPACT MITIGATION** • Definition and Classification • Organochlorine Insecticides • Organophosphate Insecticides • Carbamates • Pyrethroid Insecticides • Dinitrophenols • Herbicides • Fungicide • Control of Pesticide Pollution • Integrated Pest management	**15**
UNIT3:	**3.1:TOXINS:** • History • Classes of Toxicants : • Microbial,Mycotoxins,Algaltoxins, • Planttoxins,Animaltoxins, **3.2: FOOD ADDITIVES:** • General account of Food Additives: • Incidental or Indirect additives • Intentional or Direct additives **a.**Antioxidants b. Emulsifiers c. Enzymes d. Flavouring agents e. Colour and preservatives f. Artificial sweetening agents i)Saccharine ii)Urea derivatives	**15**

REFERENCE BOOKS FOR THEORY:

1. Ernst Hodgson(2004) A Text Book of Modern Toxicology ,A John Wiley and sons Inc,Publication.
2. Gupta P.K.(2010) Modern Toxicology, Pharma Med Press, Hyderabad.
3. Omkar(2007) Concepts of Toxicology ,Vishal Publishing Co, Jalandhar
4. Pandey K,Shukla J.P. and Trivedi S.P. (2011)Fundamentals of Toxicology,New Central Book Agency(P) Ltd.
5. P.D.Sharma (2011)Environmental Biology and Toxicology (Third edition),Rastogi Publications,Meerut-250002.

PRACTICAL COMPONENT OF ZOO-III.E-3:ENVIRONMENTAL TOXICOLOGY (DURATION-02 HRS/WEEK)		
Sr.No.	**Practical**	**No.of Practicals**
1.	To determine the effect of temperature on the toxicity of a pollutant	01
2.	To determine the effect of pH on the toxicity of a pollutant.	01
3.	To Separate and analyse the residues of carbamate pesticides by thin layer chromatography.	01
4.	To evaluate qualitatively the presence of pesticide residues in vegetable samples.	01
5.	Estimation of total dissolved solids in given water sample.	01
6.	To determine Lc^{50} of a pollutant on mosquito larvae .	02
7.	Effect of pesticides on Oxygen consumption in fish	01
8.	Estimation of Phosphorus in given water sample by Spectrophotometer	01
9.	Estimation of Boron from given water/soil sample by spectrophotometer	01
10.	Estimation of Fluorides in given water sample	01
11.	Determination of Nitrates from given water sample.	01

REFERENCE BOOKS FOR PRACTICALS:

1. Adam Wooley (2008) A Guide to Practical Toxicology:Evaluation,Prediction,and Risk IInd Edition,Informa Healthcare U.S.A.,Inc. New York.
2. Rao K.S. (1998) Practical Ecology,Anmol Publications Pvt. Ltd. New Delhi.
3. Subramanian M.A. (2004) Toxicology Principles and Methods(Second Revised Edition),M.J.P. Publishers,Triplicane Chennai.
4. Sunita Hooda and Sumanjeet Kaur (1999) Laboratory Manual for Environmental Chemistry,S.Chand and Comp.Ltd. New Delhi.
5. Trivedi R.K.,Goel P.K. and Trishal C.L.(1987) Practical Methods in Ecology and Environmental Science, Enviro Media Publications,Karad (India).

ANNEXURE – VI

PAPER TITLE:	**PARASITOLOGY**
PAPER CODE:	**ZOO-III.E-4**
NAME OF FACULTY:	**Dr. SOCORRINHA D'COSTA**
MARKS:	**100 [75 –Theory ; 25- Practicals]**
CREDITS:	**04 [03 –Theory; 01- Practical]**
CONTACT HOURS:	**THEORY : 45 HOURS (03 LEC/WEEK)** **PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)**
COURSE OBJECTIVES:	• **To be familiar with the parasite host interactions.** • **To gain knowledge on diagnosis of parasite infections and also to learn about the preventive measures.**
LEARNING OUTCOME:	**At the end of the course the learner will be acquainted with dimensions of public health viz a viz parasitic diversity, epidemiology and community prophylaxis**

UNIT	TOPICS	CONTACT HOURS
UNIT 1: **Basic Principles of Parasitology and parasitic protozoans**	**1.1 Parasite systematics, Ecology and Evolution** **1.2 Immunology and Pathology** **1.3 Symbiosis and parasitism** **1.4 Parasite host interactions** **Form, function, classification, life cycle, diagnosis and preventive measures** **1.5 *Trypanosoma gambiens*** **1.6 Amoebas -*Entamoeba histolytica*** **1.7 Malaria organisms - *Plasmodium vivax*** **1.8 Sexually transmitted parasite - *Trichomonas vaginalis***	15
UNIT 2: **Parasitic Platyhelmithes and Nematodes**	**Form, function, classification, life cycle, diagnosis and preventive measures** **2.1 Trematoda (liver fluke - *Fasciola hepatica,* intestinal fluke - *Fasciolopsis buski,* lung fluke - *Paragonimus westermani*);** **2.2 Cestoda (Tape worm - *Taenia solium*)** **2.3 Hook worms- *Ancyclostoma duodena*** **2.4 Guinea worm- *Dracanculus medinensis*** **2.5 Round worm *Ascaris lumbricoids, Enterobias vermicularis*** **2.6 *Wuchereria bancrofti***	15
UNIT 3: **Parasitic arthropods and** **Parasites of domestic livestock**	**Form, function, classification , life cycle, diagnosis and preventive measures** **3.1 Copepods** **3.2 Barnacles** **3.3 Amphipods** **3.4 Isopods** **3.5 Flea** **3.6 Ticks** **3.7 Mites** **3.8 Head and pubic lice**	15

REFERENCE BOOKS:

1. **Chatterjee, K.D. (2009) Parasitology (Protozoology and Helminthology) with two hundred fourteen illustrations. CBS, 13th edition.**

2. **Dey, N.C., Dey, T.K. and D.M. Sinha (1995) Medical Parasitology. New Central book agency private limited, Calcutta.**
3. **Paniker, J.C.K. (2007) Textbook of medical parasitology. Jaypee Brothers, New Delhi.**
4. **Schmidt, G.D. (1990) Essentials of Parassitology. Universal Book Stall, New Delhi.**

PRACTICAL COMPONENT OF ZOO-III.E-4: PARASITOLOGY (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1.	**Study of *Trypanosoma gambiens, Entamoeba histolytica, Plasmodium vivax, Trichomonas vaginalis, Fasciola hepatica, Taenia solium, Ancyclostoma duodena, Dracanculus medinensis, Ascaris lumbricoids, Wuchereria bancrofti* , copepod, barnacle, amphipod, isopod from permanent slides with respect to parasitic adaptations.**	**06**
2.	**Preparation of peripheral blood smear from the perspective of detection of haemoparasites**	**01**
3.	**Study of parasites of domestic livestock(parasite, pathogenicity)**	**04**
4.	**Study of fish parasites**	**01**

REFERENCE BOOK:

1. **Halton, D.W., Behnke, J.M. and I. Marshall (2005) Practical exercises in parasitology. Cambridge University Press.**

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PAPER TITLE:	**BIOCHEMISTRY AND METABOLIC REGULATION**
PAPER CODE:	**ZOO-IV.C-6**
NAME OF FACULTY:	**Dr. SOCORRINHA D'COSTA**
MARKS:	**100 [75 –Theory ; 25- Practicals]**
CREDITS:	**04 [03 –Theory; 01- Practical]**
CONTACT HOURS:	**THEORY : 45 HOURS (03 LEC/WEEK)** **PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)**
COURSE OBJECTIVES:	• **To understand the basic principles that govern the functioning of living systems** • **To know the structure of biomolecules and the role they play in governing life processes through the pathways** • **To be familiar with enzymes and their activities**
LEARNING OUTCOME:	**At the end of the course, the students will be able to understand better the chemical basis in life. They will appreciate better the interactions between the biological molecules.**

UNIT	TOPICS	CONTACT HOURS
UNIT 1: **Fundamentals of biochemistry and Carbohydrate metabolism**	**1.1 Principles of pH, buffer, thermodynamics** **1.2 Enzymes: classification, properties of enzyme, enzyme kinetics, MichaelisMenten Equation, enzyme inhibition** **1.3 Carbohydrate structure, aerobic and anaerobic glycolysis, Citric acid cycle, glycogenesis, glycogenolysis, Pentose phosphate pathway,** **1.4 Diabetes mellitus**	15
UNIT 2: **Lipid and Protein metabolism**	**2.1: Lipid:** **-structure and classification,** **-fatty acid synthesis** **-fatty acid oxidation(saturated and unsaturated),** **- metabolism of glycerophospholipids, sphingolipids, cholesterol** **- disorders: fatty liver types (NAFL, AFL)** **2.2 Protein:** **- structure (primary, secondary, tertiary) and classification** **- amino acid biosynthesis, nucleotide biosynthesis,** **- amino acid catabolism, urea cycle, Fate of carbamoyl P,** **- Hyper uricemia**	15
UNIT 3: **Nucleotide metabolism and integration of metabolism**	**3.1 Biosynthesis of purine and pyrimidine (de novo and salvage pathway)** **3.2 Degrdation of purine and pyrimidine** **3.3 Interconversions between the three principal components** **3.4 Metabolism in starvation: Carbohydrate, lipid, proteins (The feed/fast cycle)**	15

REFERENCE BOOKS:

1. **David, L.N. and Cox, M. Michael (2008) Lehninger principles of biochemistry. W.H. Freeman and Company, New York.**
2. **Delvin, T.M. (1997). Textbook of biochemistry with clinical correlations. Wiley liss.**
3. **Harvey, A.R. and Ferrier, D. (2011). Lippincott's Illustrated Reviews Biochemistry. Wolters Kluwer, Lippincott Williams and Wilkins. 5th Edition.**

4. **Pratt, W.C. and K. Cornely 2003 Essential Biochemistry Wiley Publications third edition.**

PRACTICAL COMPONENT OF ZOO-IV.C-6: BIOCHEMISTRY AND METABOLIC REGULATION (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1.	Principle and working of spectrophotometer	01
2.	Estimation of reducing sugars DNSA method	01
3.	Estimation of protein – Folin Lowry's method	01
4.	Estimation of fatty acids by titration method	01
5.	Separation of lipids by thin layer chromatography	02
6.	Colorimetric estimation of liver glycogen of chick by Anthrone method	02
7.	Effect of substrate concentration on amylase activity	01
8.	Estimation of DNA by DPA method	01
9.	Isolation of lecithin and cholesterol from yolk	02

REFERENCE BOOKS FOR PRACTICALS:

Plummer, M. and D.T. Plummer (1988) Introduction to practical biochemistry.Tata McGraw Hill Education ,UK.

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ANNEXURE VIII

PAPER TITLE:	**ANIMAL CELL CULTURE AND APPLICATIONS**
PAPER CODE:	**ZOO-IV-E-5**
NAME OF FACULTY:	**DR. NANDINI VAZ FERNANDES**
MARKS:	**100 [75 –Theory ; 25- Practicals]**
CREDITS:	**04 [03 –Theory; 01- Practical]**
CONTACT HOURS:	**THEORY : 45 HOURS (03 LEC/WEEK)** **PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)**
COURSE OBJECTIVES:	**This course is an introduction to the theory, standard practices, and methodologies of animal cell culture. The laboratory emphasizes the principles and practices of initiation, cultivation, maintenance of cell lines.**
LEARNING OUTCOME:	**Upon successful completion of the course, students will be able to:** - **operate, calibrate, and maintain standard equipment found in an animal cell culture laboratory;** - **Prepare and sterilize media and solutions used in cell culture.** - **Demonstrate an understanding of the concepts and applications of mammalian cell culture.** - **Recognize and employ biosafety guidelines and practices.**

MODULE	TOPICS	CONTACT HOURS
UNIT 1: LAB REQUIREMENTS FOR CELL CULTURE (15 hrs)		
	1: Historical background of Cell culture:	01
	2: Biology of cells in culture: ○ Origin and characteristics ○ Differentiation ○ kinetics of cell growth ○ Genetics of Cultured cells ○ Problems associated with cell culture	04
	3: Lab requirements for animal cell culture: ○ Lab facilities and setup for cell culture ○ Major and minor equipments ○ Environmental conditions ○ Substrates for Culturing and sub culturing	05
	4: Animal tissue culture media ○ Natural media – biological fluids, tissue extracts ○ Chemically defined media- characteristic and composition ○ Media supplements – L Glutamine, serum. Advantages and disadvantages of serum in media / serum free media	05
UNIT 2: CELL CULTURE TECHNIQUES(15 hrs)		
	5: Primary cell culture: ○ Mechanical disaggregation ○ Enzymatic disaggregation ○ Protocol for primary cell culture	06
	6: Secondary cell culture/ Sub culturing: ○ Protocol for sub culturing of suspension culture ○ Protocol for sub culturing of adherent ○ Established cell lines	06
	7: Scale up of animal cell culture: ○ Techniques of Scale up of suspension cultures ○ Techniques of Scale up of Monolayer cultures	03
UNIT 3: CELL CULTURE APPLICATIONS(15 hrs)		
	8: Cell Hybridoma Technology : ○ Steps of cell Hybridoma technology ○ Procedure ○ Production of monoclonal antibodies ○ Applications of monoclonal antibodies	05
	9: Valuable Products through cultured cells: ○ Production of Tissue plasminogen, growth factor, Erythropoietin, Factor VIII, Interferons	05
	10: Other Application: ○ Vaccines through cultured cells ○ Cytotoxicity testing ○ Fluorescent In-Situ Hybridization for disease detection ○ Cell culture in biomedical research	05

PRACTICAL COMPONENT OF ZOO-IV-E-5: DURATION -02 HRS /WEEK ANIMAL CELL CULTURE AND APPLICATIONS		
Sr. No	**Practical**	**No. of Practicals**
1.	Packing and sterilization of glass and plastic wares for cell culture & Lab Precautions and Biosafety measures	02
2.	Preparation of reagents and media for cell culture. ▪ Reagents ▪ Media / Buffers	02
3.	Quantification of cells (Viable cell count) by trypan blue exclusion dye.	01
4.	Methods used for cell disaggregation – Mechanical and Enzymatic	02
5.	Setting up of primary cell culture ▪ Suspension culture ▪ Adherent cell culture	02
6.	Setting up of chicken embryo fibroblast culture (cold trypsinization / warm trypsinisation)	02
7.	Biological waste disposal methods	01

REFERENCE BOOKS:

Essential books:

1) *Ranga MM(2012). Animal Biotechnology. Agrobios India Ltd. Jodhpur.*
2) *Mathur S(2006). Animal Cell and Tissue Culture. Agrobios India Ltd. Jodhpur.*
3) *Masters W(2005). Animal Cell Culture. Oxford University Press Inc., NewYork*
4) *Gangal S(2010). Principles and practices of Animal Tissue Culture. Second Edition. University Press PVT. LTD., Hyderabad India.*
5) *Freshney I R(2007). Culture of animal Cells: A manual of Basic Techniques. 5th edition, John Wiley & Sons Inc Pte Ltd*

REFERENCE BOOKS FOR PRACTICALS:

1) *E Book- Fletcher L, Goss E. Phelps P and Wheeler A(2014). Introduction to Biotechnology – Laboratory Manual.*
2) *Harisson M A and Rae IF(1997):General Techniques of Cell Culture Handbook in Practical animal cell biology. Cambridge University Press.*
3) *Ebook- Cell Culture basics. From www.invitrogen.com/cellculture basics.*

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ANNEXURE IX

PAPER TITLE : AQUACULTURE AND FISHERIES
PAPER CODE: ZOO-IV.E-6
NAME OF FACULTY: K.N.MISHRA
MARKS:100[75- Theory; 25- Practicals]
CREDITS: 04 [03-Theory;01- Practical)
CONTACT HOURS: Theory :45 Hours(03 LEC/WEEK) Practicals: 30 Hours(01 PRACTICAL/WEEK)
COURSE OBJECTIVES: • To improve the understanding of conservation and sustainability of living resources • To improve the social and economic benefits derived from aquaculture and fisheries. • To study the role of aquaculture in rural development in solving nutritional security and unemployment. • Empowerment of fishery and entrepreneurship development
LEARNING OUTCOMES: • The student may become future aqua culturist, entrepreneur who will provide employment to others. • Optimum utilization of unutilized and underutilized aquatic resources for fisheries and aquaculture, enhance the fish production, employment generation and even to earn the foreign exchange.

MODULE	TOPIC	CONTACT HOURS
UNIT 1:	**1.1:INLAND FISHERIES:** • fisheries: Fisheries of Ganga and Brahmputra river system • Reservoir fisheries • Lakesterine fisheries: Cat fish, Murrels, Mullets, Major carps • Cold water fisheries: Mahaseer fishery **1.2: MARINE FISHERIES:** • Estuarine fisheries:The catadromous fishes (*Polynemous indicus*,*P.tetradactylus*) and anadromous fishes(*Hilsa ilisha*,*Pama pama*,*Polynemous paradiseus*) • Coastal fisheries or Inshore fisheries: Elasmobrach fishery and Teleost fishery • Offshore and Deep sea fisheries: Pomfrets(*Pampus*,*Stromateus) Eleutheronema tetradactylus*(rava),*Polydactylus indicus*(dara), ghol(*Pseudosciaena diacanthus*),*scianids*(Kurtus) **1.3: CRUSTACEAN AND MOLLUSCAN FISHERIES:** • Prawn fisheries in Goa: Penaeid and Palaemonid groups. • Crab fisheries in Goa • Edible oyster fisheries in Goa • Mussel fisheries in Goa **1.4 :FISHING METHODS IN INDIA**: • Marine Fishing Crafts and Gears used in Goa • Inland Fishing Crafts and Gears used in Goa	**15**
UNIT 2:	**2.1: INTEGRATED FISH FARMING SYSTEMS:** • Principle of integrated Fish farming • Integration with animal husbandry • Integration with farming systems. **2.2:INDUCED BREEDING:** • Selection of site • Design and Layout of fish farm • Freshwater and brackish water pond • construction • Pond maintenance • Prevention of fish diseases • Control of aquatic weeds • Control of predatory and Weed fishes • Control of Aquatic insect • Harvesting	**15**

<table>
<tr><td>UNIT 3:</td><td>3.1: FISH CULTURE SYSTEM:
Mono culture, polyculture, composite culture, raceway culture, extensive, semi intensive, intensive, zero water exchange
Objective of fish culture
Pond preparation
Selection of species
Stocking of seed
Feed and feeding
Harvesting
Bionomics of fish culture
3.2: CAGE AND PEN CULTURE:
Advantage of Fish culture in cages
Selection of species for cage culture
Installation of cage - shape ,size and types of cages
Pen culture
Maintenance of cage and pen
3.3: PRESERVATION AND PROCESSING:
Fish marketing
Transportation
Reasons for spoilage of Fishes
Methods of fish preservation-Freeze-drying,
Salting, Refrigeration, Deep Freezing,</td><td>15</td></tr>
</table>

REFERENCE BOOKS FOR THEORY:

1. Bal D.V.,RaoVirbhadra,K (1984) Marine Fisheries, Tata McGraw- Hill Publishing Company Ltd.New Delhi.
2. Cushing D.H. (1975) Marine Ecology and Fisheries , Cambridge University Press.
3. Day,F. (1889) The Fauna of British India including Ceylon and Burma. Fishes. 2Vols.,Taylor and Francis London.
4. Khanna S.S.(1984) An Introduction to Fishes, Central Book Depot Allahabad.
5. Pandey K and Shukla J.P.(2015) Fish and Fisheries. Rastogi Publications Meerut-250002
6. Sakhare B. Viswas (2007) Applied Fisheries.Daya Publishing House Delhi-110035
7. Santhanam R (1990) Fisheries Science,Daya Publishing House Delhi.
8. SanthanamR,Ramanathan N and Jagatheesan G(1990) Coastal Aquaculture in India,CBS Publishers and distributers,Delhi.
9. Shrivastava C.B.L.(1996) A Text Book of Fishery Science and Indian Fisheries. KitabMahal22A,S.N.Marg,Allahabad.
10. Singh B.K.(2008) Applied Fisheries and Aquaculture.Swastik Publishers and distributers,Delhi.

PRACTICAL COMPONENT OF ZOO-IV.E-6: AQUACULTURE AND FISHERIES (DURATION – 02 HRS/ WEEK)		
Sr. No.	**Practical**	**No. of Practicals**
1.	Morphometric and Meristic study : a key for fish Identification	**03**
2.	Identification of important edible shrimps and crabs(any two)	**01**
3.	Identification of important Freshwater and Marine edible fishes (five fishes each from different families)	**02**
4.	Methods of Measuring gonosomatic index of Fish	**01**
5.	Estimation of Fecundity by Frequency Polygon method from a Marine Fish	**01**
6.	Food and Feeding of Fish by analysis of gut content	**01**
7.	Visit to a Fish Landing Center to study different Types of Gear and Craft	**01**
8.	Visit to Fish breeding Center to study Induced Breeding in Indian Carps	**01**
9.	Visit to ICAR/NIMR(National Institute of Malaria Research) Old Goa for Study of Aquarium and Larvivorous Fishes	**01**

REFERENCE BOOKS FOR PRACTICALS:

1. Chandy.M (1970) Fishes,National Book Trust,India,New Delhi.
2. Day.F. (1889) The Fauna of British India including Ceylon and Burma. Fishes. 2Vols.,Taylor and Francis London.
3. R.J.Ranjit Daniels (2002) Freshwater Fishes of Peninsular India, Universities Press (India)Pvt.Ltd. Hyderabad.
4. SakhareViswasB. (2007) Applied Fisheries ,Daya Publishing House Delhi.
5. Sharma U and S.P.Grover (1982) An Introduction to Indian Fisheries,Dehradun India.
6. Srivasava C.B.L.(1986) A Text Book of Fishery Science and Indian Fisheries ,KitabMahal Allahabad.

ANNEXURE – X

PAPER TITLE:	**IMMUNOLOGY**
PAPER CODE:	**ZOO-IV.E-7**
CURRICULUM DESIGNED BY :	**DR. NANDINI VAZ FERNANDES**
MARKS:	**100 [75 –Theory ; 25- Practicals]**
CREDITS:	**04 [03 –Theory; 01- Practical]**
CONTACT HOURS:	**THEORY : 45 HOURS (03 LEC/WEEK)** **PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)**
COURSE OBJECTIVES:	**Familiarize students and make them learn about the structural features of the components of the immune system as well as their functions, and understand the mechanisms involved in immune system development and responsiveness.**
LEARNING OUTCOME:	**Upon successful completion of the course, students will be able to:** • **Understand the components of the immune system and their function.** • **Be able to explain the mechanisms of immune response.** • **Perform immunoassays to detect the presence of antigens or antibodies(disease detection).**

MODULE	TOPICS	CONTACT HOURS
UNIT 1: INTRODUCTION TO IMMUNOLOGY		
	1: OVERVIEW OF IMMUNE SYSTEM: • Basic concepts in immunology • Components of the immune system	05
	2: INNATE AND ADAPTIVE IMMUNITY. • Innate immunity-Anatomical barriers/ layers of defense, cells and molecules involved in innate immunity • Adaptive immunity-cell mediated and humoral immunity, passive immunity (artificial and natural), Active(artificial and natural), Immune dysfunction	10
UNIT 2: ANTIGENS AND IMMUNOGLOBULINS		
	3: ANTIGENS. • Antigenicity and immunogenicity, Immunogens, adjuvants and haptens • Factors influencing immunogenicity • B and T cell epitopes	05
	4: IMMUNOGLOBULINS • Structure and function of different classes of Immunoglobulin. • Antigen-Antibody interactions • Immunoassays, monoclonal & polyclonal antibodies	07
	5: MAJOR HISTOCOMPATIBILITY COMPLEX. • Structure and function of endogenous and exogenous pathways of antigen presentation	03
UNIT 3: IMMUNE RESPONSE		
	6: CYTOKINES AND COMPLEMENT SYSTEM • Properties and functions of cytokines, cytokine based therapies • Components and pathways of complement activation	05
	7: HYPERSENSITIVITIES, AUTOIMMUNITY AND TRANSPLANTATION • Gell and coombs' classification, types of hypersensitivities(overview) • Autoimmune responses against self antigens (SLEs), responses to alloantigens and transplant rejection (graft rejection, types and mechanisms of transplant rejection	07
	8: VACCINES • Types of vaccines -inactivated, attenuated, toxoid, subunit, conjugate, experimental (DNA and recombinant vaccine), monovalent/polyvalent vaccines	03

PRACTICAL COMPONENT OF ZOO-IV-E-7: IMMUNOLOGY (DURATION -02 hrs/WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1	Preparation of serum from goat blood.	02
2	Slide Agglutination Reaction(blood groups – A / AB / O with Rh)	02
3	Differential count of leukocytes	01
4	Detection of presence of antigen / antibody - Simple immunodiffusion	01
5	Antibody Titre determination - Ouchterlony immunodiffusion	02
6	Antigen –antibody reaction by immunoelectrophoresis	02
7	Elisa TEST- pregnancy test	01
8	Phagocytosis – WBC (demonstration)	01

REFERENCE BOOKS:

Essential books:

1) *Abbas KA, Lechtman HA(2007). Basic Immunology, Updated Edition 2006-2007: with STUDENT CONSULT. Access (Paperback).*
2) *David M, Jonathan B, David RB and Ivan R(2006). Immunology. VII Edition, Mosby, Elsevier Publication.*
3) *Abbas KA, Lechtman HA(2003). Cellular and Molecular Immunology. Saunders Publication.*
4) *Kindt TJ, Goldsby RA, Osborne BA and Kuby J(2006). Immunology. VI edition. W H Freeman and company.*

Ebooks:

5) *Frank SA(2002).Immunology and evolution of infectious diseases. Princeton University Press, Princeton and Oxford.*
6) *Zabriskie JB(2009). Essential Clinical Immunology. Cambridge University Press.*

REFERENCE BOOKS FOR PRACTICALS:

1) *Talwar GP and Gupta SK(2012).A handbook of practical and Clinical Immunology, CBS publishers.*

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ANNEXURE XI

PAPER TITLE:EVOLUTIONARY BIOLOGY
PAPER CODE: ZOO-IV.E-8
NAME OF FACULTY: K.N.MISHRA
MARKS: 100 [75-Theory; 25 –Practicals]
CREDITS: 04[03 – Theory; 01 – Practical
CONTACT HOUR : Theory : 45 Hours(03 Lec./Week) Practicals: 30 Hours(01Practical/Week)
COURSE OBJECTIVE: • The study aims to discover the history of life and the causes of the diversity and characteristics of organisms. • To show the important contributions of evolutionary biology to other biological disciplines such as medicine
LEARNING OUTCOME: • The study will give detail knowledge about many unsolved hypothetical issues to solve it. • The student will learn that evolution is not a speculation , but a thoroughly supported hypothesis that explains the process of evolution

MODULE	TOPICS	CONTACT HOURS
UNIT 1:	**1.1: EVOLUTIONARY BIOLOGY:AN OVERVIEW** • What Is Evolution? • History Of Evolutionary Biology • Pre Darwinian • Darwin's Evolutionary Theory • Evolutionary Theories After Darwin • Famous contributions to evolutionary Biology:CarlLinneaus,Lamarck,Malthus,Darwin,Thomas Huxley,R.A.Fisher,Haldane,sewall Wright,G.G.Simpson,Dobzanhasky,Ernst Mayr,M.Kimura **1.2: THE NATURAL SELECTION:** • The Nature of Natural Selection • Postulates of natural selection • Evidences of Natural selection • Types of natural selection(Stabilizing,Directional and Disruptive selection) • Natural Selection in action(Darwin's finches, Endler's guppies examples) • Sexual Selection **1.3: RANDOM PROCESS IN EVOLUTION:** • mutation :types of mutation • genetic drift(bottle neck effect,founder's effect) • gene flow(migration/emmigration **1.4: SYNTHETIC THEORY OF EVOLUTION** • Neo-Darwinis	**20**
UNIT 2:	**2.1: NON- DARWINISM** • Neutral theory of evolution • Molecular polymorphism-nucleic acids and proteins • Molecular clocks **2.2: SPECIATION** • different concepts of speciation • Concept Of Biological Speciation(Allopatric/Sympatric) • Consequence Of Speciation • Factors involved in Biological Speciation(pre and post- zygotic mechanisms) **2.3: POPULATION GENETICS** • Hardy-Weinberg's Law(H-W) • Genes And Genotype Frequencies • Factors Affecting H-W **2.4:ADAPTATIONS :** • Definition and kinds of adaptations with some	**15**

	examples. • Pre , Post adaptations • Coadaptations and Parallel adaptations	
UNIT 3:	**3.1: PATTERNS OF EVOLUTION:** • Sequential and Convergent Evolution • Microevolution • Macroevolution(Adaptive radiation) • Megaevolution • Gradualism And Punctuated Equilibrium **3.2: EVOLUTION AND HUMAN HEALTH AND DISEASES** • Design defects • Defence mechanisms-Allergy,morning sickness • Evolution of antibiotic resistance • Evolution of behaviour,Anxiety,fear and depression.	**10**

REFERENCE BOOKS FOR THEORY:

1. Bipin Kumar(2001) Organic Evolution; Campus Books International, New Delhi.
2. Charlotte J. Avers (1989)Process and pattern in Evolution ; New York Oxford University Press.
3. Douglas J. Futuyma(2013) Evolution IIIrd edition; Sinauer Associates,Inc.Publishers Sunderland , Massachusetts U.S.A.
4. E.Peter Volpe(1989) Understanding Evolution Vth edition Universal Book Stall.
5. S.Osawa ,T.Honjo(Eds.)(1991) Evolution of life,Springer-Verlag Tokyo .
6. Savage Jay M (1969) Evolution , Amerind Publishing Co-Pvt. Ltd. New Delhi.
7. Veer Bala Rastogi (2004) Organic Evolution ,Eleventh revised edition; Kedarnath Ramnath Delhi.

PRACTICAL COMPONENT OF ZOO-IV.E-8: EVOLUTIONARY BIOLOGY DURATION -02 HRS/WEEK

Sr.No.	**Practical**	**No.of Practicals**
1.	Study of homology and analogy from suitable specimens	**01**
2.	Serial homology	**01**
3.	Variations are basis for evolution	**01**
4.	To demonstrate the role of Natural Selection in Fixing Favoured Adaptation and Eliminating Maladaptation.	**02**
5.	Problems based on Population Genetics (PTC /blood group)	**04**
6.	An exercise to illustrate the concepts of Genetic drift	**02**
7.	Vestigial organs or Vestiges in animals and humans.	**01**

REFERENCE BOOKS FOR PRACTICALS:

1. Pranab K. Banerjee (2011) Problems on Genetics,Molecular Genetics and Evolutionary Genetics, New Central Book Agency (P) Ltd. Delhi.

ANNEXURE XII

Question paper pattern of the college

Q1	Q2	Q3	Q4	Max Marks	Total Marks
Any 3 OF 4 **(3 marks each)**	**Any 2 OF 3** **(6 marks each)**	**Any 2 OF 3** **(6 marks each)**	**Any 1 OF 2** **(12 marks each)**	**45**	**72**

Annexure II

REVISED SYLLABUS OF ZOO-I.C-1 Approved by BOS

PAPER TITLE:	**Animal Diversity: Non Chordates**
PAPER CODE:	**ZOO-I.C-1**
NAME OF FACULTY:	**Ms. SOCORRINHA D'COSTA**
MARKS:	**100 [75 –Theory ; 25- Practicals]**
CREDITS:	**04 [03 –Theory; 01- Practical]**
CONTACT HOURS:	**THEORY : 45 HOURS (03 LEC/WEEK)** **PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)**
COURSE OBJECTIVES:	• **To be familiar with the different non-chordate phyla.** • **To know the general and distinguishing characters of each of them.** • **To study how the different systems evolved in their complexity.** • **To compare and contrasts the life processes in different phyla.**
LEARNING OUTCOME:	**At the end of the course, the students will be familiar with the non-chordate world that surrounds us. They will be able to appreciate the process of evolution and see how it progressed from simple, unicellular cells to complex, multicellular organisms. Students will be able to identify the invertebrates and classify them upto the class level. Students will understand the basis of life processes in the non-chordates.**

MODULE	TOPICS	CONTACT HOURS
Unit 1: **Evolution of Animal Diversity and Diversity of lower non chordates**	1.1 Non chordate evolution and diversity 1.2 Taxonomy and phylogeny of animals 1.3 Invertebrate cladogram 1.4 Protista Classification and general characters upto class for the following phyla: 1.5 Porifera 1.6 Cnidaria 1.7 Platyhelminthes 1.8 Aschelminthes 1.9 Annelida	15
Unit 2: **Diversity of higher Non Chordates And Biological systems of non chordates 1**	Classification and general characters upto class for the following phyla: 3.1:Onycophora 3.2: Arthropoda 3.3: Mollusca 3.4: Echinodermata 3.5: Hemichordata Comparison of life processes such as nutrition, sensory and neural control and coordination, sense organs	15
Unit 3: **Biological systems of Non Chordates 2**	Comparison of life processes such as blood vascular system, exoskeleton, endoskeleton, locomotion and muscular system, respiration, excretion, reproduction and development of phylum porifera to hemichordata	15

REFERENCE BOOKS:

1. Barnes R.D. (2000). Invertebrate Zoology.Hall Saunders International Edition, London.

2. Barrington E.J.W. 1979. Invertebrate structure and Function.John Wiley and Sons Inc.

3. Jordan, E. L. and Verma, P.S. (2000). Invertebrate Zoology. S. Chand & Co. Pvt. Ltd. New Delhi.

4. Marshall A.J.and W.D. Williams. 1974. Textbook of Zoology. Macmillan.

5. Pechenik J.A.(2002). Biology of the invertebrates. Tata McGraw hill Publishing company limited, New Delhi .

PRACTICAL COMPONENT OF ZOO-I.C-1: ANIMAL DIVERSITY: NON CHORDATES (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1.	**Identification of organisms from phylum protozoa to phylum Hemichordata**	**06**
2.	**Observation of permanent slides**	**03**
3.	**Mountings: Cockroach mouth parts, prawn appendages**	**02**
4.	**Field trip to terrestrial environment to study the invertebrates in their natural habitats**	**01**

REFERENCE BOOKS FOR PRACTICALS:

1) Lal S.S. (2004) A textbook of practical zoology vertebrate. Rastogi publications, Meerut India.
2) Ziser. W.S (2014) Biology 1413 Introductory Zoology Lab Manual.Morton Publishing Co. Austin Community College.

Annexure II

REVISED SYLLABUS OF ZOO-I.C-2 Approved by BOS

PAPER TITLE:	**CELL AND MOLECULAR BIOLOGY**
PAPER CODE:	**ZOO-I.C-2**
NAME OF FACULTY:	**DR. NANDINI VAZ FERNANDES**
MARKS:	**100 [75 –Theory ; 25- Practicals]**
CREDITS:	**04 [03 –Theory; 01- Practical]**
CONTACT HOURS:	**THEORY : 45 HOURS (03 LEC/WEEK)** **PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)**
COURSE OBJECTIVES:	**This course will give firm and rigorous foundation in the principles of modern molecular and cellular biology. It discusses the fundamental processes that enable cells to grow, move and communicate and will cover topics such as cell architecture, cell chemistry, cell division, functions and cell cycle. Students will also learn current molecular biological techniques that are used to study cell biology. Laboratories will focus both on exercises that help illustrate cellular phenomena, as well as on the introduction of techniques and procedures commonly utilized in modern cell and molecular biology research.**
LEARNING OUTCOME:	**Upon successful completion of the course, students will be able to:** • **Develop deeper understanding of what life is and how it functions at cellular level.** • **Describe cellular membrane structure and function, fine structure and function of cell organelles.** • **Perform a variety of molecular and cellular biology techniques.**

UNIT	TOPICS	CONTACT HOURS
UNIT1: TECHNIQUES OF CELL STUDY AND CELL CHEMISTRY (15 Hrs)		
	1: MICROSCOPY • Light Microscopy • Electron Microscopy (SEM, TEM, IEM,STEM).	04
	2: CELL STUDY METHODS • Cell Fractionation, Chromatography and electrophoresis • X-ray diffraction and NMR spectroscopy • Radioisotope tracer technique, Autoradiography, intracellular electrodes	04
	3: MOLECULES IN CELL. • Micromolecules in cells: Sugars, Fatty acids, aminoacids, Nucleotides. • Macromolecules in cells: Nucleic acids, proteins, Polysaccharides, glycogen, fats.	05
	4: CHEMICAL BONDS IN BIOMOLECULES • covalent bonds, ionic bonds, noncovalent interactions	02
UNIT 2: CELL ARCHITECTURE (15 Hrs)		
	5: MEMBRANE STRUCTURE AND MEMBRANE PROTEINS • lipid bilayer – composition and structural organization (amphipathic phospholipids, Fluidity of cell membrane) • Membrane Proteins –structure and function (transmembrane proteins, peripheral membrane proteins) • Phospholipids, sphingolipids, Cholesterol in cell membrane.	06
	6: MOLECULAR STRUCTURE AND FUNCTION • Plasma Membrane • Cell matrix: Physical nature and Properties. • Nucleus: Ultra Structure and function • Mitochondria: Ultra Structure and functions • Endoplasmic Reticulum: ultra structure, modifications, functions	06
	7: MOLECULAR STRUCTURE AND FUNCTION • Golgi Complex: detailed structure and function • Ribosomes- Structure and function • Microsomes: Lysosome-morphology and function, Microbodies • Cytoskeleton – Microtubules, Microfilaments, intermediate filaments	03
UNIT 3: CELLULAR TRANSPORT OF PROTEINS AND VESICLES(15 Hrs)		
	8: TRANSPORT ACROSS CELLL MEMBRANES • Principle of transmembrane transport (transporters and channels, active and passive transport, osmosis) • Transporters and their function- passive transporters, Pumps (Na^+, K^+, Ca^{++}), functions of transporters. • Ion Channels - ion channels activities, regulation of opening and closing of channels. • Protein transport into organelles (nucleus, mitochondria, ER).	10
	9: VESICULAR TRANSPORT. • Vesicular transport – transport of soluble proteins, vesicle budding, vesicle docking, endocytic pathways • General principles of cell signaling, G-Protein coupled receptors, enzyme coupled receptors	05

REFERENCE BOOKS:

Essential books:

1) *Alberts B, Hopkins, Lewis J, Raff M, Robertis K, Walter P (2014): Essential Cell Biology, Fourth Edition, Graland Science Taylor & Francis Group, UK.*
2) *Lodish H, Berk A, Kaiser CA, Krienger M, Scott MP, Anthony, Bretscher A, Amon A. Scott MP (2013): Molecular Cell Biology, Seventh Edition, W. H. Freeman and Company New York.*

Supplementary Reading:

3) *Gupta PK (2003): Cell and Molecular Biology, Second Edition, Rakesh Kumar Rastogi for Rastogi Publications, Meerut, New Delhi, India.*
4) *Bolsover SR, Shephard EA, Hugh AW, Hyams JS (2011): Cell Biology, Third Edition, Wiley Blackwell, A John Wiley & Sons, Inc., Publications.*
5) *Verma PS and Agarwal VK (2007): Cell Biology Genetics Molecular Biology Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.*
6) *Bhamrah HS, Juneja K(2007): Molecular Cell Biology, First Edition, Anmol Publications Pvt. Ltd. New Delhi.*
7) *Gerald Karp: Cell Biology, International Student Edition*

PRACTICAL COMPONENT OF ZOO-I.C-2: CELL AND MOLECULAR BIOLOGY (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1.	**Introduction to Lab techniques – Pipetting, preparation of buffers and solutions, Lab equipments (use and maintenance), acquaintance with general laboratory practices**	**02**
2.	**Cytochemistry: Localisation of Proteins, Carbohydrates & fats using different stains.**	**03**
3.	**Comparison of membrane permeability – Cellophane and Chick intestine.**	**01**
4.	**Osmotic studies – Using Human Red blood cells.**	**01**
5.	**Permament slides:** - **Mitotic stages** - **Meiotic stages (mounting from grasshopper testes)** - **Histology - Study of different cell types (animal cells)**	**03**
6.	**Technique of Agarose gel electrophoresis(Observation of technique)**	**01**
7.	**Protein study – SDS-PAGE(Observation of technique)**	**01**

REFERENCE BOOKS FOR PRACTICALS:

1) *Alberts B, Hopkins, Lewis J, Raff M, Robertis K, Walter P (2014): Essential Cell Biology, Fourth Edition, Graland Science Taylor & Francis Group, UK.*
2) *Bolsover SR, Shephard EA, Hugh AW, Hyams JS (2011): Cell Biology, Third Edition, Wiley Blackwell, A John Wiley & Sons, Inc., Publications.*
3) *Verma PS and Agarwal VK (2007): Cell Biology Genetics Molecular Biology Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.*
4) *Alberts B, Johnson A, Lewis J, Raff M, Robertis K, Walter P (2008): Molecular Biology of the Cell, Fifth Edition, Published by Garland Science, Taylor & Francis Group, UK.*
5) *Lodish H, Berk A, Kaiser CA, Krienger M, Scott MP, Anthony, Bretscher A, Amon A. Scott MP (2013): Molecular Cell Biology, Seventh Edition, W. H. Freeman and Company New York.*

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PAPER TITLE:	**DEVELOPMENTAL BIOLOGY**
PAPER CODE:	**ZOO-V.C-7**
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To understand the processes of fertilization, polyspermy and activation of egg metabolism • To know the basics of animal development, specifically in sea urchin and chick • To be familiar with the processes that help in the establishment of basic plan of development
LEARNING OUTCOME:	• At the end of the course, the students will be able to understand the basic plan of animal development. They will be familiar with the processes which occur during the course of development in invertebrates and vertebrates. This paper will provide the basic knowledge of developmental biology.

SYLLABUS OF ZOO-V.C-7: DEVELOPMENTAL BIOLOGY
THEORY (45 HOURS – 03 LECTURES/ WEEK)

MODULE	TOPICS	CONTACT HOURS
MODULE 1: Early embryonic development and early development of model organism: sea urchin	1.1: Introduction to cell division: mitosis and meiosis 1.2: Fertilization: structure of the gametes 1.3: Species recognition specificity of egg and sperm 1.4: Gamete fusion and the prevention of polyspermy 1.5: The activation of egg metabolism 1.6: Fusion of the genetic material 1.7: Rearrangement of the egg cytoplasm 1.8: Sea Urchin: cleavage, gastrulation, blastula formation 1.9: Fate maps and the determination of sea urchin blastomeres, gastrulation 1.10: Embryonic stem cells: Pluripotency and tutipotency	**05** **04** **06**
MODULE 2: Early development of model organism: chick	2.1: Chick: cleavage, gastrulation, primitive streak, epiboly 2.2: Axis formation in the chick embryo 2.3: Development upto three days of incubation 2.4: Extra embryonic membranes of chick development, structure and functions of yolk sac, amnion, chorion and allantois	**05** **07** **03**
MODULE 3: Growth and regeneration	3.1: Nuclear transplantations and embryonic inductions 3.2: Size and proportion, aging, theories of ageing, postnatal disorders of growth and differentiation 3.3: Distribution of regenerative capacity, Planarian regeneration, regeneration of limb and tail in vertebrates 3.4: Hejmadi Mohanty's experiment	**04** **06** **05**

REFERENCE BOOKS:

1. *Gilberts, S.F. (2013). Developmental Biology, Sinauer Associates, Sunderland.*
2. *Jain, P.C. (2013). Elements of developmental biology, Vishal Publications, Jalandhar*
3. *Slack, J.M.W. (2006). Essential developmental biology. Blackwell Publishing, U.K.*

PRACTICAL COMPONENT OF ZOO-V.C-7 (DURATION -02 HRS /WEEK)		
SR. NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1.	Observation of developmental stages of sea urchin: cleavage, blastula, gastrula (permanent slides)	**01**
2.	Study of morphogenetic movement *in vivo* in hens egg using vital staining technique by preparing window opening	**01**
3.	*In vitro* observation of different extra embryonic membrane in a six days old chick embryo	**01**
4.	Preparation of permanent slides of chick embryo: 24 hours, 36 hours,48 hours, 72 hours	**06**
5.	Effect of retinoic acid on regeneration of fin in fish	**01**
6.	Mounting of eye vesicles and limb buds of six day old chick embryo	**01**
7.	Effect of lead acetate / mercuric chloride on the neural tube development of chick embryo	**01**

REFERENCE BOOKS:

1. *Beffa – Mari, M. And J. Knight (2005) Key experiments in practical developmental biology. Cambridge University Press.*
2. *Tyler, M.S. (2000) Developmental biology, a guide for experimental study. Sinauer Associates, Inc. Publishers, Sunderland, MA.*

PAPER TITLE	**MOLECULAR GENETICS AND FORENSIC SCIENCE**
PAPER CODE	**ZOO-V.E-9**
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	This course will ellucidate the functional aspects of the genetic material at molecular level, focusing on gene expression and gene regulation. It will also expose students to the basics of forensic science and understand diagnostic genetics.
LEARNING OUTCOME	Upon successful completion of the course, students will be able to understand : ▪ The process of replication, transcription and translation ▪ Difference between the gene expression in prokaryotes and eukaryotes ▪ Branches of forensic science ▪ The molecular tools used in genetic diagnosis

SYLLABUS OF ZOO-V.E-9 : MOLECULAR GENETICS AND FORENSIC SCIENCE

THEORY (45 HOURS – 03 LECTURES/WEEK)

MODULE	TOPICS	CONTACT HOURS
MODULE 1 : Gene Expression and Gene Regulation	1.1 : DNA Replication: DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication	2
	1.2 : Transcription: transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors	5
	1.3 : Translation: Genetic code, Process of protein synthesis, Difference between prokaryotic and eukaryotic translation, Post Transcriptional Modifications and Processing of Eukaryotic RNA	4
	1.4 : Transcription regulation in prokaryotes : Principles of transcriptional regulation with examples from lac-operon and trp-operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencers elements; Gene silencing	4
MODULE 2 : Basics of Forensic Science	2.1 : Definition, overview of Disciplines of Forensic science	3
	2.2 : Crime and Crime Scene management : Types of crime scenes – indoor and outdoor. Securing and isolating the crime scene. Crime scene search methods. Safety measures at crime scenes. Legal considerations at crime scenes. Documentation of crime scenes – photography, videography, sketching and recording notes.	6
	2.3 : Forms of forensic evidences : - Biological evidence: Bloodstains, hair, semen, DNA - Physical and trace evidence – pattern of blood stains, fingerprints, fibres, weapons - Documents- types of forensic documents (genuine and forged), methods of detecting forged documents (handwriting analysis, Analysis of paper and inks)	6
MODULE 3 : Diagnostic Genetics	3.1 : Cytogenetics/ Molecular Cytogenetics/ Biochemical/ Molecular methods of detecting genetic disorders - Adult and Newborn screening	6
	3.2 : Cytogenetics/ Molecular Cytogenetics/ Molecular methods of detecting genetic disorders – Prenatal and Preimplantation screening	5
	3.3: Forensic testing - DNA fingerprinting, paternity testing, personal /individual identification	4

REFERENCE BOOKS :

1) *J. Prahlow (2010); Forensic Pathology for Police, Death Investigators, Attorneys, 17 and Forensic Scientists, DOI 10.1007/978-1-59745-404-9_2, C Springer Science + Business Media, LLC (Ebook available)*
2) *Robert Schleif (1993). Genetics and Molecular Biology. S E C O N D E D I T I O N. Department of Biology,The Johns Hopkins University, Baltimore, Maryland. The Johns Hopkins University Press 2715 North Charles Street Baltimore, Maryland 21218-4319, The Johns Hopkins Press Ltd., London (Ebook available)*
3) *Richard Saferstein (2011); Forensic Science,II Edition, Prentice Hall publishers, Sanfrancisco*
4) *Griffith A, Wesseler S, Lewontin R Gelbart W, Suzuki D and Miller J(2000). Introduction to Genetic Analysis. Eigth Edition.(Ebook available)*
5) *Tom Strachan and Read A (2010): Human Molecular Genetics. Fourth Edition. Garland Science Publisher, New York, NY 10017*

PRACTICAL COMPONENT OF ZOO–V.E-9 (DURATION - 02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Isolation of DNA from peripheral blood/tissue (chick liver).	01
2	Microscopic examination of Hair a. Human scalp Hair b. Animal Hair	02
3	Sketching and Photography of various type of crime scene.	02
4	Presumptive Tests for Blood a. Phenolphthalin Assay b. Benzidine c. Leucomalachite Green (L.M.G.) d. Luminol Test	02
5	Examination of ink by TLC method	01
6	To perform ridge tracings and ridge counting	01
7	Analysis of DNA fingerprints	03

REFERENCES BOOKS :

1) *Hikmet Geckil ().Molecular Biology Lab manual. UMBC. (Ebook available).*
2) *J. Prahlow (2010); Forensic Pathology for Police, Death Investigators, Attorneys, 17 and Forensic Scientists, DOI 10.1007/978-1-59745-404-9_2, C Springer Science+Business Media, LLC (Ebook available.)*

PAPER TITLE	**ECONOMIC ZOOLOGY**
PAPER CODE	**ZOO-V.E-10**
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	To study the various aspects of economic zoology To study the species of economic importance, classification To gain an insight whether own business can be started based on studying the zoological species and their products
LEARNING OUTCOME	How zoological species contribute to economic sources can be learned. Students will learn the techniques of rearing and maintenance of the species, harvesting their products and selling of species and the products

SYLLABUS OF ZOO-V.E- 10 : ECONOMIC ZOOLOGY

THEORY (45 HOURS – 03 LECTURES/WEEK)

MODULE	TOPICS	CONTACT HOURS
MODULE 1 : Scope of Economic Zoology	1.1 : Economic Zoology, History, Scope,	**3**
	1.2 : Species of bionomic importance (Honey bee, Silkworm, lac insect, mackerel, domestic fowl, goat, sheep, cow, buffalo, pig, rats, mice)	**3**
	1.3 : Source, properties, constituents and nutritive value of products of bionomic importance: eggs of poultry, milk, meat, honey, medicinal value of synthetic insulin (recombinant), significance of wool, silk, lac	**5**
	1.4 : Organizations and their functions: agricultural and processed food products export development authority (APEDA), the marine products exports developmental authority (MPEDA), central silk board (CSB), central bee research and training institute (CBRTI), pharmaceutical and biotechnology industries (Lupin) and contract research organizations (Intox), and research institutes (NIN, Hyderabad)	**4**
MODULE 2 : Models in Economic Zoology	2.1 : Insects, products and applications : lac insects, honey bees, silkworms	**3**
	2.2 : Vermiculture: Rearing and maintenance of earthworms	**2**
	2.3 : Aquaculture : rearing and maintenance of prawns, oysters, edible and ornamental fishes	**3**
	2.4 : Poultry : rearing and maintenance of domestic fowl, applications and products	**3**
	2.5 : Business models of apiculture, sericulture, aquaculture and poultry	**4**
MODULE 3 : Pharma products and biological control	3.1 : Pharmaceuticals from animals and their Applications (antiserum), from transgenic animals (malaria vaccine, alpha 1 antitrypsin, lactoferrin, fibrinogen)	**5**
	3.2 : Species used in biological control : *Casnoidea indica*, Trichogramma, *Poecilia reticulata / Gambusia affinis*	**5**
	3.3 : Maintenance and breeding of animals for research: mice, rats, guinea pigs, rabbits, marmosets, guidelines given by committee for the purpose of control and supervision of experiments on animals (CPCSEA)	**5**

REFERENCE BOOKS :

1) *G. S. Shukla, V. B. Upadhyay (2008) Economic Zoology, Rastogi Publications, Meerut*
2) *H. Osborn (1908) Economic Zoology an introductory text book in zoology with special reference to its applications in agriculture, commerce and medicine The Macmillan Company*
3) *K. P. Shrivastava, Gs Dhaliwal (2015) Text Book of Applied Entomology Kalyani Publishers*
4) *P. K. Gupta (2011) Vermicomposting for Sustainable Agriculture, Agrobios India Ltd*
5) *S. Singh (1962) Bee-Keeping in India ICAR New Delhi p. 214*

PRACTICAL COMPONENT OF ZOO-V.E-10 (DURATION - 02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Vermicomposting	05
2	Preparation of dairy products from milk : cheese and butter	02
3	Laboratory observations of insects – Honeybee, Silk moth, Lac insect	01
4	Visit to dairy industry/poultry/ piggery/apiary/silk industry/ biotechnology industry/pharmaceutical industry/research institute	04

REFERENCE BOOKS :

1) *A. K. Tripathi (2009) Mulberry Sericulture: Problems And Prospects Aph Publishing Corporation*
2) *C.L. Metcalf and W.P Flint (1962) Destructive and Useful Insects New York, N.Y. : McGraw-Hill*

PAPER TITLE	**ECOLOGY AND ETHOLOGY**
PAPER CODE	**ZOO-V.E-11**
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	• To study the distribution of organisms, their interrelations in populations and communities and interactions between biotic and abiotic components • To study impact of anthropogenic activities on ecosystem and study behaviour of organisms under natural conditions
LEARNING OUTCOME	• The student will gain better understanding in ecology and ethology • This course also has applied value towards conservation of biodiversity and sustainable development

SYLLABUS OF ZOO-V.E- 11 : ECOLOGY AND ETHOLOGY
THEORY (45 HOURS – 03 LECTURES/WEEK)

MODULE	TOPICS	CONTACT HOURS
MODULE 1 : Basic Ecology	1.1 : Introduction to Ecology : What is Ecology? History of ecology, ecology today, scope of ecology, objective of study, subdivisions of ecology 1.2 : Ecosystem Ecology : kinds of ecosystem (marine, fresh water, terrestrial),Gaia hypothesis, deep ecology, energy flow within the Ecosystem, food chains and energy flow, ecological pyramids, ecological niche nutrient and Cycling of trace elements: Cobalt (Co), Molybdenum (Mo) and Lead. 1.3 : Population Ecology : population density, natality, mortality, survivorship curve and life tables, age distribution, biotic potential of population, growth models, population dispersal, regulation of population, co-operative and disoperative coactions and carrying capacity, predator –prey relationships, symbiosis	03 06 06
MODULE 2 : Conservation Ecology and Basic Ethology	2.1 : Community Ecology : characters of a community, classification of a community, community periodism, community stratification, community succession 2.2 : Biodiversity and conservation : application of ecology in biodiversity conservation 2.3 : Introduction to Ethology : the history of ethology, approaches to study of behavior, types of behavior – instinct and learning, economic and social aspect of behaviour, ethologists and their work – Lorenz, Tinbergen, Goodall, M.K. Chandrashekar, animal behaviour : an evolutionary approach 2.4 : Concept of Ethology : stimuluous - response concept, reflexes, innate releasing mechanisms, fixed action pattern, ethogram releaser, motivation or drive with respect to hunger and sexual behaviour	03 04 04 04
MODULE 3 : Advanced Ethology	3.1 : Approaches to studying behaviour, methods associated with neurophysiological approach, psychological and ethological approach. 3.2 : Pheromones : introduction, types of pheromones, the primer pheromones, the imprinting pheromones 3.3 : Hormones : effect of hormones on sexual behaviour, maternal behaviour, territorial marking, learning and memory 3.4 : Patterns of behavior : feeding, aggressive and reproductive behavior, biological clocks 3.5 : Communication behavior : introduction, communication signals, communication among bees : Honeybee dances	03 03 03 03 03

REFERENCE BOOKS :

1. *Arora, Mohan. P. (2004) : Ecology , Himalaya Publishing House*
2. *Aubrey Manning and stamp Dawkins (1997) : An Introduction to Animal behaviour (fourth edition), Cambridge University Press.*
3. *Dash M. C. (2001) : Fundamental of Ecology , Tata Mc Graw – Hill publishing Company Limited New Delhi*
4. *Felicity Huntingford (1984) : The study of Animal behaviour , Chapman and Hall.*
5. *Hoshang S. Gundevia and Hare Govind Singh (2006) : A Text Book of Animal Behaviour, S. Chand & Company LTD. New Delhi-110055.*
6. *Juneja Kavita (2002) : Ecology , Anmol Publications PVT. LTD. New Delhi-110002 (India)*
7. *Mathur Reena (1994) : Animal Behaviour, Rastogi and Company, Meerut-250002 India.*
8. *Rana, S. V. S.(2003) : Essentials of Ecology and Environmental Science ,Prentice- Hall of India Private Limited , New Delhi-110001*
9. *Ranga, M. M.(2002) : Animal Behaviour Second Enlarged Edition , Agrobios (India)*
10. *Robert A. Wallace (1938) : Animal Behaviour Its Development, Ecology and Evolution , Goodyear Publishing Company, Inc. Santa Monica, California.*
11. *Sharma P.D.(2014-15) : Ecology and Environment, Rastogi Publications. Meerut (12th revised edition) -25002.*
12. *W.H. Thorpe (1979) : The Origins and rise of Ethology, Praeger Publishers.*

PRACTICAL COMPONENT OF ZOO–V.E-11 (DURATION - 02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Determination of population density in a natural/ hypothetical community by Quadrats method and calculation of Shannon-Weiner diversity Index for the same community	02
2	Study of an aquatic/mangrove ecosystem : Mmeasurement of the area, temperature, turbidity, determination of pH, and dissolved oxygen content (Winkler's method), and free CO_2	04
3	To study the habituation to light stimulus in earthworm/ crabs/ snails/ spider web	01
4	To demonstrate photactic and geotactic responses of the animal provided earthworm/ crabs	01
5	Study of Life Tables and plotting of surviourship curves of different types from the hypothetical/ real data provided.	01
6	Report on a visit to National Parks/ Biodiversity Parks/ Wild life sanctuary	03

REFERENCE BOOKS :

1. *K. S. Rao (1998) : Practical Ecology, Anmol Publications PVT. LTD.*
2. *Odum E. P. (2008) : Fundamentals of Ecology, Indian Edition. Brooks/ Cole*
3. *Michael (1984) : Ecological methods for Field and Laboratory Investigations. Tata Mc Graw-Hill Publishing Company Limited New Delhi*
4. *Robert Leo Smith : Ecology and Field Biology, Harper and Row Publisher.*

PAPER TITLE	**FISH PRESERVATION AND PROCESSING**
PAPER CODE	**ZOO-V.E-12**
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	• To familiarize the students with different methods of fish preservation and processing • To acquaint them with techniques and precautions for hygienic fish handling • The course content is locally relevant and prepares students for entrepreneurship and self employment
LEARNING OUTCOME	By the end of the course, the students will be familiar with the economic benefits of fishes. They will also be able to understand the nutritional values of the fishes and to identify some of the fish pathogens

SYLLABUS OF ZOO-V.E- 12 : FISH PRESERVATION AND PROCESSING
THEORY (45 HOURS – 03 LECTURES/WEEK)

MODULE	TOPICS	CONTACT HOURS
MODULE 1 : Fishery Development	1.1 : Status of Development of the fishery and seafood processing industry. 1.2 : Empowerment through Aquatic Products: (Background, Nutritional security, Role of Fisheries Fisheries Sector, Role of Tifac in Fisheries Sector, Objectives, Integrated Fisheries Project (IFP), Indian national centre for ocean information services (INCOIS), Catch per unit effort (CPUE), Maximum sustainable yield (MSY)	05 10
MODULE 2 : Fish Handling and preservation	2.1 : Recent Scenario : Quality Changes and Shelf life of Chilled Fish, The effect of Hygiene during handling 2.2 : Fish Handling Methods: Organoleptic test, Assessment of Fish Quality, Quality assessment of Fresh Fish, Quality Assessment of Fish Products, Physical methods, Assurance of Fresh Fish Quality, Post harvest Changes in Fish, How does a Fish Lose its Quality, fish as vectors of zoonotic diseases 2.3: Fish Preservation: Reasons for Spoilage of Fishes, Methods of Fish	04 08 03
MODULE 3 : Value of Fish	3.1 : Economic Importance of Fish: Food value, Fish By-Products, surimi, Goan fish para, balchao 3.2 : Postmortem changes in Fish, Bacteriological Changes, Lipid Oxidation and Hydrolysis, Chemical Composition, Lipids, Proteins, N-containing Extractives,Vitamins and Minerals, 3.3: Aquatic Resources and their utilization, value added product: chitin	05 05 05

REFERENCE BOOKS :

1) *Braj Kishore Singh (2008) Applied Fisheries and Aquaculture Swastik Publishers and Distributers Delhi,India*

2) *Pandey and Shukla (2015) Fish and Fisheries, IIIrd Revised Edition, Rastogi Publications Meerut, India*

PRACTICAL COMPONENT OF ZOO-V.E-12 (DURATION - 02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Estimation of Proteins and Lipids form fish tissue	02
2	Determination of moisture and ash content from the fish	01
3	Preparation of fish Fillet	01
4	Study of Fish Parasites – ectoparasites (gills); endoparasites (gut)	02
5	Method of fish preservation (salting, pickling)	02
6	Visit to Fish Processing Centre/ Fishing Co-operative Society / Fishery Institute/Fishery survey of India, Vasco (FSI)	04

REFERENCE BOOKS :

1) *Braj Kishore Singh (2008) Applied Fisheries and Aquaculture Swastik Publishers and Distributers Delhi,India*
2) *Pandey and Shukla (2015) Fish and Fisheries, IIIrd Revised Edition, Rastogi Publications Meerut, India*

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COURSE STRUCTURE

CORE AND ELECTIVE PAPERS FOR ZOOLOGY MAJOR				
SEMESTER	**SUBJECT CODE CORE PAPERS**	**CORE PAPERS**	**SUBJECT CODE ELECTIVE PAPERS**	**ELECTIVE PAPERS**
Semester 1	ZOO-I.C-1	Animal Diversity: Non Chordates		
	ZOO-I.C-2	Cell and Molecular Biology		
Semester 2	ZOO-II.C-3	Diversity and Biological Systems of Chordates		
	ZOO-II.C-4	Fundamentals of Animal and Human Genetics		
Semester 3	ZOO-III.C-5	Human Physiology	ZOO-III.E-1	Vertebrate Endocrinology
			ZOO-III.E-2	Basic Microbiology and Fundamentals of Animal Biotechnology
			ZOO-III.E-3	Environmental Toxicology
			ZOO-III.E-4	Parasitology
Semester 4	ZOO-IV.C-6	Biochemistry and Metabolic Regulation	ZOO-IV.E-5	Animal cell culture and Application s
			ZOO- IV.E-6	Aquaculture and Fisheries
			ZOO- IV.E-7	Immunology
			ZOO- IV.E-8	Evolutionary Biology
Semester 5	ZOO-V.C-7	Developmental Biology	ZOO- V.E-9	Molecular Genetics and Forensic Science
			ZOO- V.E-10	Economic Zoology
			ZOO- V.E-11	Ecology and Ethology
			ZOO- V.E-12	Fish Preservation and Processing

Semester 6	ZOO-VI.C-8	Wildlife Biology	ZOO- VI.E-13	Health and Nutrition
			ZOO- VI.E-14	Basic and Applied Entomology
			ZOO- VI.E-15	Laboratory Technique in Pathology
			ZOO- VI.E-16	Bio Enterpreneurship

Annexure – Syllabus approved by BOS

PAPER TITLE	**WILDLIFE BIOLOGY**
PAPER CODE	**ZOO-VI-C-8**
MARKS	100 [75 –Theory ; 25- Practical]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES	This course is designed to enable students to understand the basics of wildlife status, conservation, assessment and management.
LEARNING OUTCOME	Upon successful completion of the course, students will be able to: - Know the techniques used in assessment and monitoring of wildlife. - Know about the diversity, extent, range of wildlife population dynamics.

SYLLABUS: WILDLIFE BIOLOGY (ZOO-VI-C-8): THEORY (45 HOURS - 03 LEC/WEEK)		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: INTRODUCTION TO WILDLIFE	**UNIT 1: Introduction to wildlife** • Values of wildlife - Conservation ethics, Importance of conservation, Causes of depletion, World conservation strategies. **UNIT 2: Evaluation and management of wildlife** • Habitat analyses, Physical parameters: Topography, Geology, Soil and water. • Biological Parameters: food, cover, forage, browse and ground cover estimation. • Standard evaluation procedures: remote sensing and GIS.	**15**

MODULE 2: POPULATION ESTIMATION AND PROTECTED AREAS	**UNIT 3: Population estimation** • Population density, natality, mortality, fertility schedules and sex ratio computation. • Analysis of scat and dropping of ungulates and carnivores. • Trichotaxonomy, pug marks and census method based on indirect evidences. **UNIT 4: Protected areas** • Protected Area network (PAN): National parks and wildlife sanctuaries. • Biogeographical features of important features of protected areas in India (any 3). • Tiger conservation - tiger reserves in India, challenges and management of tiger reserves.	**15**
MODULE 3: MANAGEMENT OF WILDLIFE	**UNIT 5: Management of habitats** • Setting back succession, grazing logging, mechanical treatment, advancing the succession process, artificial feeding grounds. • Cover construction, preservation of general genetic diversity, restoration of degraded habitats, **UNIT 6: Management planning of wildlife in protected areas** • Habitat carrying capacity, visitors carrying capacity, eco tourism / wild life tourism, concept of climax persistence, ecology of perturbance. • Role of national / state statutory bodies on governing wildlife (NBWL, IUCN, CITES, state wildlife boards and forest department). **UNIT 8: Management of critical population** • Radio- telemetry, care of injured and diseased animal, quarantine, common diseases of wild animals, capture and translocation of wildlife. • Captive management – a brief idea.	**15**

PRACTICAL COMPONENT OF WILDLIFE BIOLOGY ZOO-VI-C-8: (DURATION: 30 HOURS – 02hrs/WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1.	Study of butterflies and their host plants on the campus / molluscs/ ants/ spiders / birds	02
2.	Acquainting oneself with basic equipment needed in wildlife studies; use, care and maintenance (compass, binoculars, spotting scope, range finders, Global Positioning System, various types of cameras and lenses)	02
3.	Familiarization and study of species specific evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers, feathers, etc. – case study	02
4.	Demonstration of various field techniques for flora and fauna: PCQ, Ten tree method, Circular, Square and rectangular plots, Parker's 2 Step and other methods for ground cover assessment, Tree canopy cover assessment, Shrub cover assessment	03

5.	Trail / transect-quadrate monitoring for abundance and diversity estimation of mammals and birds (direct and indirect evidences) (on campus or fieldtrip)	03

REFERENCE BOOKS:

1. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
2. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence. Cambridge University.
3. Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5th edition. The Wildlife Society, Allen Press.
4. Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences
5. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.

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PAPER TITLE	**HEALTH AND NUTRITION**
PAPER CODE	**ZOO-VI-E-13**
MARKS	100 [75 –Theory ; 25- Practical]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES	This course is an introduction to the nutrients, their functions and role in maintaining good health of humans.
LEARNING OUTCOME	Upon successful completion of the course, students will be able to: - Know about nutrients and their function - Understand nutritional biochemistry and role of lifestyle and food habits in causing diseases

SYLLABUS: HEALTH AND NUTRITION (ZOO-VI-E-13): THEORY (45 HOURS - 03 LEC/WEEK)		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: BASIC CONCEPT OF FOOD AND NUTRITION	**UNIT 1: Overview of health and nutrition** • Definition of health and nutrition • Scope of nutrition, food as a source of nutrients • Nutrients and energy • Adequate, optimum and balanced diet • Malnutrition and health. **UNIT 2: Nutritional Biochemistry** • Carbohydrates, lipids, proteins - definition, classification, structure and properties • Significance of acid value, iodine value and saponification value of lipids • Essential and non-essential amino acids • Enzymes- definition, classification, properties(overview). • Coenzymes, vitamins (fat soluble and water soluble), structure and properties • Minerals- iron, calcium, phosphorus, iodine, selenium and zinc and their properties	**15**

MODULE 2: NUTRIENTS AND DIETARY PATTERN FOR HUMANS	**UNIT 3: Functions of food components of food-nutrients** • Biochemical role and dietary sources of macro and micronutrients (carbohydrates, lipids and proteins, fat soluble vitamins-A, D, E and K , water soluble vitamins – thiamin, riboflavin, niacin, pyridoxine, folate, vitamin B12 and vitamin - C Minerals – calcium, iron and iodine). • Changes of nutrient value during cooking of the following food groups: cereals, pulses and vegetables. Nutrient loss - dry, moist, frying and microwave cooking. **UNIT 4: Nutrition and dietetics** • Physiological considerations, nutrient needs and dietary pattern for various groups- adults, pregnant and nursing mothers, infants, pre-school and school children, adolescents and geriatric nutrition.	**15**
MODULE 3: DIET RELATED DISEASES	**UNIT 5: Health and diseases** • Major nutritional deficiency diseases- protein energy malnutrition, Vitamin deficiency, iron deficiency anaemia, iodine deficiency disorders, their causes, symptoms, treatment, prevention and government programmes, if any. • Life style related diseases- obesity, hypertension, hyperurecimia, diabetes mellitus, polycystic ovarian disease (PCOD) - their causes and prevention through dietary/lifestyle modifications. • Social health problems: smoking, alcoholism, drug dependence and Acquired Immune Deficiency Syndrome (AIDS); • Common ailments- irritable bowel disease (IBD), constipation: causes and dietary management **UNIT 6: Food hygiene** • Potable water- sources and methods of purification at consumer level • Food and water borne infections: bacterial infection: cholera, typhoid, dysentery; viral infection: hepatitis, poliomyelitis, protozoan infection: Amoebiasis, Giardiasis; Parasitic infection: Taeniasis and Ascariasis their causative agent, symptoms, transmission and prevention. • Brief account of food spoilage: Causes and preventive measures	**15**

PRACTICAL COMPONENT OF 'HEALTH AND NUTRITION ZOO-VI-E-13: DURATION (30 HOURS – 02hrs/WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
6.	To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric	02

7.	To determine absorbed oil content in fried foods	02
8.	Estimation of lactose in milk	02
9.	Ascorbic acid estimation in food by titrimetry	01
10.	Estimation of calcium in foods by titrimetry	01
11.	Observation of any two grain pests	01
12.	Project based: • Identify nutrient rich sources of foods, their seasonal availability and price • Study of nutrition labeling on selected foods	03

REFERENCE BOOKS:

1) Mudambi, SR and Rajagopal, MV. (2007). Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; New Age International Publishers.
2) Srilakshmi B. (2002). Nutrition Science; New Age International (P) Ltd.
3) Srilakshmi B. (2007). Food Science; Fourth Ed; New Age International (P) Ltd.
4) Swaminathan M. (2009). Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.
5) Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; Oxford & IBH Publishing Co. Pvt Ltd.
6) Wardlaw GM, Hampl JS. (2007). Perspectives in Nutrition; Seventh Ed; McGraw Hill.
7) Lakra P, Singh MD. (2008). Textbook of Nutrition and Health; First Ed; Academic Excellence.

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PAPER TITLE	**BASIC AND APPLIED ENTOMOLOGY**
PAPER CODE	**ZOO-VI.E-14**
MARKS	100 [75 -Theory; 25-Practical]
CREDITS	04 [03- Theory; 01- Practical]
CONTACT HOURS	Theory: 45 HOURS [03 Lectures Per Week] Practical: 30 HOURS [01 Practical Per Week]
COURSE OBJECTIVE	• To develop a strong foundation in entomology, including understanding of the importance of insects to the human society. • To review important areas in insect biology such as morphology, physiology, ecology, behaviour, genetics, phylogeny, ontogeny and population biology. • To develop a sufficient background for advanced entomology.
LEARNING OUTCOME	• The students will achieve entrepreneurial opportunities in entomology. • They will gain knowledge on bionomically important insects and their products, insect pests of public health and veterinary importance and their management.

SYLABUS: BASIC AND APPLIED ENTOMOLOGY (ZOO-VI.E-14) **THEORY (45 HOURS - 03 LEC / WEEK)**		
MODULE	**TOPIC**	**CONTACT HOURS**
MODULE 1 Fundamentals of Entomology	**Unit 1: Class Insecta**: • Salient features • Classification of insects up to orders – an overview **Unit 2: Morphological studies:** • of antenna, • wings, • legs • Mouth parts **Unit 3: Techniques:** • Collection of insects • Preservation of insects	**15**
MODULE 2 Bionomics and control of crop pests and medically important pests	**Unit 4: Pest of agricultural importance:** • Paddy pests, cashew pests, coconut pests, areca nut pests, pulse pests, sugarcane pests, vegetable pests, fruit pests (two pests from each of the above) **Unit 5: Insects of medicinal importance:** • mosquitoes, housefly, sand fly, cockroaches, human lice, bed bug, rat fleas **Unit 6:Termites:** • social organization, termitaria and termite control measures	**15**
MODULE 3 Useful insects and pest management	**Unit 7: Useful insects:** • Honeybees (Apiculture); Mulberry silk worm(sericulture); lac insects (lac culture) **Unit 8: Insect pest control methods:** • biological, chemical (attractants, pheromones and hormones), Integrated Pest Management (IPM) **Unit 9: Role of insects in ecosystem services**	**15**

PRACTICAL COMPONENT OF BASIC AND APPLIED ENTOMOLOGY ZOO-VI.E-14 PRACTICAL (DURATION: 30 HOURS – 02hrs/WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS (12)**
1.	Collection techniques of Insects – light traps, sweep net, Berlese funnel	02
2.	Identification and study of economically important insects.	02
3.	Field trips to ICAR Old Goa / Govt. of Goa agriculture department/ National Malaria Research Institute (NMRI).	02
4.	Study of insects of college campus dragon fly/ pests of different plants.	03
5.	Study of local insect pests of agriculture.	03

REFERENCE BOOKS:

1) Aitwal, A.S (1993): Agricultural pests of India and South East Asia. Kalyani publication, New Delhi.
2) Awasthi,V.B (2007):Introduction to general and applied entomology ,2nd edition. Scientific publishers India Jodhpur.
3) David, B.V. and Ananthakrishnan, T.N (2006): General and applied entomology, 2nd edition Tata McGraw hill, New Delhi.
4) Reddy,D.S(2010) Applied entomology,2nd edition New Vishal publications

REFERENCE BOOKS FOR PRACTICALS:

1. Fenemore, P.G. and Prakash, A. (1995): Applied Entomology, Wiley Eastern Limited new age international.
2. Varasi, M.S. (1992): Text book of entomology, Himalaya Publishing House, 1st edition.

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PAPER TITLE	**LABORATORY TECHNIQUES IN PATHOLOGY**
PAPER CODE	**ZOO-VI.E-15**
MARKS	100 [75 –Theory; 25- Practical]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC / WEEK) PRACTICAL: 30 HOURS (01 PRACTICAL / WEEK)
COURSE OBJECTIVES	This course is an introduction to the various techniques used in pathological diagnosis.
LEARNING OUTCOME	Upon successful completion of the course, students will be able to: - Know the tests done for disease detection of various body fluids and tissues. - Understand the clinical implication of the pathological tests.

SYLABUS: LABORATORY TECHNIQUES IN PATHOLOGY (ZOO-VI.E-15) THEORY (45 HOURS - 03 LEC / WEEK)		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: BLOOD ANALYSIS	**UNIT 1:** Introduction to medical lab techniques and its importance **UNIT 2: :** Analyses of human Blood: • Ways of obtaining blood samples, precautions and complications. • Methods of estimation and clinical significance of: hemoglobin, Packed Cell Volume (PCV), RBC count, WBC count, Complete Blood Count (CBC), platelets, Erythrocyte Sedimentary Rate (ESR), Differential Leucocyte Count (DLC).	**15**
MODULE 2: EVALUATION OF EXCRETORY MATERIAL AND GAMETES	**UNIT 3:**.Urine Analyses • Physical characteristics, preservation of urine sample • Gross examination, chemical examination, abnormal constituents and its clinical implications. • Microscopy of urinary sediments **UNIT 4:** Stool Analyses • Stool tests for protozoan parasites and helminth eggs. • Clinical significance. **UNIT 5:** Semen analyses: • Constituents of semen • Gross and microscopic, cytochemical examination, clinical implications.	**15**
MODULE 3: LIVER FUNCTION CYTOLOGY IMAGING	**UNIT 6:** Clinical status of liver function - • Function of liver. • Tests of excretion by liver, evaluation of synthesis in liver, evaluation of enzyme activity. **UNIT 7:** Clinical cytological studies • Fine Needle Aspiration Cytology (FNAC), Ultrasound guided FNAC, aspiration of intra thoracic masses, Techniques of preparing cell smears, staining techniques **UNIT 8**: Medical imaging • X-Ray, PET, CT Scan, MRI, Dexa Scan, Ultrasound, Doppler’s Test (using photographs/reports etc).	**15**

PRACTICAL COMPONENT OF: LABORATORY TECHNIQUES IN PATHOLOGY ZOO-VI.E-15 - (30 HOURS – 02hrs/WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1.	Preparation of blood smears and staining techniques (Leishman's staining, Giemsa staining, Field's staining).	02
2.	Use of different types of anticoagulants, obtaining serum from blood, preparation of cell suspension (blood cells).	01
3.	RBC Count, WBC Count, Differential WBC Count	03
4.	Urine analysis – normal and abnormal constituents	02
5.	Blood sugar estimation using glucometer	01
6.	Estimation of hemoglobin (Sahli's method)	01
7.	Estimation of PCV	01
8.	Estimation of ESR (Wintrobe's / Westergreen method)	01

REFERENCE BOOKS:

1. Sood R (1999). Medical laboratory techniques, Jaypee publishers, New Delhi.
2. Park, K. (2007), Preventive and Social Medicine, B.B. Publishers
3. Godkar P.B. and Godkar D.P (2007). Textbook of Medical Laboratory Technology, II Edition, Bhalani Publishing House.
4. Cheesbrough M (2002)., A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses
5. Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd. New Delhi.

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PAPER TITLE	**BIOENTREPRENEURSHIP**
PAPER CODE	**ZOO-VI.E- 16**
MARKS	100 [75 –Theory; 25- Practical]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC / WEEK) PRACTICAL: 30 HOURS (01 PRACTICAL / WEEK)

COURSE OBJECTIVES	• To help students recognize the opportunities of enterprises in the field of life sciences • To encourage students to think independently and explore new vistas • To familiarise them with the basic skills required for a start-up
LEARNING OUTCOME	At the end of the course, • Students will be exposed to various opportunities available in life science for start-ups. • They will be familiar with the methodologies and regulations required to start an enterprise. • It will also help the student to develop independent thinking skill required at the time of crucial decision making.

SYLABUS: BIOENTREPRENEURSHIP
ZOO-VI.E- 16 - THEORY (45 HOURS - 03 LEC / WEEK)

UNIT	TOPICS	CONTACT HOURS
MODULE 1: Entrepreneurship Development	**Unit 1: Introduction to entrepreneurship:** • entrepreneurial competencies and goal setting, bio entrepreneurship, building a bio-enterprise : balance management, capital, technology **Unit 2: Introduction to innovation:** • identifying business opportunities **Unit 3: Raising funds**: public and private	**15**
MODULE 2: Business plan And Guidelines and regulations for entrepreneurship in life sciences	**Unit 4: Business model canvas** **Unit 5: Guidelines and regulations:** • Certification and licensing, acts, regulations and guidelines, marketing and export process, accessing university technology, research and development agencies in India **Unit 6: Role of micro, medium and small scale industry sector** **Unit 7: Innovations in research:** • writing project proposals to various funding bodies such as MHRD, UGC, DST, DBT, etc.	**15**

MODULE 3: Start -up, quality, safety and procedural compliances in a bio enterprise	**Unit 8**: Intellectual Property Rights and trademark of biological resources **Unit 9**: quality, safety and procedural compliances • Bio safety and its implementations • Quality control in entrepreneurship • WHO Guidelines for setting up of a contract research organization. Starting a research laboratory in India – guidelines and permits required	**15**

PRACTICAL COMPONENT OF BIOENTREPRENEURSHIP ZOO-VI.E-16 (30 HOURS – 02hrs/WEEK)		
SR. NO.	**PRACTICAL**	**NO. OF PRACTICAL**
1.	Exercises on lateral thinking	01
2.	Testing entrepreneurial competencies	01
3.	Online search for patented technologies	01
4.	Identifying Business Opportunities	02
5.	Business Model Canvas	03
6.	Presentation of Business Model Canvas by students	01
7.	Interaction with successful entrepreneur	02
8.	Interaction with Banker/ Angel Investor	01

REFERENCES:

1. Garg, M.C. (2015) Entrepreneurial development. Guset User.
2. Kolchinsky, P. (2004) The entrepreneurs guide to a biotech startup. 4th edition. www.evelexa.com

Additional reading:

1. Simon, S. 2009. Start with why: How great leaders inspire everyone to take action. Penguin Group (USA) Inc .
2. Welch, J. and Byrne, J.A. 2003. Straight from the gut. Business plus publishers.

WEBLIOGRAPHY:

1. http://www.creativeboom.com/resources/10-free-brain-teasing-puzzle-resources-for-team-building-games-and-getting-your-creative-juices-flowing/
2. https://www.scribd.com/document/60183753/39034324-Test-for-Personal-Entrepreneurial-Competencies
3. http://www.wipo.int/edocs/pubdocs/en/patents/434/wipo_pub_l434_02.pdf
4. https://ipindiaonline.gov.in/patentsearch/Granted%20Search%20Engine%20Help%20file.pdf
5. https://canvanizer.com/new/business-model-canvas

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PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
(Autonomous)
PROGRAMME BSC ZOOLOGY
COURSE CURRICULUM

COURSE STRUCTURE: PROGRAMME BSC ZOOLOGY						
SEMESTER	**CORE**		**ELECTIVE**			
I	**ZOO-I.C-1** Animal Diversity : Non Chordates	**ZOO-I.C-2** Cell and Molecular Biology	--------	--------	--------	--------
II	**ZOO-II.C-3** Diversity and Biological Systems of Chordates	**ZOO-II.C-4** Fundamentals of Animal and Human Genetics	--------	--------	--------	--------
III	**ZOO-III.C-5** Human Physiology		**ZOO-III.E-1** Vertebrate Endocrinology	**ZOO-III.E-2** Basic microbiology and Fundamentals of Animal Biotechnology	**ZOO-III.E-3** Environmental Toxicology	**ZOO-III.E-4** Parasitology
IV	**ZOO-IV.C-6** Biochemistry and Metabolic Regulation		**ZOO-IV.E-5** Animal cell culture and Applications	**ZOO-IV.E-6** Aquaculture and Fisheries	**ZOO-IV.E-7** Immunology	**ZOO-IV.E-8** Evolutionary Biology
V	**ZOO-V.C-7** Developmental Biology		**ZOO-V.E-9** Molecular Genetics and Forensic Science	**ZOO-V.E-10** Economic Zoology	**ZOO-VI.E-11** Basic and Applied Entomology	**ZOO-V.E-12** Fish Preservation and Processing
VI	**ZOO-VI.C-8** Wildlife Biology		**ZOO-VI.E-13** Health and Nutrition	**ZOO-V.E-14** Ecology and Ethology	**ZOO-VI.E-15** Laboratory Techniques in Pathology	**ZOO-VI.E-16** Bio Entrepreneurship

SEMESTER I and II:

SEMESTER	COURSE CODE	CORE COURSES	NUMBER OF CREDITS	CONTACT HOURS
Semester I	ZOO-I.C-1	Animal Diversity : Non Chordates	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-I.C-2	Cell and Molecular Biology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
Semester II	ZOO-II.C-3	Diversity and Biological Systems of Chordates	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-II.C-4	Fundamentals of Animal and Human Genetics	Theory = 03 Practicals =01	Theory = 45 Practicals =30

SEMESTER I

CORE COURSE : ANIMAL DIVERSITY: NON CHORDATES	
COURSE CODE:	ZOO-I.C-1
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To be familiar with the different non-chordate phyla. • To know the general and distinguishing characters of each of them. • To study how the different systems evolved in their complexity. • To compare and contrasts the life processes in different phyla.
LEARNING OUTCOME:	At the end of the course, the students will be familiar with the non-chordate world that surrounds us. They will be able to appreciate the process of evolution and see how it progressed from simple, unicellular cells to complex, multicellular organisms. Students will be able to identify the invertebrates and classify them upto the class level. Students will understand the basis of life processes in the non-chordates.

ZOO-I.C-1: ANIMAL DIVERSITY: NON CHORDATES		
MODULE	**TOPICS**	**CONTACT HOURS**
Module 1: Evolution of Animal Diversity and Diversity of lower non chordates	• Non chordate evolution and diversity • Taxonomy and phylogeny of animals • Invertebrate cladogram • Protista Classification and general characters upto class for the following phyla: • Porifera • Cnidaria • Platyhelminthes • Aschelminthes • Annelida	15
Module 2: Diversity of higher Non Chordates	Classification and general characters upto class for the following phyla: • Onycophora • Arthropoda • Mollusca • Echinodermata • Hemichordata	15
Module 3: Biological systems of Non Chordates 2	• Comparison of life processes such as nutrition, sensory and neural control and coordination, blood vascular system, exoskeleton, endoskeleton, locomotion and muscular system, respiration, excretion, reproduction and development of phylum Porifera to Hemichordata.	15

PRACTICAL COMPONENT OF ZOO-I.C-1: ANIMAL DIVERSITY: NON CHORDATES (DURATION -02 HRS /WEEK)		
Sr. No	Practical	No. of Practicals
1.	Identification of organisms from phylum protozoa to phylum Hemichordata	06
2.	Observation of permanent slides	03
3.	Mountings: Cockroach mouth parts, prawn appendages	02
4.	Field trip to terrestrial environment to study the invertebrates in their natural habitats	01

REFERENCE BOOKS:

1. Barnes R.D. (2000). Invertebrate Zoology.Hall Saunders International Edition, London.
2. Barrington E.J.W. 1979. Invertebrate structure and Function.John Wiley and Sons Inc.
3. Jordan, E. L. and Verma, P.S. (2000). Invertebrate Zoology. S. Chand & Co. Pvt. Ltd. New Delhi.
4. Marshall A.J.and W.D. Williams. 1974. Textbook of Zoology. Macmillan.
5. Pechenik J.A.(2002). Biology of the invertebrates. Tata McGraw hill Publishing company limited, New Delhi .

REFERENCE BOOKS FOR PRACTICALS:

1) Ziser. W.S (2014) Biology 1413 Introductory Zoology Lab Manual.Morton Publishing Co. Austin Community College.
2) Lal S.S. (2004) A textbook of practical zoology vertebrate. Rastogi publications, Meerut India.

CORE COURSE : CELL AND MOLECULAR BIOLOGY	
COURSE CODE:	ZOO-I.C-2
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	This course will give firm and rigorous foundation in the principles of modern molecular and cellular biology. It discusses the fundamental processes that enable cells to grow, move and communicate and will cover topics such as cell architecture, cell chemistry, cell division, functions and cell cycle. Students will also learn current molecular biological techniques that are used to study cell biology. Laboratories will focus both on exercises that help illustrate cellular phenomena, as well as on the introduction of techniques and procedures commonly utilized in modern cell and molecular biology research.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: • Develop deeper understanding of what life is and how it functions at cellular level. • Describe cellular membrane structure and function, fine structure and function of cell organelles. • Perform a variety of molecular and cellular biology techniques.

ZOO-I.C-2 : CELL AND MOLECULAR BIOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: TECHNIQUES OF CELL STUDY AND CELL CHEMISTRY (15 Hrs)	Unit 1: MICROSCOPY • Light Microscopy • Electron Microscopy.	15
	Unit 2: CELL STUDY METHODS • Cell Fractionation, Chromatography and electrophoresis.	
	Unit 3: MOLECULES IN CELL. • Micromolecules in cells: Sugars, Fatty acids, aminoacids, Nucleotides. • Macromolecules in cells: Nucleic acids, proteins, Polysaccharides, glycogen, fats.	
	Unit 4: CHEMICAL BONDS IN BIOMOLECULES • covalent bonds, ionic bonds, noncovalent interactions	
MODULE 2: CELL ARCHITECTURE (15 Hrs)	Unit 5: MEMBRANE STRUCTURE AND MEMBRANE PROTEINS • lipid bilayer – composition and structural organization (amphipathic phospholipids, Fluidity of cell membrane) • Membrane Proteins –structure and function (transmembrane proteins, peripheral membrane proteins) • Phospholipids, sphingolipids, Cholesterol in cell membrane.	15
	Unit 6: MOLECULAR STRUCTURE AND FUNCTION • Plasma Membrane • Cell matrix: Physical nature and Properties. • Nucleus: Ultra Structure and function • Mitochondria: Ultra Structure and functions • Endoplasmic Reticulum: ultra structure, modifications, functions	
	UNIT 7: MOLECULAR STRUCTURE AND FUNCTION • Golgi Complex, Ribosomes, Microsomes, Cytoskeleton	
MODULE 3: CELLULAR TRANSPORT OF PROTEINS AND VESICLES (15 Hrs)	Unit 8: TRANSPORT ACROSS CELLL MEMBRANES • Principle of transmembrane transport (transporters and channels, active and passive transport, osmosis) • Transporters and their function- passive transporters, Pumps (Na^+, K^+, Ca) • Ion Channels - ion channels activities, regulation of opening and closing of channels. • Protein transport into organelles (nucleus, mitochondria,ER).	15
	Unit 9: VESICULAR TRANSPORT. • Vesicular transport – transport of soluble proteins, vesicle budding, vesicle docking, endocytic pathways.	

PRACTICAL COMPONENT OF ZOO-I.C-2: CELL AND MOLECULAR BIOLOGY (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1)	Introduction to Lab techniques – Pipetting, preparation of buffers and solutions, Lab equipments (use and maintenance), acquaintance with general laboratory practices	02
2)	Cytochemistry: Localisation of Proteins, Carbohydrates & fats using different stains.	03
3)	Comparison of membrane permeability – Cellophane and Chick intestine.	02
4)	Osmotic studies – Using Human Red blood cells.	01
5)	Permament slides: - Mitotic stages - Meiotic stages (mounting from grasshopper testes) - Histology - Study of different cell types (animal cells)	03
6)	Technique of Agarose gel electrophoresis (Observation of technique)	01

REFERENCE BOOKS:

Essential books:

1) *Alberts B, Hopkins, Lewis J, Raff M, Robertis K, Walter P (2014): Essential Cell Biology, Fourth Edition, Graland Science Taylor & Francis Group, UK.*
2) *Lodish H, Berk A, Kaiser CA, Krienger M, Scott MP, Anthony, Bretscher A, Amon A. Scott MP (2013): Molecular Cell Biology, Seventh Edition, W. H. Freeman and Company New York.*

Supplementary Reading:

3) *Gupta PK (2003): Cell and Molecular Biology, Second Edition, Rakesh Kumar Rastogi for Rastogi Publications, Meerut, New Delhi, India.*
4) *Verma PS and Agarwal VK (2007): Cell Biology Genetics Molecular Biology Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.*

REFERENCE BOOKS FOR PRACTICALS:

1) *Alberts B, Hopkins, Lewis J, Raff M, Robertis K, Walter P (2014): Essential Cell Biology, Fourth Edition, Graland Science Taylor & Francis Group, UK.*
2) *Bolsover SR, Shephard EA, Hugh AW, Hyams JS (2011): Cell Biology, Third Edition, Wiley Blackwell, A John Wiley & Sons, Inc., Publications.*
3) *Verma PS and Agarwal VK (2007): Cell Biology Genetics Molecular Biology Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.*

SEMESTER – II

CORE COURSE: **DIVERSITY AND BIOLOGICAL SYSTEMS OF CHORDATES**	
COURSE CODE:	ZOO-II.C-3
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To be familiar with the different Chordate phyla. • To know the general and distinguishing characters of each of them. • To compare and contrast the major biological systems amongst them.
LEARNING OUTCOME:	At the end of the course, the students will be familiar with the chordate world that surrounds us. They would be able to identify the different chordates upto the order. They will understand the functioning and mechanism of the various biological systems in the chordates.

ZOO-II.C-3: DIVERSITY AND BIOLOGICAL SYSTEMS OF CHORDATES		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Diversity of chordates(upto order)	1.1: Chordata: General plan of organization and Outline classification 1.2: General characters and classification of Protochordates 1.3: General characters and classification of Agnatha (upto class) 1.4: General characters and classification of Pisces, Amphibia, Reptilia, Aves, Mammalia upto orders	15
MODULE 2: Biological Systems I	3.1: Integument: Pisces, Amphibia, Reptilia, Aves, Mammalia 3.2:Locomotory apparatus: Pisces , Amphibia, Reptilia , Aves, Mammalia 3.3: Digestive system: Pisces , Amphibia, Reptilia , Aves, Mammalia 3.4: Respiratory system: Pisces , Lungs in Amphibia, Reptilia , Aves, Mammalia	15
MODULE 3: Biological systems - II	3.1: Circulatory system: Pisces , Amphibia, Reptilia Aves, Mammalia 3.2: Brain and cranial nerves: Pisces , Amphibia, Reptilia , Aves, Mammalia 3.3: Reproductive system: Pisces , Amphibia, Reptilia , Aves, Mammalia	

PRACTICAL COMPONENT OF ZOO-II.C-3: DIVERSITY OF CHORDATES (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1.	Identification and Systematic classification of organisms from protochordates to mammalia	05
2.	Mounting of scales and chromatophores in fishes	01
3.	Observation of general viscera of chordate phyla	01
4.	Identification of Indian venomous and non venomous snakes with the help of keys provided (four each)	01
5.	Observation of pectin of eye (chick), skulls of representatives of pisces, amphibian, aves and mammals.	01
6.	Observation of permanent slides (amphioxus, doliolum, salpa) and observation of hyoid apparatus of chick; reptiles and mammals	01
7.	Field trip to wild life sanctuary	02

REFERENCE BOOKS:

1. Cleveland Hickman Jr., Roberts Larry, Susan Keen, Allan Larson and Eisenhour D (2014). Animal Diversity. McGraw Hill Science.
2. Kardong K(2011). Vertebrates: Comparative anatomy, evolution, function. McGraw-Hill Higher Education.
3. Kent G.C. and Carr R.K. (2000). Comparative anatomy of the vertebrates. McGraw-Hill Higher Education.
4. Young J.Z. (2006). The life of vertebrates. Radha Press Delhi, Indian Edition.

REFERENCE BOOKS FOR PRACTICALS:

1) Ziser. W.S (2014) Biology 1413 Introductory Zoology Lab Manual. Morton Publishing Co. Austin Community College.
2) Lal S.S. (2004) A textbook of practical zoology vertebrate. Rastogi publications, Meerut India.

CORE COURSE: FUNDAMENTALS OF ANIMAL AND HUMAN GENETICS	
COURSE CODE:	ZOO-II.C-4
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	This course is intended to provide solid understanding of concepts and principles of genetics as it applies to animals and humans. Students will receive good foundation of chromosome structure, its aberrations and inheritance patterns of traits and disease which will help one to develop conceptual skills to address questions in genetic research.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: • Describe the basic structure of genes and chromosomes. • Relate an organism's genotype and phenotype and explain the role of genes in inheritance. • Understand the reason why a given genotype does not always result in the same phenotype • Demonstrate knowledge of genetic principles and their application in society • Construct and analyze pedigrees to determine mode of inheritance of disorders and traits.

ZOO-II.C-4: FUNDAMENTALS OF ANIMAL AND HUMAN GENETICS

MODULE	TOPICS	CONTACT HOURS
MODULE 1: Transmission Genetics	UNIT 1: MODES OF INHERITANCE • Mendels laws of inheritance , test cross, back cross • Gene interactions: 9:3:3:1/12:3:1 / 9:3:4 /9:6:1 / 9:7 / 15:1 / 13:3. lethal genes, penetrance. • Inheritance of Multiple Alleles and Multiple genes	15
	UNIT 2: PATTERN OF INHERITANCE BY PEDIGREES • Construction of Pedigrees • Analysis of Pedigree analysis : autosomal dominant, autosomal recessive, X-Linked dominant, X-linked recessive, Y-linked, Mitochondrial inheritance • Sex limited and Sex influenced and multifactorial inheritance disorders in humans	
MODULE 2: Chromosome Structure and Abnormalities in Humans	UNIT 3: CHROMOSOME STRUCTURE • Chromosome morphology- chromatid, Centromere, secondary constriction, chromomere • Heterochromatin and euchromatin • Chromosome structure and organization. • Human chromosomes and karyotype.	15
	UNIT 4: CHROMOSOMAL ABERRATION • Numerical aberrations: Types- Aneuploidies and Euploidies, Mosaicism, • Structural Abnormalities: Types-Deletions, inversions, Translocations, duplications.	
MODULE 3: Gene Mutations, Sex Determination .	UNIT 5: GENETIC MUTATIONS. • characteristics of mutations • classification of mutations (Spontaneous, Induced) molecular basis of mutations • Mutagens – physical and chemical	15
	UNIT 6: SEX DETERMINATION. • Environmental Sex Determination – hormonal, egg size, incubation temperature. • Chromosomal sex determination - XX♀and XO♂, XO ♀ and XX ♂, ZW♀ and ZZ♂, XX♀and XY♂, Diploid female and Haploid male, single gene effect. • Molecular basis of sex determination: Geneic imbalance, Sex index, Intersex and gynandomorphs, X/A Ratio. • Sex determination by Y linked genes, Dosage compensation, X-inactivation	

PRACTICAL COMPONENT OF ZOO-II.C-4: FUNDAMENTALS OF ANIMAL AND HUMAN GENETICS. DURATION - 02 HRS /WEEK		
Sr. No	Practical	No. of Practicals
1)	Verification of Mendel’s laws - monohybrid cross	01
2)	Verification of Mendel’s laws - dihybrid cross	01
3)	Manual Karyotyping of human chromosome plates: 1) Normal Male and Female 2) Downs syndrome	03
4)	Drosophila Culture technique	01
5)	Study of Mutants of Drosophila	01
6)	Exercises for Multiple alleles and Multiple genes	02
7)	Construction and analysis of pedigrees	03

REFERENCE BOOKS FOR THEORY:

1) Gardner EJ, Simmons MJ and Snustad DP (2013): Principles of Genetics, Eighth Edition, John Wiley Publication, Singapore.
2) De Robertis EDP, De Robertis EMF (2012): Cell and Molecular Biology, Eigth Edition. Wolter Kluwer Publication, Philadelphia.
3) Singh BD (2014): Fundamentals of Genetics. Second Edition, Kalyani Publishers, New Delhi.
4) Lewis R (2009): Human Genetics, Concepts and Applications, Seventh Edition. McGraw-Hill International Edition, New York.
5) Gangane SD (2009): Human genetics, Third Edition, Reed Elsevier India Pvt Ltd., Haryana India.
6) Gardner A, Davies T (2010): Human Geentics, Second Edition, Scion Publishing Ltd, UK.
7) Marcus A(2011): Genetics, MJP Publishers, Chennai.
8) Verma PS and Agarwal VK (2014): Cell Biology Genetics Molecular Biology Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.
9) Kothari ML, Mehta L, Roychoudhury SS (2009): Essentials of Human Genetics, Fifth edition, University Press Pvt. Ltd. Hyderabad.

REFERENCE BOOKS FOR PRACTICALS:

1) Gangane SD (2009): Human genetics, Third Edition, Reed Elsevier India Pvt Ltd., Haryana India.
2) Marcus A(2011): Genetics, MJP Publishers, Chennai.
3) Gardner A, Davies T (2010): Human Genetics, Second Edition, Scion Publishing Ltd, UK.
4) Lewis R (2009): Human Genetics, Concepts and Applications, Seventh Edition. McGraw-Hill International Edition, New York.

SEMESTER –III and IV

SEMESTER	COURSE CODE	COURSES	CREDITS	CONTACT HOURS
Semester III	ZOO-III.C-5	Human Physiology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-III.E-1	Vertebrate Endocrinology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-III.E-2	Basic microbiology and Fundamentals of Animal Biotechnology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-III.E-3	Environmental Toxicology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
Semester IV	ZOO-IV.C-6	Biochemistry and Metabolic Regulation	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-IV.E-5	Animal cell culture and Applications	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-IV.E-6	Aquaculture and Fisheries	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-IV.E-7	Immunology	Theory = 03 Practicals =01	Theory = 45 Practicals =30

SEMESTER –III

CORE COURSE :HUMAN PHYSIOLOGY	
COURSE CODE:	ZOO-III.C-5
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	The primary goal of this course is to offer an in-depth presentation of the function of the major organs and organ systems of the human body. The course is designed to expand physiological concepts presented in prerequisite courses.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: • describe and explain the normal function of the cells, tissues, organs, and organ systems of the human body • develop understanding of the functional relationships of anatomical structures to one another

ZOO-III.C-5: HUMAN PHYSIOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Physiology Of Digestion And Respiration	UNIT 1: *DIGESTIVE SYSTEM* • Structural organization, histology and functions of gastrointestinal tract and its associated glands; • Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins.	15
	UNIT 2: *RESPIRATORY SYSTEM* • Histology of trachea and lung; • Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; • Transport of oxygen in the blood oxygen- hemoglobin & myoglobin , dissociation curve and the factors influencing it Carbon monoxide poisoning; Carbon dioxide transport in the blood; • Buffering action of blood and haemoglobin Control of respiration	
MODULE 2: Physiology Of Excretion And Circulation	UNIT 3: *EXCRETORY SYSTEM* • Structure of kidney and its histological details, Renal blood supply; Mechanism urine • Formation and its regulation, Regulation of acid-base balance.	15
	UNIT 4: *CIRCULATORY SYSTEM* • An outline structure of heart and working of heart. • Origin and conduction of cardiac impulses functions of AV node; Cardiac cycle; nervous and chemical regulation of heart rate; Blood pressure and its regulation; Electrocardiogram • Components of blood and their functions; Haemopoiesis.	
MODULE 3: Physiology Of Nervous System, Muscles And Reproductive System	UNIT 5: *NERVOUS SYSTEM* • Structure of neuron, resting membrane potential , Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; • types of synapsis, Synaptic transmission and, Neuromuscular junction; Reflex action & its types - reflex arc • Physiology of hearing and vision	15
	UNIT 6: *MUSCLE* • Histology of different types of muscle; • Ultra structure of skeletal muscle; • Molecular and chemical basis of muscle contraction; • Characteristics of muscle twitch; Motor Unit, summation & tetanus	
	UNIT 7: *REPRODUCTIVE SYSTEM* • Histology of male and female reproductive systems. • Puberty, Physiology of male and female reproduction.	

PRACTICAL COMPONENT OF ZOO-III.C-5: HUMAN PHYSIOLOGY (DURATION -02 HRS /WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1)	Enumeration of red blood cells / WBC using haemocytometer	02
2)	Estimation of haemoglobin using Sahli's haemoglobinometer	01
3)	Determination of activities of digestive enzymes (Amylase, Pepsin, Trypsin and Lipase)	02
4)	Temporary preparation of Striated muscle fibers and nerve cells.	02
5)	Urine analysis (for organic, inorganic and abnormal components)	03
6)	Examination of sections of mammalian tissues: Lung, Kidney, Gonads, Intestine, Muscles, Spinal cord, Bone and cartilage	02

REFERENCE BOOKS:

Essential books:

1. *Singh HD(2011):Textbook of Human Physiology, S Chand Publishers, New Delhi.*
2. *Widmaier, Raff, & Strang(2008), Vander's Human Physiology: The Mechanisms of Body Function, 12thedition, McGraw Hill,. ISBN 978-0-07-337810-7*
3. *Tortara G J and Derrickson BH(2009). Principles of Anatomy and physiology, 12th Edition. John Wiley & sons, Inc.*
4. *Guyton Ac and Hall JE(2011). Testbook of Medical Physiology, 12th Edition, Harcourt Asia Pvt Ltd, WB Saunders Company.*

Supplementary Reading:

5. *Openstax College (2013). Anatomy and Physiology. Vol II. Mainstreet MS, Houston Texas(Ebook)*
6. *Forciea B (2012). An eText of Human Anatomy and Physiology(Ebook).*
7. *Wingerd B(2008). The Human Body, Essential Anatomy and Physiology. University Readers, SanDiego CA.*

REFERENCE BOOKS FOR PRACTICALS:

1. *Openstax College (2013). Anatomy and Physiology. Vol II. Mainstreet MS, Houston Texas(Ebook*
2. *Forciea B (2012). An eText of Human Anatomy and Physiology(Ebook).*
3. *Wingerd B(2008). The Human Body, Essential Anatomy and Physiology. University Readers, SanDiego CA.*

ELECTIVE COURSE: VERTEBRATE ENDOCRINOLOGY	
COURSE CODE:	ZOO-III.E-1
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To study the endocrine organs of vertebrates • To understand the underlying principles of hormone functions • To gain an insight into the current and important issues in endocrinology
LEARNING OUTCOME:	At the end of the course, the students will be familiar with all the endocrine organs and their functions in body growth, metabolism, reproduction and development. They will be able to appreciate better the contemporary issues in endocrinology.

ZOO-III.E-1: VERTEBRATE ENDOCRINOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Anatomy and histology	Unit 1: • Aim and scope of endocrinology, • techniques in endocrinology - histology, histochemistry, immunocytochemistry, in situ hybridisation, radio immune assay, surgical techniques, • Regulation of hormone secretion: feedback mechanisms - positive, negative, short loop, long loop	15
	Unit 2: • Anatomy and histology of endocrine glands- • Pituitary, Pineal gland, Thyroid, Parathyroid, • Thymus, Adrenal, Endocrine pancreas, GI tract, • Endocrine hypothalamus, Gonads, Placenta	
MODULE 2: Hormones	Unit 3: • Classification of hormones • Hormone structure • Biological actions of hormones	15
	Unit 4: • Mechanisms of hormone action • Receptor and it regulation • Steroid and peptide hormones actions	
	Unit 5: Hormones and Homeostasis - Calcium and glucose	
MODULE 3: Pathological conditions	Unit 6: Biosynthesis and secretion of hormones - steroid hormones, thyroid hormones	15
	Unit 7: Growth factors - neurotropic growth factors, hematopoietic growth factors, other peptide growth factors	
	Unit 8: Endocrine disorders - goitre, gigantism, dwarfism, cretinism, diabetes mellitus, insepidus	

PRACTICAL COMPONENT OF ZOO-III.E-1: Vertebrate Endocrinology (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1)	Histological slides ofEndocrine hypothalamus, Gonads, Placenta pituitary, Pineal gland, thyroid gland, Parathyroid,Thymus, adrenal gland, pancreas, ovary, testis	04
2)	Display of Pituitary and gonads in fishes/chick	03
3)	Preparation of histological slides using microtomy	05

REFERENCE BOOKS:

1. David, N.O. and J.A. Carr (2013) Vertebrate Endocrinology. Academic press publications 5th edition.
2. Hadley, M. and Levine, J (2006) Endocrinology. Benjamin Cummings 6th edition.
3. Kovacs, J.W. and S.R. Ojeda (2011) Textbook of endocrine physiology 6th edition. Oxford university press.
4. Yadav, P.R. (2004) Endocrinology. Discovery Publishing House, New Delhi.
5. Hadley, M (1992) Endocrinology, Third edition, prentice Hall, New Jersey.
6. Matsumoto, A. and S. Ishi, (1992)(eds). Atlas of endocrine organs, vertebrates and Invertebrates springier verlag, Germany.
7. Norris D. O., Vertebrate Endocrinology, Elsevier Academic Press.
8. Turner, C.D and Bagnara, J.T., (1994) General Endocrinology, 6th Edition, WB Saunder's company, Philadelphia (Saunder's International Students edition).
9. 5. Wilson J.D and Foster D.W (1992) William's textbook of endocrinology, 8th edition, WB saunders company, Philadelphia.
10. Yadav, P.R (2004) Endocrinology. Discovery Publishing House, New Delhi.

ELECTIVE COURSE: BASIC MICROBIOLOGY AND FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY	
COURSE CODE:	ZOO-III-E-2
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	To provide a comprehensive survey of microbiology with basic information on bacteria and learn the fundamentals of biotechnological techniques.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: • Gain working knowledge of basic bacterial laboratory techniques, as well as the foundations of biotechnological tools. • Students will also master the basic laboratory skills and techniques necessary to work efficiently in a microbiology laboratory and perform techniques of gene insertion and selection of recombinant plasmids.

ZOO-III-E-2: BASIC MICROBIOLOGY AND FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY

MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Microbiology	1: Introduction to Microorganisms-Bacteria o Structure and Identification of bacteria(morphological types) o Nutritional types o Nutritional requirements	15
	2: Isolation and Culture of Bacteria: o Cultivation of bacteria o Different methods of isolation and maintenance of pure cultures o Culture characteristics	
	3: Use of microorganisms in biotechnology-An overview: o Production of valuable substances o Fuel Production, recovery of minerals and oils o Microorganisms in bioassays o Food and agriculture sector o Medicine and health	
MODULE 2: Tools in Biotechnology	4: Scope and importance of Biotechnology o Definition o Contribution and importance of biotechnology	15
	5: Nucleic Acid Enzymology: o Restriction enzymes, Ligases, Alkaline phosphatase o Polynucleotide kinase, Terminal Transferases, S1 Nuclease o Polymerases, Reverse transcriptase	
	6: Gene Cloning vectors: o Plasmids, Bacteriophage, cosmids o Shuttle and expression vectors	
MODULE 3: Genetic Engineering	7: Techniques in genetic engineering: o Gene transfer methods o Methods of Labeling Nucleic acids o Nucleic acid Hybridization o Polymerase chain reaction	15
	8: Recombinant DNA technology: o Procedure / Technique	
	9: Blotting Techniques: o Southern Blotting o Northern Blotting o Western Blotting	
	10: DNA sequencing techniques: o Chemical Degradation method o Chain termination method o Automated Sequencing	

PRACTICAL COMPONENT OF ZOO-III-E-2: BASIC MICROBIOLOGY & FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY DURATION - 02 HRS /WEEK		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1)	Preparation of culture media for bacteria (Plates, Slants, deeps, Broth).	03
2)	Staining of Microorganisms (Gram staining, negative staining).	02
3)	Isolation of pure colonies of Bacteria (streak plate method – 3 Quadrant And 5 Quadrant methods)	03
4)	Identification of Products of metabolic pathways of microbial cells.	02
5)	Bacteriological testing of Milk.	01
6)	DNA sequencing - Analysis of prints.	01

REFERENCE BOOKS:

Essential books:

1) *Pelczar MJ, Chan ECS, Krieg NR(2009). Microbiology. Tata Mc Graw Hill, New York.*
2) *Dubey RC and Maheshwari DK (2012). A test book of Microbiology. S Chand Publishers, New Delhi.*
3) *Prave P, Faust U, Sittig W and Sukatsh DA(2004). Fundamentals of Biotechnolgy.*
4) *Purohit SS(2008). BiotechnologyFundamentals and applications. Agrobios, Jodhpur India.*
5) *Ranga MM(2012): Animal Biotechnology. Agrobios, Jodhpur India.*

Supplementary reading:

6) *Black JG(2005). Microbiology principles and explorations. John Wiley and sons Inc.*
7) *Sullia SB and Shantharam S(2006). General Microbiology. Oxford and IBH Publishing Co Pvt Ltd, NewDelhi.*

REFERENCE BOOKS FOR PRACTICALS:

1) *Gunasekaran P(2009). Lab Manual in Microbiology. New Age International Ltd. Publishers, New Delhi.*

ELECTIVE COURSE: ENVIRONMENTAL TOXICOLOGY	
COURSE CODE:	ZOO-III-E-3
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To study the different environmental pollutants and their toxicity. • To know the physiological effects of toxicant exposure.
LEARNING OUTCOME:	After completion of the course students are expected to be able to: • Distinguish,classify and characterize a variety of environmental pollutants based on their biological and physical properties. • Identify the main sources and types of environmental pollutants and assess their potential environmental fate. • Will learn mechanisms of detoxification of various varieties of toxicants. • Will learn bio-indicators of exposure to specific environmental contaminants. • Identify potential solutions to anthropogenic pollution

ZOO-III-E-3: ENVIRONMENTAL TOXICOLOGY		
MODULE	**TOPIC**	**CONTACT HOURS**
MODULE 1: Introduction To Toxicology	**1.1Introduction To Toxicology:** o Definition and History of Toxicology and Toxicity o Disciplines of Toxicology o Biouptake,Bioaccumulation,Biotransfer and Biological Magnification, Relationship to Other Sciences, Scope and importance of Toxicology **1.2: Classes Of Toxicant:** • Define Toxicant and Toxins, their classification • Toxicants in Air, Water and Soil • Toxicants in Domestic and Occupational Settings • Synthetic drugs: Solvents; Therapeutic drugs, Drugs of abuse,Combustion products,Cosmetics • Movement and fate of Toxicants in the environment	15
MODULE 2: Environmental Impact Mitigation	**2.1: Toxicity Of Heavy Metals:** • Toxicity of Arsenic, Lead, Mercury, • Cadmium,Copper, Zinc, Aluminium,Iron and Manganese; Sources and portals of heavy metal pollutants; Toxicity of substances on Human and Animals **2.2: Agro-Chemical Pesticides And Their Environmental Impact Mitigation** • Definition and Classification • Organochlorine Insecticides, Organophosphate Insecticides, Carbamates, Pyrethroid Insecticides, Dinitrophenols, Herbicides, Fungicide • Control of Pesticide Pollution; Integrated Pest management	15
MODULE 3: Food Additives AND Toxicity tests.	**3.2: Food Additives:** • General account of Food Additives: • Incidental or Indirect additives • Intentional or Direct additives: **a.**Antioxidants b. Emulsifiers c. Enzymes d. Flavouring agents e. Colour and preservatives f. Artificial sweetening agents i)Saccharine ii)Urea derivatives • Types of toxicity tests; Test types based on number and species; Test types based on exposure of toxicant; Test types based on length of exposure acute , sub acute, chronic)	15

PRACTICAL COMPONENT OF ZOO-III.E-3:ENVIRONMENTAL TOXICOLOGY (DURATION-02 HRS/WEEK)

Sr.No.	Practical	No.of Practicals
1.	To determine the effect of temperature on the toxicity of a pollutant	01
2.	To determine the effect of pH on the toxicity of a pollutant.	01
3.	To evaluate qualitatively the presence of pesticide residues in vegetable samples.	02
4.	Estimation of total dissolved solids in given water sample.	01
5.	To determine Lc^{50} of a pollutant on mosquito larvae .	01
6.	Effect of pesticides on Oxygen consumption in fish	02
7.	Estimation of Phosphorus in given water sample by Spectrophotometer	01
8.	Estimation of Boron from given water/soil sample by spectrophotometer	01
9.	Determination of Nitrates from given water sample.	01
10.	Field trip (case study of polluted water body)	01

REFERENCE BOOKS FOR THEORY:

1. Ernst Hodgson(2004) A Text Book of Modern Toxicology ,A John Wiley and sons Inc,Publication.
2. Gupta P.K.(2010) Modern Toxicology, Pharma Med Press, Hyderabad.
3. Omkar(2007) Concepts of Toxicology ,Vishal Publishing Co, Jalandhar
4. Pandey K,Shukla J.P. and Trivedi S.P. (2011)Fundamentals of Toxicology,New Central Book Agency(P) Ltd.
5. P.D.Sharma (2011)Environmental Biology and Toxicology (Third edition),Rastogi Publications,Meerut-250002.

REFERENCE BOOKS FOR PRACTICALS:

1. Wooley, A (2008) A Guide to Practical Toxicology: Evaluation, Prediction, and Risk IInd Edition, Informa Healthcare U.S.A.,Inc.New York.
2. Rao K.S. (1998) Practical Ecology, Anmol Publications Pvt. Ltd. New Delhi.
3. Subramanian M.A. (2004) Toxicology Principles and Methods(Second Revised Edition),M.J.P. Publishers, Triplicane Chennai.
4. Sunita Hooda and Sumanjeet Kaur(1999)Laboratory Manual for Environmental Chemistry, S. Chand and Comp. Ltd. New Delhi.

ELECTIVE COURSE: PARASITOLOGY	
PAPER CODE:	ZOO-III.E-4
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To be familiar with the parasite host interactions. • To gain knowledge on diagnosis of parasite infections and also to learn about the preventive measures.
LEARNING OUTCOME:	At the end of the course the learner will be acquainted with dimensions of public health viz a viz parasitic diversity, epidemiology and community prophylaxis

ZOO-III.E-4: PARASITOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Basic Principles of Parasitology and parasitic protozoans	1.1 Parasite systematics, Ecology and Evolution 1.2 Immunology and Pathology 1.3 Symbiosis and parasitism 1.4 Parasite host interactions Form, function, classification, life cycle, diagnosis and preventive measures *1.5 Trypanosoma gambiens* 1.6 Amoebas –*Entamoeba histolytica* *1.7* Malaria organisms - *Plasmodium vivax* 1.8 Sexually transmitted parasite – *Trichomonas vaginalis*	15
MODULE 2: Parasitic Platyhelmithes and Nematodes	Form, function, classification, life cycle, diagnosis and preventive measures 2.1 Trematoda(liver fluke - *Fasciola hepatica*, intestinal fluke – *Fasciolopsis buski*, lung fluke – *Paragonimus westermani*); 2.2 Cestoda (Tape worm - *Taeniasolium*) 2.3 Hook worms- *Ancyclostoma duodena* 2.4Guinea worm- *Dracanculus medinensis* 2.5Round worm *Ascaris lumbricoids, Enterobias vermicularis* 2.6 *Wuchereria bancrofti*	15
MODULE 3: Parasitic arthropods and Parasites of domestic livestock	Form, function, classification , life cycle, diagnosis and preventive measures: Copepods, Barnacles, Amphipods, Isopods, Flea, Ticks, Mites, Head and pubic lice	15

PRACTICAL COMPONENT OF ZOO-III.E-4: PARASITOLOGY (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1)	Study of*Trypanosomagambiens, Entamoebahistolytica, Plasmodiumvivax, Trichomonasvaginalis, Fasciola hepatica,Taeniasolium, Ancyclostoma duodena, Dracanculusmedinensis, Ascarislumbricoids, Wuchereriabancrofti*, copepod, barnacle, amphipod, isopod from permanent slides with respect to parasitic adaptations.	06
2)	Preparation of peripheral blood smear from the perspective of detection of haemoparasites	01
3)	Study of parasites of domestic livestock(parasite, pathogenicity)	04
4)	Study of fish parasites	01

REFERENCE BOOKS:

1. Chatterjee, K.D. (2009) Parasitology (Protozoology and Helminthology) with two hundred fourteen illustrations. CBS, 13^{th} edition.
2. Dey, N.C., Dey, T.K. and D.M. Sinha (1995) Medical Parasitology. New Central book agency private limited, Calcutta.
3. Paniker, J.C.K. (2007) Textbook of medical parasitology. Jaypee Brothers, New Delhi.
4. Schmidt, G.D. (1990) Essentials of Parasitology. Universal Book Stall, New Delhi.

REFERENCE BOOK FOR PRACTICALS :

1. Halton, D.W., Behnke, J.M. and I. Marshall (2005) Practical exercises in parasitology. Cambridge University Press.

SEMESTER IV:

CORE COURSE: BIOCHEMISTRY AND METABOLIC REGULATION	
COURSE CODE:	ZOO-IV.C-6
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To understand the basic principles that govern the functioning of living systems • To know the structure of biomolecules and the role they play in governing life processes through the pathways • To be familiar with enzymes and their activities
LEARNING OUTCOME:	At the end of the course, the students will be able to understand better the chemical basis in life. They will appreciate better the interactions between the biological molecules.

ZOO-IV.C-6: BIOCHEMISTRY AND METABOLIC REGULATION		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Fundamentals of biochemistry and Carbohydrate metabolism	1.1 Principles of pH, buffer, thermodynamics 1.2Enzymes: classification, properties of enzyme, enzyme kinetics, MichaelisMenten Equation, enzyme inhibition 1.3 Carbohydrate structure, aerobic and anaerobic glycolysis, Citric acid cycle, glycogenesis, glycogenolysis, Pentose phosphate pathway, 1.4 Diabetes mellitus	15
MODULE 2: Lipid and Protein metabolism	2.1: Lipid: -structure and classification, -fatty acid synthesis -fatty acidoxidation(saturated and unsaturated), - metabolism of glycerophospholipids, sphingolipids, cholesterol - disorders: fatty liver types (NAFL, AFL) 2.2 Protein: - structure(primary, secondary, tertiary) and classification -amino acid biosynthesis, nucleotide biosynthesis, - amino acid catabolism, urea cycle, Fate of carbamoyl P, - Hyper uricemia	15
MODULE 3: Nucleotide metabolism and integration of metabolism	3.1Biosynthesis of purine and pyrimidine (de novo and salvage pathway) 3.2 Degrdation of purine and pyrimidine 3.3 Interconversions between the three principal components 3.4 Metabolism in starvation: Carbohydrate, lipid, proteins (The feed/fast cycle)	15

PRACTICAL COMPONENT OF ZOO-IV.C-6: BIOCHEMISTRY AND METABOLIC REGULATION (DURATION -02 HRS /WEEK		
Sr. No	Practical	No. of Practicals
1)	Principle and working of spectrophotometer	01
2)	Estimation of reducing sugars DNSA method	01
3)	Estimation of protein – Folin Lowry's method	01
4)	Estimation of fatty acids by titration method	01
5)	Separation of lipids by thin layer chromatography	02
6)	Colorimetric estimation of liver glycogen of chick by Anthrone method	02
7)	Effect of substrate concentration on amylase activity	02
8)	Estimation of DNA by DPA method	02

REFERENCE BOOKS:

1. David, L.N. and Cox, M. Michael (2008) Lehninger principles of biochemistry. W.H. Freeman and Company, New York.
2. Delvin, T.M. (1997). Textbook of biochemistry with clinical correlations. Wiley liss.
3. Harvey, A.R. and Ferrier, D. (2011). Lippincott's Illustrated Reviews Biochemistry. Wolters Kluwer, Lippincott Williams and Wilkins. 5th Edition.
4. Pratt, W.C. and K. Cornely 2003 Essential Biochemistry Wiley Publications third edition.

REFERENCE BOOKS FOR PRACTICALS:

Plummer, M. and D.T. Plummer (1988) Introduction to practical biochemistry.Tata McGraw Hill Education ,UK.

ELECTIVE COURSE: ANIMAL CELL CULTURE AND APPLICATIONS	
COURSE CODE:	ZOO-IV-E-5
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	This course is an introduction to the theory, standard practices, and methodologies of animal cell culture. The laboratory emphasizes the principles and practices of initiation, cultivation, maintenance of cell lines.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: ▪ operate, calibrate, and maintain standard equipment found in an animal cell culture laboratory; ▪ Prepare and sterilize media and solutions used in cell culture. ▪ Demonstrate an understanding of the concepts and applications of mammalian cell culture. ▪ Recognize and employ biosafety guidelines and practices.

ZOO-IV-E-5: ANIMAL CELL CULTURE AND APPLICATIONS		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: LAB REQUIREMENTS FOR CELL CULTURE	1: Historical background of Cell culture:	15
	2: Biology of cells in culture: Origin and characteristics, Differentiation, kinetics of cell growth, Genetics of Cultured cells, Problems associated with cell culture	
	3: Lab requirements for animal cell culture: o Lab facilities and setup for cell culture o Major and minor equipments o Environmental conditions o Substrates for Culturing and sub culturing	
	4: Animal tissue culture media o Natural media – biological fluids, tissue extracts o Chemically defined media- characteristic and composition o Media supplements – L Glutamine, serum. Advantages and disadvantages of serum in media / serum free media	
MODULE 2: CELL CULTURE TECHNIQUES	5: Primary cell culture: o Mechanical disaggregation o Enzymatic disaggregation o Protocol for primary cell culture	15
	6: Secondary cell culture/ Sub culturing: o Protocol for sub culturing of suspension culture o Protocol for sub culturing of adherent o Established cell lines	
	7: Scale up of animal cell culture: o Techniques of Scale up of suspension cultures o Techniques of Scale up of Monolayer cultures	
MODULE 3: CELL CULTURE APPLICATIONS	8: Cell Hybridoma Technology : o Steps of cell Hybridoma technology o Procedure o Production of monoclonal antibodies o Applications of monoclonal antibodies	15
	9: Valuable Products through cultured cells: Production of Tissue plasminogen, growth factor, Erythropoietin, Factor VIII, Interferons.	
	10: Other Application: Vaccines through cultured cells, Cytotoxicity testing, Fluorescent In-Situ Hybridization for disease detection, Cell culture in biomedical research.	

PRACTICAL COMPONENT OF ZOO-IV-E-5: DURATION -02 HRS /WEEK ANIMAL CELL CULTURE AND APPLICATIONS		
Sr. No	**Practical**	**No. of Practicals**
1.	Packing and sterilization of glass and plastic wares for cell culture & Lab Precautions and Biosafety measures	02
2.	Preparation of reagents and media for cell culture. ▪ Reagents ▪ Media / Buffers	02
3.	Setting up of primary cell culture - Methods used for cell disaggregation – Mechanical and Enzymatic - Quantification of cells (Viable cell count) by Tryphan blue exclusion dye. - Suspension culture - Adherent cell culture - Chicken embryo fibroblast culture	07
4.	Biological waste disposal methods	01

REFERENCE BOOKS:

1) *Ranga MM(2012). Animal Biotechnology. Agrobios India Ltd. Jodhpur.*
2) *Mathur S(2006). Animal Cell and Tissue Culture. Agrobios India Ltd. Jodhpur.*
3) *Masters W(2005). Animal Cell Culture. Oxford University Press Inc., NewYork*
4) *Gangal S(2010). Principles and practices of Animal Tissue Culture. Second Edition. University Press PVT. LTD., Hyderabad India.*
5) *Freshney I R(2007). Culture of animal Cells: A manual of Basic Techniques. 5th edition, John Wiley & Sons Inc Pte Ltd*

REFERENCE BOOKS FOR PRACTICALS:

1) *E Book- Fletcher L, Goss E. Phelps P and Wheeler A(2014). Introduction to Biotechnology – Laboratory Manual.*
2) *Harisson M A and Rae IF(1997):General Techniques of Cell Culture Handbook in Practical animal cell biology. Cambridge University Press.*
3) *Ebook- Cell Culture basics. From www.invitrogen.com/ cellculture basics.*

ELECTIVE COURSE : AQUACULTURE AND FISHERIES	
COURSE CODE:	ZOO-IV.E-6
MARKS:	100[75- Theory; 25- Practicals]
CREDITS:	04 [03-Theory;01- Practical)
CONTACT HOURS	Theory :45 Hours(03 LEC/WEEK) Practicals: 30 Hours(01 PRACTICAL/WEEK)
COURSE OBJECTIVES:	• To improve the understanding of conservation and sustainability of living resources • To improve the social and economic benefits derived from aquaculture and fisheries. • To study the role of aquaculture in rural development in solving nutritional security and unemployment. • Empowerment of fishery and entrepreneurship development
LEARNING OUTCOMES:	• The student may become future aqua culturist, entrepreneur who will provide employment to others. • Optimum utilization of unutilized and underutilized aquatic resources for fisheries and aquaculture, enhance the fish production, employment generation and even to earn the foreign exchange.

ZOO-IV.E-6: AQUACULTURE AND FISHERIES		
MODULE	**TOPIC**	**CONTACT HOURS**
MODULE 1:	**1.1:Inland Fisheries:** • Riverine ;Reservoir fisheries; Lakesterine fisheries; Cold water fisheries **1.2: Marine Fisheries:** • Estuarine fisheries:The catadromous fishes (*Polynemous indicus,P.tetradactylus*) and anadromous fishes(*Hilsa ilisha,Pama pama,Polynemous paradiseus*) • Coastal fisheries or Inshore fisheries: Elasmobrach fishery and Teleost fishery • Offshore and Deep sea fisheries: Pomfrets(*Pampus,Stromateus) Eleutheronema tetradactylus*(rava). **1.3: Crustacean And Molluscan Fisheries:** • Prawn fisheries in Goa: Penaeid and Palaemonid groups. • Crab fisheries in Goa • Edible oyster fisheries in Goa • Mussel fisheries in Goa	15
MODULE 2:	**2.1: Integrated Fish Farming Systems:** • Principle of integrated Fish farming; Integration with animal husbandry and farming systems. **2.2:Induced Breeding:** • Selection of site; Design and Layout of fish farm; Freshwater and brackish water; pond construction; Pond maintenance; Prevention of fish diseases; Control of aquatic weeds, predatory and Weed fishes, Aquatic insect; Harvesting. **.4 :Fishing Methods:** • Marine Fishing Crafts and Gears used in Goa. • Inland Fishing Crafts and Gears used in Goa	15
MODULE 3:	**3.1: Fish Culture System:** • Overview of Mono culture, polyculture, composite culture, raceway culture, extensive, semi intensive, intensive, zero water exchange, Objective of fish culture, Pond preparation, Selection of species, Stocking of seed, Feed and feeding, Harvesting, Bionomics of fish culture **3.2: Cage And Pen Culture:** • Advantage of Fish culture in cages, Selection of species for cage culture, Installation of cage - shape ,size and types of cages, Pen culture, Maintenance of cage and pen	**15**

PRACTICAL COMPONENT OF ZOO-IV.E-6: AQUACULTURE AND FISHERIES (DURATION – 02 HRS/ WEEK)		
Sr. No.	**Practical**	**No. of Practicals**
1.	Morphometric and Meristic study : a key for fish Identification	04
2.	Identification of : -Important edible prawns, shrimps and crabs(anytwo) - Important Freshwater and Marine edible fishes- oil sardine, sole fish, white sardine,mullet,Scianera	03
5.	Estimation of Fecundity by Frequency Polygon method from a Marine Fish	01
6.	Food and Feeding of Fish by analysis of gut content	01
7.	Field based: • To study different types of gear and craft • To study fish breeding • Study of aquarium and larvivorous fishes	03

REFERENCE BOOKS FOR THEORY:

1. Bal D.V.,RaoVirbhadra,K (1984) Marine Fisheries, Tata McGraw- Hill Publishing Company Ltd.New Delhi.
2. Cushing D.H. (1975) Marine Ecology and Fisheries , Cambridge University Press.
3. Day,F. (1889) The Fauna of British India including Ceylon and Burma. Fishes. 2Vols., Taylor and Francis London.
4. Khanna S.S.(1984) An Introduction to Fishes, Central Book Depot Allahabad.
5. Pandey K and Shukla J.P.(2015) Fish and Fisheries. Rastogi Publications Meerut-250002
6. Sakhare B. Viswas (2007) Applied Fisheries.Daya Publishing House Delhi-110035
7. Santhanam R (1990) Fisheries Science,Daya Publishing House Delhi.
8. SanthanamR,Ramanathan N and Jagatheesan G(1990) Coastal Aquaculture in India,CBS Publishers and distributers,Delhi.
9. Shrivastava C.B.L.(1996) A Text Book of Fishery Science and Indian Fisheries. KitabMahal22 A,S.N.Marg, Allahabad.
10. Singh B.K.(2008) Applied Fisheries and Aquaculture.Swastik Publishers and distributers,Delhi.

REFERENCE BOOKS FOR PRACTICALS:

1. Chandy.M (1970) Fishes,National Book Trust,India,New Delhi.
2. Day.F. (1889) The Fauna of British India including Ceylon and Burma. Fishes. 2Vols.,Taylor and Francis London.
3. R.J.Ranjit Daniels (2002) Freshwater Fishes of Peninsular India, Universities Press (India)Pvt.Ltd. Hyderabad.
4. SakhareViswasB. (2007) Applied Fisheries ,Daya Publishing House Delhi.
5. Sharma U and S.P.Grover (1982) An Introduction to Indian Fisheries,Dehradun India.
6. Srivasava C.B.L.(1986) A Text Book of Fishery Science and Indian Fisheries ,KitabMahal Allahabad.

ELECTIVE COURSE: IMMUNOLOGY	
COURSE CODE:	ZOO-IV.E-7
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	Familiarize students and make them learn about the structural features of the components of the immune system as well as their functions, and understand the mechanisms involved in immune system development and responsiveness.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: • Understand the components of the immune system and their function. • Be able to explain the mechanisms of immune response. • Perform immunoassays to detect the presence of antigens or antibodies(disease detection).

ZOO-IV-E-7: IMMUNOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Introduction To Immunology	1: OVERVIEW OF IMMUNE SYSTEM: • Basic concepts in immunology • Components of the immune system	15
	2: INNATE AND ADAPTIVE IMMUNITY. • Innate immunity-Anatomical barriers/ layers of defense, cells and molecules involved in innate immunity • Adaptive immunity-cell mediated and humoral immunity, passive immunity (artificial and natural), Active(artificial and natural), Immune dysfunction	
MODULE 2: Antigens And Immunoglobulins	3: ANTIGENS. • Antigenicity and immunogenicity, Immunogens, adjuvants and haptens • Factors influencing immunogenicity • B and T cell epitopes	15
	4: IMMUNOGLOBULINS • Structure and function of different classes of Immunoglobulin. • Antigen-Antibody interactions • Immunoassays, monoclonal & polyclonal antibodies	
	5: MAJOR HISTOCOMPATIBILITY COMPLEX. • Structure and function of endogenous and exogenous pathways of antigen presentation	
MODULE 3: Immune Response	6: CYTOKINES AND COMPLEMENT SYSTEM • Properties and functions of cytokines, cytokine based therapies • Components and pathways of complement activation	15
	7: HYPERSENSITIVITIES, AUTOIMMUNITY AND TRANSPLANTATION • Gell and coombs' classification, types of hypersensitivities(overview) • Autoimmune responses against self antigens (SLEs), responses to alloantigens and transplant rejection (graft rejection, types and mechanisms of transplant rejection	
	8: VACCINES • Types of vaccines -inactivated, attenuated, toxoid, subunit, conjugate, experimental (DNA and recombinant vaccine), monovalent/polyvalent vaccines	

PRACTICAL COMPONENT OF ZOO-IV-E-7: IMMUNOLOGY (DURATION -02 hrs/WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1	Preparation of serum from goat blood.	02
2	Slide Agglutination Reaction(blood groups – A / AB / O with Rh)	02
3	Differential count of leukocytes	01
4	Detection of presence of antigen / antibody - Simple immunodiffusion	01
5	Antibody Titre determination - Ouchterlony immunodiffusion	02
5	Antigen –antibody reaction by immunoelectrophoresis	02
6	Elisa TEST- pregnancy test	01
7	Phagocytosis – WBC (demonstration)	01

REFERENCE BOOKS:

Essential books:

1) *Abbas KA, Lechtman HA(2007). Basic Immunology, Updated Edition 2006-2007: with STUDENT CONSULT. Access (Paperback).*
2) *David M, Jonathan B, David RB and Ivan R(2006). Immunology. VII Edition, Mosby, Elsevier Publication.*
3) *Abbas KA, Lechtman HA(2003). Cellular and Molecular Immunology. Saunders Publication.*
4) *Kindt TJ, Goldsby RA, Osborne BA and Kuby J(2006). Immunology. VI edition. W H Freeman and company.*

Ebooks:

5) *Frank SA(2002).Immunology and evolution of infectious diseases. Princeton University Press, Princeton and Oxford.*
6) *Zabriskie JB(2009). Essential Clinical Immunology. Cambridge University Press.*

REFERENCE BOOKS FOR PRACTICALS:

1) *Talwar GP and Gupta SK(2012).A handbook of practical and Clinical Immunology, CBS publishers.*

ELECTIVE COURSE : EVOLUTIONARY BIOLOGY	
COURSE CODE:	ZOO-IV.E-8
MARKS:	100 [75-Theory; 25 –Practicals]
CREDITS:	04[03 – Theory; 01 – Practical
CONTACT HOUR :	Theory : 45 Hours(03 Lec./Week) Practicals: 30 Hours(01Practical/Week)
COURSE OBJECTIVE:	• The study aims to discover the history of life and the causes of the diversity and characteristics of organisms. • To show the important contributions of evolutionary biology to other biological disciplines such as medicine
LEARNING OUTCOME:	• The study will give detail knowledge about many unsolved hypothetical issues to solve it. • The student will learn that evolution is not a speculation , but a thoroughly supported hypothesis that explains the process of evolution

ZOO-IV.E-8: EVOLUTIONARY BIOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1:	**1.1: EVOLUTIONARY BIOLOGY:AN OVERVIEW** • What Is Evolution, History Of Evolutionary Biology, Pre Darwinian, Darwin's Evolutionary Theory, Evolutionary Theories After Darwin • Famous contributions to evolutionary Biology: CarlLinneaus,Lamarck,Malthus,Darwin,Thomas Huxley,R.A.Fisher,Haldane,sewall Wright, G.G.Simpson, Dobzanhasky,Ernst Mayr, M.Kimura. **1.2: THE NATURAL SELECTION:** • Natural Selection: Nature; Postulates;Evidences; Types of natural selection(Stabilizing,Directional and Disruptive selection) • Natural Selection in action(Darwin's finches, Endler's guppies examples); Sexual Selection **1.3: RANDOM PROCESS IN EVOLUTION:** • types of mutation, genetic drift, gene flow(migration/emmigration	15
MODULE 2:	**2.1: NON- DARWINISM** • Neutral theory of evolution • Molecular polymorphism-nucleic acids and proteins, Molecular clocks **2.2: SPECIATION** • Concepts of speciation; Concept Of Biological Speciation(Allopatric/Sympatric); Consequence Of Speciation; Factors involved in Biological Speciation(pre and post- zygotic mechanisms) **2.3: POPULATION GENETICS** • Hardy-Weinberg's Law(H-W); Genes And Genotype Frequencies; Factors Affecting H-W **2.4:ADAPTATIONS :** • Definition and kinds of adaptations with some examples, Pre , Post adaptations ; Coadaptations and Parallel adaptations	15
MODULE 3:	**3.1: PATTERNS OF EVOLUTION:** • Sequential and Convergent Evolution; Microevolution; Macroevolution(Adaptive radiation); Megaevolution; Gradualism And Punctuated Equilibrium **3.2: EVOLUTION AND HUMAN HEALTH AND DISEASES** • Design defects; Defence mechanisms-Allergy,morning sickness; Evolution of antibiotic resistance; Evolution of behaviour,Anxiety,fear and depression.	15

PRACTICAL COMPONENT OF ZOO-IV.E-8: EVOLUTIONARY BIOLOGY (DURATION -02 HRS/WEEK)		
Sr.No.	**Practical**	**No.of Practicals**
1.	Study of homology and analogy from suitable specimens	01
2	Serial homology	01
3	Variations are basis for evolution	01
4	To demonstrate the role of Natural Selection in Fixing Favoured Adaptation and Eliminating Maladaptation.	02
5	Problems based on Population Genetics (PTC /blood group)	04
6.	An exercise to illustrate the concepts of Genetic drift	02
1.	Vestigial organs or Vestiges in animals and humans.	01

REFERENCE BOOKS:

1. Bipin Kumar(2001) Organic Evolution; Campus Books International, New Delhi.
2. Charlotte J. Avers (1989)Process and pattern in Evolution ; New York Oxford University Press.
3. Douglas J. Futuyma(2013) Evolution IIIrd edition; Sinaue Associates,Inc.Publishers Sunderland , Massachusetts U.S.A.
4. E.Peter Volpe(1989) Understanding Evolution Vth edition Universal Book Stall.
5. S.Osawa ,T.Honjo(Eds.)(1991) Evolution of life,Springer-Verlag Tokyo .
6. Savage Jay M (1969) Evolution , Amerind Publishing Co-Pvt. Ltd. New Delhi.
7. Veer Bala Rastogi (2004) Organic Evolution ,Eleventh revised edition; Kedarnath Ramnath Delhi.
8. Pranab K. Banerjee (2011) Problems on Genetics,Molecular Genetics and Evolutionary Genetics, New Central Book Agency (P) Ltd. Delhi

SEMESTER V AND VI

SEMESTER	COURSE CODE	COURSES	CREDITS	CONTACT HOURS
SEMESTER V	ZOO-V.C-7	Developmental Biology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-V.E-9	Molecular Genetics and Forensic Science	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-V.E-11	Basic and Applied Entomology	Theory = 04	Theory = 60
	*ZOO-V.E-12	Fish Preservation and Processing	Theory = 04	Theory = 60
SEMESTER VI	ZOO-VI.C-8	Wildlife Biology	Theory = 04	Theory = 60
	ZOO-VI.E-13	Health and Nutrition	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-VI.E-14	Ecology and Ethology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-VI.E-16	Bio Entrepreneurship	Theory = 04	Theory = 60

SEMESTER V:

CORE COURSE:DEVELOPMENTAL BIOLOGY	
COURSE CODE:	ZOO-V.C-7
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To understand the processes of fertilization, polyspermy and activation of egg metabolism • To know the basics of animal development, specifically in sea urchin and chick • To be familiar with the processes that help in the establishment of basic plan of development
LEARNING OUTCOME:	• At the end of the course, the students will be able to understand the basic plan of animal development. They will be familiar with the processes which occur during the course of development in invertebrates and vertebrates. This paper will provide the basic knowledge of developmental biology.

ZOO-V.C-7: CORE COURSE:DEVELOPMENTAL BIOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Early embryonic development and early development of model organism: sea urchin	1.1: Introduction to cell division: mitosis and meiosis 1.2: Fertilization: structure of the gametes 1.3: Species recognition specificity of egg and sperm 1.4: Gamete fusion and the prevention of polyspermy 1.5: The activation of egg metabolism 1.6: Fusion of the genetic material 1.7: Rearrangement of the egg cytoplasm 1.8: Sea Urchin: cleavage, gastrulation, blastula formation 1.9: Fate maps and the determination of sea urchin blastomeres, gastrulation 1.10: Embryonic stem cells: Pluripotency and tutipotency	15
MODULE 2: Early development of model organism: chick	2.1: Chick: cleavage, gastrulation, primitive streak, epiboly 2.2: Development upto three days of incubation 2.3: Extra embryonic membranes of chick development, structure and functions of yolk sac, amnion, chorion and allantois	15
MODULE 3: Growth and regeneration	3.1: Nuclear transplantations and embryonic inductions 3.2: Size and proportion, aging, theories of ageing, postnatal disorders of growth and differentiation 3.3: Distribution of regenerative capacity, Planarian regeneration, regeneration of limb and tail in vertebrates 3.4: Hejmadi Mohanty’s experiment	15

PRACTICAL COMPONENT OF ZOO-V.C-7 (DURATION -02 HRS /WEEK)		
SR. NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1)	Observation of developmental stages of sea urchin: cleavage, blastula, gastrula (permanent slides)	01
2)	Study of morphogenetic movement *in vivo* in hens egg using vital staining technique by preparing window opening	02
3)	*In vitro* observation of different extra embryonic membrane in a six days old chick embryo	01
4)	Preparation of permanent slides of chick embryo: 24 hours, 36 hours,48 hours, 72 hours	06
5)	Effect of retinoic acid on regeneration of fin in fish	01
6)	Mounting of eye vesicles and limb buds of six day old chick embryo	01

REFERENCE BOOKS:

1. *Gilberts, S.F. (2013). Developmental Biology, Sinauer Associates, Sunderland.*
2. *Jain, P.C. (2013). Elements of developmental biology, Vishal Publications, Jalandhar*
3. *Slack, J.M.W. (2006). Essential developmental biology. Blackwell Publishing, U.K.*

REFERENCE BOOKS FOR PRACTICALS:

1. *Beffa – Mari, M. And J. Knight (2005) Key experiments in practical developmental biology. Cambridge University Press.*
2. *Tyler, M.S. (2000) Developmental biology, a guide for experimental study. Sinauer Associates, Inc. Publishers, Sunderland, MA.*

ELECTIVE COURSE: MOLECULAR GENETICS AND FORENSIC SCIENCE	
COURSE CODE	ZOO-V.E-9
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	This course will ellucidate the functional aspects of the genetic material at molecular level, focusing on gene expression and gene regulation. It will also expose students to the basics of forensic science and understand diagnostic genetics.
LEARNING OUTCOME	Upon successful completion of the course, students will be able to understand: ▪ The process of replication, transcription and translation ▪ Difference between the gene expression in prokaryotes and eukaryotes ▪ Branches of forensic science ▪ The molecular tools used in genetic diagnosis

ZOO-V.E-9: MOLECULAR GENETICS AND FORENSIC SCIENCE		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1 : Gene Expression and Gene Regulation	1.1 : DNA Replication: DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication 1.2: Transcription: transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors 1.3 : Translation: Genetic code, Process of protein synthesis, Difference between prokaryotic and eukaryotic translation, Post Transcriptional Modifications and Processing of Eukaryotic RNA 1.4: Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac-operon and trp-operon; Transcription regulation in eukaryotes: Activators,repressors, enhancers, silencers elements; Gene silencing	15
MODULE 2 : Basics of Forensic Science	2.1 : Definition, overview of Disciplines of Forensic science 2.2: Crime and Crime Scene management: Types of crime scenes – indoor and outdoor. Securing and isolating the crime scene. Crime scene search methods. Safety measures at crime scenes. Legal considerations at crime scenes. Documentation of crime scenes – photography, videography, sketching and recording notes. 2.3: Forms of forensic evidences: -Biological evidence: Bloodstains, hair, semen, DNA -Physical and trace evidence –pattern of blood stains, fingerprints, fibres, weapons - Documents- types of forensic documents (genuine /forged),methods of detecting forged documents(handwriting analysis, Analysis of paper and inks)	15
MODULE 3 : Diagnostic Genetics	3.1 : Cytogenetics/ Molecular Cytogenetics/ Biochemical/ Molecular methods of detecting genetic disorders - Adult and Newborn screening 3.2: Cytogenetics/ Molecular Cytogenetics/ Molecular methods of detecting genetic disorders – Prenatal and Preimplantation screening 3.3: Forensic testing - DNA fingerprinting, paternity testing, personal /individual identification	15

PRACTICAL COMPONENT OF ZOO–V.E-9: MOLECULAR GENETICS AND FORENSIC SCIENCE (DURATION -02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Isolation of DNA from peripheral blood/tissue (chick liver).	01
2	Microscopic examination of Hair a. Human scalp Hair b. Animal Hair	03
3	Sketching and Photography of various type of crime scene.	03
4	Presumptive Tests for Blood a. Phenolphthalin Assay	01
6	To perform ridge tracings and ridge counting	01
7	Analysis of DNA fingerprints	03

REFERENCE BOOKS :

1) *J. Prahlow (2010); Forensic Pathology for Police, Death Investigators, Attorneys, 17 and Forensic Scientists, DOI 10.1007/978-1-59745-404-9_2, C Springer Science + Business Media, LLC (Ebook available)*
2) *Robert Schleif (1993). Genetics and Molecular Biology. S E C O N D E D I T I O N. Department of Biology,The Johns Hopkins University, Baltimore, Maryland. The Johns Hopkins University Press 2715 North Charles Street Baltimore, Maryland 21218-4319, The Johns Hopkins Press Ltd., London (Ebook available)*
3) *Richard Saferstein (2011); Forensic Science,II Edition, Prentice Hall publishers, Sanfrancisco*
4) *Griffith A, Wesseler S, Lewontin R Gelbart W, Suzuki D and Miller J(2000). Introduction to Genetic Analysis. Eigth Edition.(Ebook available)*
5) *Tom Strachan and Read A (2010): Human Molecular Genetics. Fourth Edition. Garland Science Publisher, New York, NY 10017*

REFERENCES BOOKS FOR PRACTICALS:

1) J. Prahlow (2010); Forensic Pathology for Police, Death Investigators, Attorneys, 17 and Forensic Scientists, DOI 10.1007/978-1-59745-404-9_2, C Springer Science+Business Media, LLC (Ebook available.)

ELECTIVE COURSE: ECONOMIC ZOOLOGY	
COURSE CODE	ZOO-V.E-10
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	To study the various aspects of economic zoology To study the species of economic importance, classification To gain an insight whether own business can be started based on studying the zoological species and their products
LEARNING OUTCOME	How zoological species contribute to economic sources can be learned. Students will learn the techniques of rearing and maintenance of the species, harvesting their products and selling of species and the products

ZOO-V.E- 10 : ECONOMIC ZOOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1 : Scope of Economic Zoology	1.1 : Economic Zoology, History, Scope, 1.2 : Species of bionomic importance (Honey bee, Silkworm, lac insect, mackerel, domestic fowl, goat, sheep, cow, buffalo, pig, rats, mice) 1.3 : Source, properties, constituents and nutritive value of products of bionomic importance: eggs of poultry, milk, meat, honey, medicinal value of synthetic insulin (recombinant), significance of wool, silk, lac 1.4 : Organizations and their functions: agricultural and processed food products export development authority (APEDA), the marine products exports developmental authority (MPEDA), central silk board (CSB), central bee research and training institute (CBRTI), pharmaceutical and biotechnology industries (Lupin) and contract research organizations (Intox), and research institutes (NIN, Hyderabad)	15
MODULE 2 : Models in Economic Zoology	2.1 : Insects, products and applications : lac insects, honey bees, silkworms 2.2 : Vermiculture: Rearing and maintenance of earthworms 2.3 : Aquaculture : rearing and maintenance of prawns,oysters, edible and ornamental fishes 2.4 : Poultry : rearing and maintenance of domestic fowl, applications and products 2.5 : Business models of apiculture, sericulture, aquaculture and poultry	15
MODULE 3 : Pharma products and biological control	3.1 : Pharmaceuticals from animals and their Applications (antiserum), from transgenic animals (malaria vaccine, alpha 1 antitrypsin, lactoferrin, fibrinogen) 3.2 : Species used in biological control : *Casnoidea indica*, Trichogramma, *Poecilia reticulata / Gambusia affinis* 3.3 : Maintenance and breeding of animals for research: mice, rats, guinea pigs, rabbits, marmosets, guidelines given by committee for the purpose of control and supervision of experiments on animals (CPCSEA)	15

PRACTICAL COMPONENT OF ZOO-V.E-10 ECONOMIC ZOOLOGY (DURATION - 02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Vermicomposting	05
2	Preparation of dairy products from milk : cheese and butter	02
3	Laboratory observations of insects – Honeybee, Silk moth, Lac insect	01
4	Visit to dairy industry/poultry/ piggery/apiary/silk industry/ biotechnology industry/pharmaceutical industry/research institute	04

REFERENCE BOOKS :

1) *G. S. Shukla, V. B. Upadhyay (2008) Economic Zoology, Rastogi Publications, Meerut*
2) *H. Osborn (1908) Economic Zoology an introductory text book in zoology with special reference to its applications in agriculture, commerce and medicine The Macmillan Company*
3) *K. P. Shrivastava, Gs Dhaliwal (2015) Text Book of Applied Entomology Kalyani Publishers*
4) *P. K. Gupta (2011) Vermicomposting for Sustainable Agriculture, Agrobios India Ltd*
5) *S. Singh (1962) Bee-Keeping in India ICAR New Delhi p. 214*

REFERENCE BOOKS FOR PRACTICALS:

1) *A. K. Tripathi(2009) Mulberry Sericulture: Problems And Prospects Aph Publishing Corporation*
2) *C.L. Metcalf and W.P Flint (1962) Destructive and Useful Insects New York, N.Y. : McGraw-Hill*

ELECTIVE COURSE: BASIC AND APPLIED ENTOMOLOGY	
COURSE CODE	ZOO-VI.E-14
MARKS	100 [75 -Theory; 25- Fieldbased report]
CREDITS	04
CONTACT HOURS	Theory: 45 HOURS [03 Lectures Per Week] Fieldbased work: 15 HOURS.
COURSE OBJECTIVE	• To develop a strong foundation in entomology, including understanding of the importance of insects to the human society. • To review important areas in insect biology such as morphology, physiology, ecology, behaviour, genetics, phylogeny, ontogeny and population biology. • To develop a sufficient background for advanced entomology.
LEARNING OUTCOME	• The students will achieve entrepreneurial opportunities in entomology. • They will gain knowledge on bionomically important insects and their products, insect pests of public health and veterinary importance and their management.

ZOO-VI.E-14: BASIC AND APPLIED ENTOMOLOGY		
MODULE	**TOPIC**	**CONTACT HOURS**
MODULE 1 Fundamentals of Entomology	Unit 1: Class Insecta: • Salient features • Classification of insects up to orders – an overview Unit 2: Morphological studies: • of antenna, wings, legs, Mouth parts Unit 3: Techniques: • Collection of insects • Preservation of insects	15
MODULE 2 Bionomics and control of crop pests and medically important pests	Unit 4: Pest of agricultural importance: • Paddy pests, cashew pests, coconut pests, areca nut pests, stored grain pest, sugarcane pests, vegetable pests, fruit pests (two pests from each of the above) Unit 5: Insects of medicinal importance: • mosquitoes, housefly, sand fly, cockroaches, human lice, bed bug, rat fleas Unit 6:Termites: • social organization, termitaria and termite control measures	15
MODULE 3 Useful insects and pest management	Unit 7: Useful insects: • Honeybees (Apiculture); Mulberry silk worm(sericulture); lac insects (lac culture) Unit 8: Insect pest control methods: • biological, chemical (attractants, pheromones and hormones), Integrated Pest Management (IPM) Unit 9: Role of insects in ecosystem services	15
MODULE 4 Field based Study	<u>Field based study report:</u> • Identification and study of agricultural pests / pest of fruits / vegetables. • Insect collection techniques: light traps, sweep net, Berlese funnel. • Study of insects of college campus dragon fly/ pests of different plants • Visit to ICAR old Goa/ Gov.t of Goa agriculture department/national Malaria research Institute	15

REFERENCE BOOKS:

1) Aitwal, A.S (1993): Agricultural pests of India and South East Asia. Kalyani publication, New Delhi.
2) Awasthi,V.B (2007):Introduction to general and applied entomology ,2nd edition. Scientific publishers India Jodhpur.
3) David, B.V. and Ananthakrishnan, T.N (2006): General and applied entomology, 2nd edition Tata McGraw hill, New Delhi.
4) Reddy,D.S(2010) Applied entomology,2nd edition New Vishal publications

REFERENCE BOOKS FOR PRACTICALS:

1. Fenemore, P.G. and Prakash, A. (1995): Applied Entomology, Wiley Eastern Limited new age international.
2. Varasi, M.S. (1992): Text book of entomology, Himalaya Publishing House, 1st edition.

ELECTIVE COURSE: FISH PRESERVATION AND PROCESSING	
COURSE CODE	ZOO-V.E-12
MARKS	100 [75 -Theory; 25- Fieldbased report]
CREDITS	04
CONTACT HOURS	Theory: 45 HOURS [03 Lectures Per Week] Fieldbased work: 15 HOURS.
COURSE OBJECTIVES	• To familiarize the students with different methods of fish preservation and processing • To acquaint them with techniques and precautions for hygienic fish handling • The course content is locally relevant and prepares students for entrepreneurship and self employment
LEARNING OUTCOME	By the end of the course, the students will be familiar with the economic benefits of fishes. They will also be able to understand the nutritional values of the fishes and to identify some of the fish pathogens

ZOO-V.E- 12 : FISH PRESERVATION AND PROCESSING		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Fishery Development	1.1 : Status of Development of the fishery and seafood processing industry. 1.2: Empowerment through Aquatic Products: (Background,Nutritionalsecurity,Role ofFisheries Fisheries Sector,Role of Tifac in Fisheries Sector,Objectives,Integrated Fisheries Project(IFP),Indian national centre for ocean information services (INCOIS), Catch per unit effort (CPUE), Maximum sustainable yield (MSY	15
MODULE 2: Fish Handling and preservation	2.1: Recent Scenario: Quality Changes and Shelf life of Chilled Fish,Theeffect of Hygiene duringhandling 2.2: Fish Handling Methods: Organoleptic test, Assessment of Fish Quality,Quality assessment of Fresh Fish,Quality Assessment of Fish Products,Physical methods,Assurance of Fresh Fish Quality, Post harvest Changes in Fish,How does a Fish Lose its Quality, fish as vectors of zoonotic diseases 2.3: Fish Preservation: Reasons for Spoilage of Fishes,Methods of Fish.	15
MODULE 3: Value of Fish	3.1:Economic Importance of Fish:Food value,Fish By-Products, surimi, Goan fish para, balchao 3.2: Postmortem changesin Fish,Bacteriological Changes, Lipid Oxidation and Hydrolysis, Chemical Composition,Lipids,Proteins,N- containing Extractives,Vitamins and Minerals, 3.3: Aquatic Resources and their utilization, value added product: chitin	15
MODULE 4 Field based Study	Field Based study: Visit to Fish Processing Centre/ Fishing Co-operative Society / Fishery Institute/Fishery survey of India, Vasco (FSI) to study the following: 1) Quality control of fishes 2) Fish parasites (ecto and endo) 3) Fish filleting, 4) Fish preservation (salting/ pickling)	15

REFERENCE BOOKS :

1) Braj Kishore Singh (2008) Applied Fisheries and Aquaculture Swastik Publishers and Distributers
Delhi,India

2) Pandey and Shukla (2015) Fish and Fisheries, IIIrd Revised Edition, Rastogi Publications Meerut, India

REFERENCE BOOKS FOR PRACTICALS:

1) Braj Kishore Singh (2008) Applied Fisheries and Aquaculture Swastik Publishers and Distributers
Delhi,India

2) Pandey and Shukla (2015) Fish and Fisheries, IIIrd Revised Edition, Rastogi Publications Meerut, India

SEMESTER VI:

CORE COURSE: WILDLIFE BIOLOGY	
COURSE CODE	**ZOO-VI-C-8**
MARKS	100 [75 -Theory; 25- Fieldbased report]
CREDITS	04
CONTACT HOURS	Theory: 45 HOURS [03 Lectures Per Week] Fieldbased work: 15 HOURS.
COURSE OBJECTIVES	This course is designed to enable students to understand the basics of wildlife status, conservation, assessment and management.
LEARNING OUTCOME	Upon successful completion of the course, students will be able to: ▪ Know the techniques used in assessment and monitoring of wildlife. ▪ Know about the diversity, extent, range of wildlife population dynamics.

ZOO-VI-C-8: WILDLIFE BIOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Introduction To Wildlife	UNIT 1: Introduction to wildlife • Values of wildlife - Conservation ethics, Importance of conservation, Causes of depletion, World conservation strategies. UNIT 2: Evaluation and management of wildlife • Habitat analyses, Physical parameters: Topography, Geology, Soil and water. • Biological Parameters: food, cover, forage, browse and ground cover estimation. • Standard evaluation procedures: remote sensing and GIS.	15
MODULE 2: Population Estimation And Protected Areas	UNIT 3: Population estimation • Population density, natality, mortality, fertility schedules and sex ratio computation. • Analysis of scat and dropping of ungulates and carnivores. • Trichotaxonomy, pug marks and census method based on indirect evidences. UNIT 4: Protected areas • Protected Area network (PAN): National parks and wildlife sanctuaries. • Biogeographical features of important features of protected areas in India (any 3). • Tiger conservation - tiger reserves in India, challenges and management of tiger reserves.	15
MODULE 3: Management Of Wildlife	UNIT 5: Management of habitats • Setting back succession, grazing logging, mechanical treatment, advancing the succession process, artificial feeding grounds. • Cover construction, preservation of general genetic diversity, restoration of degraded habitats, UNIT 6: Management planning of wildlife in protected areas • Habitat carrying capacity, visitors carrying capacity, eco tourism / wild life tourism, concept of climax persistence, ecology of perturbance. • Role of national / state statutory bodies on governing wildlife (NBWL, IUCN, CITES, state wildlife boards and forest department). UNIT 8: Management ofcritical population • Radio- telemetry, care of injured and diseased animal, quarantine, common diseases of wild animals, capture and translocation of wildlife. • Captive management – a brief idea.	15

MODULE 4:	Field based study report on:	15
Field based Study	• Study of butterflies and their host plants on the campus / molluscs/ ants/ spiders / birds • Any two biodiversity monitoring by various field techniques for flora and fauna: • Trail / transect-quadrate monitoring for abundance and diversity estimation of mammals and birds (direct and indirect evidences) (on campus or fieldtrip) • Identification of animals through pug marks, hoofmarks, scats, pellet groups, nest, antlers, feathers, etc. • Local case study report of wild life conflict Use of compass, binoculars, spotting scope, range finders, Global Positioning System on field.	

REFERENCE BOOKS:

1. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
2. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence. Cambridge University.
3. Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5^{th} edition. The Wildlife Society, Allen Press.
4. Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences
5. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.

ELECTIVE COURSE: HEALTH AND NUTRITION	
COURSE CODE	**ZOO-VI-E-13**
MARKS	100 [75 –Theory ; 25- Practical]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES	This course is an introduction to the nutrients, their functions and role in maintaining good health of humans.
LEARNING OUTCOME	Upon successful completion of the course, students will be able to: ▪ Know about nutrients and their function ▪ Understand nutritional biochemistry and role of lifestyle and food habits in causing diseases

ZOO-VI-E-13: HEALTH AND NUTRITION		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: BASIC CONCEPT OF FOOD AND NUTRITION	UNIT 1: Overview of health and nutrition • Definition of health and nutrition • Scope of nutrition, food as a source of nutrients • Nutrients and energy • Adequate, optimum and balanced diet • Malnutrition and health. UNIT 2: Nutritional Biochemistry • Carbohydrates, lipids, proteins - definition, classification, structure and properties • Significance of acid value, iodine value and saponification value of lipids • Essential and non-essential amino acids • Enzymes- definition, classification, properties(overview). • Coenzymes, vitamins (fat soluble and water soluble), structure and properties • Minerals- iron, calcium, phosphorus, iodine, selenium and zinc and their properties	**15**
MODULE 2: NUTRIENTS AND DIETARY PATTERN FOR HUMANS	UNIT 3: Functions of food components of food-nutrients • Biochemical role and dietary sources of macro and micronutrients (carbohydrates, lipids and proteins, fat soluble vitamins-A, D, E and K , water soluble vitamins – thiamin, riboflavin, niacin, pyridoxine, folate, vitamin B12 and vitamin - C Minerals – calcium, iron and iodine). • Changes of nutrient value during cooking of the following food groups: cereals, pulses and vegetables. Nutrient loss - dry, moist, frying and microwave cooking. UNIT 4: Nutrition and dietetics • Physiological considerations, nutrient needs and dietary pattern for various groups- adults, pregnant and nursing mothers, infants, pre-school and school children, adolescents and geriatric nutrition.	**15**

<table>
<tr><td>MODULE 3: DIET RELATED DISEASES</td><td>UNIT 5:Health and diseases
• Major nutritional deficiency diseases- protein energy malnutrition, Vitamin deficiency, iron deficiency anaemia, iodine deficiency disorders, their causes, symptoms, treatment, prevention and government programmes, if any.
• Life style related diseases- obesity, hypertension, hyperurecimia, diabetes mellitus, polycystic ovarian disease (PCOD) - their causes and prevention through dietary/lifestyle modifications.
• Social health problems: smoking, alcoholism, drug dependence and Acquired Immune Deficiency Syndrome (AIDS);
• Common ailments- irritable bowel disease (IBD), constipation: causes and dietary management
UNIT 6: Food hygiene
• Potable water- sources and methods of purification at consumer level
• Food and water borne infections: bacterial infection: cholera, typhoid, dysentery; viral infection: hepatitis, poliomyelitis, protozoan infection: Amoebiasis, Giardiasis; Parasitic infection: Taeniasis and Ascariasis their causative agent, symptoms, transmission and prevention.
• Brief account of food spoilage: Causes and preventive measures</td><td>15</td></tr>
</table>

<table>
<tr><th colspan="3">PRACTICAL COMPONENT OF 'HEALTH AND NUTRITION
ZOO-VI-E-13: DURATION (30 HOURS – 02hrs/WEEK)</th></tr>
<tr><th>SR. NO</th><th>PRACTICAL</th><th>NO. OF PRACTICAL S</th></tr>
<tr><td>1.</td><td>To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric</td><td>03</td></tr>
<tr><td>2.</td><td>Estimation of lactose in milk</td><td>02</td></tr>
<tr><td>3.</td><td>Titrametic estimation of:
• Ascorbic acid estimation in food
• Calcium in food</td><td>02</td></tr>
<tr><td>4.</td><td>Observation of any two grain pests</td><td>01</td></tr>
<tr><td>5.</td><td>Project based:
• Identify nutrient rich sources of foods, their seasonal availability and price
• Study of nutrition labeling on selected foods</td><td>04</td></tr>
</table>

REFERENCE BOOKS:

1) Mudambi, SR and Rajagopal, MV. (2007). Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; New Age International Publishers.
2) Srilakshmi B. (2002). Nutrition Science; New Age International (P) Ltd.
3) Srilakshmi B. (2007). Food Science; Fourth Ed; New Age International (P) Ltd.
4) Swaminathan M. (2009). Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.
5) Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; Oxford & IBH
   Publishing Co. Pvt Ltd.
6) Wardlaw GM, Hampl JS. (2007). Perspectives in Nutrition; Seventh Ed; McGraw Hill.
7) Lakra P, Singh MD. (2008). Textbook of Nutrition and Health; First Ed; Academic
   Excellence.

ELECTIVE COURSE: ECOLOGY AND ETHOLOGY	
COURSE CODE	ZOO-V.E-14
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	• To study the distribution of organisms, their interrelations in populations and communities and interactions between biotic and abiotic components • To study impact of anthropogenic activities on ecosystem and study behaviour of organisms under natural conditions
LEARNING OUTCOME	• The student will gain better understanding in ecology and Ethology • This course also has applied value towards conservation of biodiversity and sustainable development.

ZOO-V.E- 11 : ECOLOGY AND ETHOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1 : Basic Ecology	1.1 :Introduction to Ecology : What is Ecology? History of ecology, ecology today, scope of ecology, objective of study,subdivisions of ecology 1.2 : Ecosystem Ecology:kinds of ecosystem,Gaia hypothesis, energy flow within the Ecosystem, food chains, ecological pyramids, ecological niche nutrient and Cycling of trace elements: Cobalt (Co), Molybdenum (Mo) and Lead. 1.3: Population Ecology: survivorship curve and life tables,age distribution,biotic potential of population, growth models, population dispersal, regulation of population, co-operative and disoperative coactions and carrying capacity,predator –prey relationships,symbiosis	
MODULE 2 : Conservation Ecology and Basic Ethology	2.1: Community Ecology:characters of a community, classification of a community,community periodism, community stratification,community succession 2.3:Introduction to Ethology: the history of ethology, types of behavior – instinct and learning,economic and social aspect of behaviour, ethologists and their work – Lorenz, Tinbergen, Goodall, M.K. Chandrashekar, animal behaviour :an evolutionary approach 2.4: Concept of Ethology:stimuluous –response concept,reflexes, innate releasing mechanisms,fixed action pattern,ethogram releaser,motivation or drive with respect to hunger and sexual behaviour	
MODULE 3 : Advanced Ethology	3.1 : Approaches to studying behaviour, methods associated with neurophysiological approach,psychological and ethological approach. 3.2: Pheromones :introduction,types of pheromones,the primer pheromones,the imprinting pheromones 3.3:Hormones: effect of hormones on sexual behaviour,maternal behaviour,territorial marking, learning and memory 3.4:Patterns of behavior :feeding, aggressive and reproductive behavior, biological clocks 3.5:Communication behavior :introduction,communication signals,	

PRACTICAL COMPONENT OF ZOO–V.E-14: ECOLOGY AND ETHOLOGY (DURATION -02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Field Based practicals: • Determination of population density in a natural/ hypothetical community by Quadrats method in intertidal zone. • Report on a visit to National Parks/ Biodiversity Parks/ Wild life sanctuary • Observation of random subjects for understanding human behaviour.	05
2	Study of an aquatic/mangrove ecosystem: Mmeasurement of the area,temperature, turbidity,determination of pH,and dissolved oxygen content (Winkler's method),and free CO_2	03
3	Ethology: • To study the habituation to light stimulus in earthworm/crabs/snails/ spider web • To demonstrate photactic and geotactic responses of the animal provided earthworm/crabs	02
4	Study of Life Tables and plotting of surviourship curves of different types from the hypothetical/real data provided.	02

REFERENCE BOOKS :

1. *Arora, Mohan. P. (2004) : Ecology , Himalaya Publishing House*
2. *Aubrey Manning and stamp Dawkins (1997) : An Introduction to Animal behaviour (fourth edition), Cambridge University Press.*
3. *Dash M. C. (2001) : Fundamental of Ecology , Tata Mc Graw – Hill publishing Company Limited New Delhi*
4. *Felicity Huntingford (1984) : The study of Animal behaviour , Chapman and Hall.*
5. *Hoshang S. Gundevia and Hare Govind Singh (2006) : A Text Book of Animal Behaviour, S. Chand & Company LTD. New Delhi-110055.*
6. *Juneja Kavita (2002) : Ecology , Anmol Publications PVT. LTD. New Delhi-110002 (India)*
7. *Mathur Reena (1994) : Animal Behaviour, Rastogi and Company, Meerut-250002 India.*
8. *Rana, S. V. S.(2003) : Essentials of Ecology and Environmental Science ,Prentice- Hall of India Private Limited , New Delhi-110001*
9. *Ranga, M. M.(2002) : Animal Behaviour Second Enlarged Edition , Agrobios (India)*
10. *Robert A. Wallace (1938) : Animal Behaviour Its Development, Ecology and Evolution , Goodyear Publishing Company, Inc. Santa Monica, California.*
11. *Sharma P.D.(2014-15) : Ecology and Environment, Rastogi Publications. Meerut (12th revised edition) -25002.*
12. *W.H. Thorpe (1979) : The Origins and rise of Ethology, Praeger Publishers.*

ELECTIVE COURSE: LABORATORY TECHNIQUES IN PATHOLOGY	
COURSE CODE	ZOO-VI.E-15
MARKS	100 [75 –Theory; 25- Practical]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC / WEEK) PRACTICAL: 30 HOURS (01 PRACTICAL / WEEK)
COURSE OBJECTIVES	This course is an introduction to the various techniques used in pathological diagnosis.
LEARNING OUTCOME	Upon successful completion of the course, students will be able to: ▪ Know the tests done for disease detection of various body fluids and tissues. ▪ Understand the clinical implication of the pathological tests.

ZOO-VI.E-15: LABORATORY TECHNIQUES IN PATHOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Blood Analysis	UNIT 1: Introduction to medical lab techniques and its importance UNIT 2: : Analyses of human Blood: • Ways of obtaining blood samples, precautions and complications. • Methods of estimation and clinical significance of: hemoglobin, Packed Cell Volume (PCV), RBC count, WBC count, Complete Blood Count (CBC), platelets, Erythrocyte Sedimentary Rate (ESR), Differential Leucocyte Count (DLC).	15
MODULE 2: Evaluation Of Excretory Material And Gametes	UNIT 3:.Urine Analyses • Physical characteristics, preservation of urine sample • Gross examination, chemical examination, abnormal constituents and its clinical implications. • Microscopy of urinary sediments UNIT 4: Stool Analyses • Stool tests for protozoan parasites and helminth eggs. • Clinical significance. UNIT 5: Semen analyses: • Constituents of semen • Gross and microscopic, cytochemical examination, clinical implications.	15
MODULE 3: Liver Function Cytology Imaging	UNIT 6: Clinical status of liver function - • Function of liver. • Tests of excretion by liver, evaluation of synthesis in liver, evaluation of enzyme activity. UNIT 7: Clinical cytological studies • Fine Needle Aspiration Cytology (FNAC), Ultrasound guided FNAC, aspiration of intra thoracic masses, • Techniques of preparing cell smears, staining techniques UNIT 8: Medical imaging • X-Ray, PET, CT Scan, MRI, Dexa Scan, Ultrasound, Doppler's Test (using photographs/reports etc).	15

PRACTICAL COMPONENT OF: LABORATORY TECHNIQUES IN PATHOLOGY ZOO-VI.E-15 - (30 HOURS – 02hrs/WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1.	Preparation of blood smears and staining techniques (Leishman's staining, Giemsa staining, Field's staining).	02
2.	Use of different types of anticoagulants, obtaining serum from blood, preparation of cell suspension (blood cells).	01
3.	RBC Count, WBC Count, Differential WBC Count	03
4.	Urine analysis – normal and abnormal constituents	02
5.	Blood sugar estimation using glucometer	01
6.	Estimation of hemoglobin (Sahli's method)	01
7.	Estimation of PCV	01
8.	Estimation of ESR (Wintrobe's / Westergreen method)	01

REFERENCE BOOKS:

1. Sood R (1999). Medical laboratory techniques, Jaypee publishers, New Delhi.
2. Park, K. (2007), Preventive and Social Medicine, B.B. Publishers
3. Godkar P.B. and Godkar D.P (2007). Textbook of Medical Laboratory Technology, II Edition, Bhalani Publishing House.
4. Cheesbrough M (2002)., A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses
5. Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd. New Delhi.

ELECTIVE COURSE: BIOENTREPRENEURSHIP	
COURSE CODE	ZOO-VI.E- 16
MARKS	100 [75 -Theory; 25- Fieldbased report]
CREDITS	04
CONTACT HOURS	Theory: 45 HOURS [03 Lectures Per Week] Fieldbased work: 15 HOURS.
COURSE OBJECTIVES	• To help students recognize the opportunities of enterprises in the field of life sciences • To encourage students to think independently and explore new vistas • To familiarise them with the basic skills required for a start-up
LEARNING OUTCOME	At the end of the course, • Students will be exposed to various opportunities available in life science for start-ups. • They will be familiar with the methodologies and regulations required to start an enterprise. • It will also help the student to develop independent thinking skill required at the time of crucial decision making.

ZOO-VI.E- 16: BIOENTREPRENEURSHIP		
UNIT	**TOPICS**	**CONTACT HOURS**
MODULE 1: Entrepreneurship Development	Unit 1: Introduction to entrepreneurship: • entrepreneurial competencies and goal setting, bio entrepreneurship, building a bio-enterprise : balance management, capital, technology Unit 2: Introduction to innovation: • identifying business opportunities Unit 3: Raising funds: public and private	15
MODULE 2: Business plan And Guidelines and regulations for entrepreneurship in life sciences	Unit 4: Business model canvas Unit 5: Guidelines and regulations: • Certification and licensing, acts, regulations and guidelines, marketing and export process, accessing university technology, research and development agencies in India Unit 6:Role of micro, medium and small scale industry sector Unit 7: Innovations in research: writing project proposals to various funding bodies such as MHRD, UGC, DST, DBT, etc.	15
MODULE 3: Start -up, quality, safety and procedural compliances in a bio enterprise	Unit 8: Intellectual Property Rights and trademark of biological resources Unit 9: quality, safety and procedural compliances • Bio safety and its implementations • Quality control in entrepreneurship • WHO Guidelines for setting up of a contract research organization. • Starting a research laboratory in India – guidelines and permits required	15
MODULE 4: Field and project based component	Field and project based component: -Lateral thinking and testing entrepreneurial competencies of the students - Interactions with successful entrepreneur, Banker/ Angel Investor / workshops on entrepreneurship. - Visit to a bio-startup/ Formulating and presenting Business model	15

REFERENCES:

1. Garg, M.C. (2015) Entrepreneurial development. Guset User.
2. Kolchinsky, P. (2004) The entrepreneurs guide to a biotech startup. 4th edition. www.evelexa.com

Additional reading:

1. Simon, S. 2009. Start with why: How great leaders inspire everyone to take action. Penguin Group (USA) Inc .
2. Welch, J. and Byrne, J.A. 2003. Straight from the gut. Business plus publishers.

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PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
(Autonomous)
PROGRAMME BSC ZOOLOGY

UG Curriculum:

1) **Skill Enhancement Course (SEC):**

WASTE MANAGEMENT TECHNIQUES ZOO-III-E-04 (Elective) ZOO-III-SE-1: SKILL ENHANCEMENT COURSE:	
COURSE CODE	Elective: ZOO-III.E- 4 Skill Enhancement Course(SEC): ZOO-III-SE-1
MARKS	100 [25 -Theory; 75- Practice Based]
CREDITS	04
CONTACT HOURS	Theory: 15 HOURS [01 Lectures Per Week] Practice based: 45 HOURS.
COURSE OBJECTIVES	• To familiarize students with the techniques of waste management. • To encourage students to get hands on experience on techniques of managing waste. • To help students understand the importance of reducing, reusing and recycling
COURSE OUTCOME	CO1: Understand concept of types of waste, its transport and disposal. CO2: Perform composting techniques / procedures. CO3: Identify means of reducing waste production. CO4: Plan and conduct research in areas of waste management

ZOO-III-E-04 /ZOO-III-SE-1: WASTE MANAGEMENT TECHNIQUES (SE- As Skill Enhancement Course)		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Introduction to waste management	UNIT 1: Overview of types of waste, collection, transport, treatment and disposal of waste. UNIT 2: Waste generated- sources, and management, Storage and collection of different kinds of wastes. UNIT 3: Need for Waste management and effect on the community. UNIT 4: Waste treatment methods: Physicochemical Treatment of Solid and Hazardous Waste, Chemical treatment processes, Biological Treatment of Solid and Hazardous Waste, 3 Rs- Reuse Reduce and Recycle.	05
MODULE 2: Composting Techniques	UNIT 5: Soil structure and its maintenance. UNIT 6: Organic composting- Methods, Procedure - Microorganisms, materials used, design and maintenance, Biogas. UNIT 7: Vermicomposting- Earthworms – biology- life cycle and feeding. Types – morphological and ecological grouping – Epigeic, Anecic and Endogeic species, Nutrient value of worm cast/vermicompost, requirements of vermicomposting. Maintenance of composting – Collection of vermicompost Small Scale Earthworm farming for home gardens. Marketing the products of vermiculture. Predator/pathogen control.	05
MODULE 3: Waste management Techniques and Rules	UNIT 8: Sewage disposal; Medical waste management. Sources, measures and health effects; disposal options UNIT 9: Bioremediation, ground water contamination and remediation Landfill designing and Incineration. UNIT 10: Radioactive and E- waste management-Sources, measures and health effects. UNIT 11: Relevant Regulations- • Municipal solid waste (management and handling) rules (SWM 2000 and amendments of 2016: SO.1357 (E) Sec. 3(II). • Hazardous waste (management and handling) rules 2015(Chapter II and IV; Schedule I,II,III and IV). • Biomedical waste handling rules 2016 (GSPCB – Schedule I and II). • Plastic waste management rules 2016 (Part-II, Section-3, Sub-section (i)])	05
MODULE 4: PRACTICE BASED	Practice of the following: The students of this course are expected to work on these different waste management practice activities: 1) Leaf composting on campus 2) Vermicomposting 3) Awareness on waste segregation. 4) Waste collection Drives. 5) Research on waste management. 6) Case studies/ mini projects. The report of the same will be submitted as portfolio.	45

REFERENCE BOOKS:

1. *Edwards CA, Hendrix P and Arancon N (2014) Biology and Ecology of Earthworms, Springer Publishers.*
2. *Karaca A (2011) Soil Biology: Biology of Earthworms. Springer Publishers.*
3. *Edwards CA, Arancon NQ and Sherman RL (2011) Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management, CRC Press, USA.*
4. *Ranganathan LS (2006) Vermibiotechnology– From Soil Health to Human Health. Agrobios, India.*
5. *Ismail SA (2005) The Earthworm Book. Edition, Other India Press, Apusa, Goa, India.*
6. *Ismail SA (1997) Vermicology: The Biology of Earthworms. Orient Longman, India.*
7. *A. D.Bhide and B.B.Sundaresan, "Solid Waste Management –Collection, Processing and disposal" Mudrashilpa Offset Printers, Nagpur, 2001.*
8. *Biomedical waste (Management and Handling) Rules, 1998.*

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2) Skill Enhancement Course (SEC):

ELECTIVE COURSE / SKILL ENHANCEMENT COURSE: BIOENTREPRENEURSHIP	
COURSE CODE	Elective: ZOO-VI.E- 16 Skill Enhancement Course(SEC): ZOO-VI-SE-2
MARKS	100 [25 -Theory; 75- Practice Based]
CREDITS	04
CONTACT HOURS	Theory: 15 HOURS [01 Lectures Per Week] Practise based: 45 HOURS.
COURSE OBJECTIVES	• To help students recognize the opportunities of enterprises in the field of life sciences • To encourage students to think independently and explore new vistas • To familiarize them with the basic skills required for a start-up
COURSE OUTCOME	CO1: Understand concept of business Proposals CO2: Familiar with the methodologies and regulations required to start an enterprise CO3: Identify opportunities available in life science for start-ups. CO4: Generate Ideas and initiate a Business Plan.

ZOO-VI.E- 16/ ZOO-VI-SE-2 : BIOENTREPRENEURSHIP		
UNIT	**TOPICS**	**CONTACT HOURS**
MODULE 1: Introduction to Entrepreneurship	Unit 1: Introduction to entrepreneurship: Entrepreneurial competencies and goal setting, bio entrepreneurship, building a bio-enterprise : balance management, capital, technology Unit 2: Introduction to innovation: • identifying business opportunities Unit 3: Raising funds: public and private	05
MODULE 2: Business plan and Guidelines for entrepreneurship	Unit 4: Business model canvas Unit 5: Guidelines and regulations: Certification and licensing, acts, regulations and guidelines, marketing and export process, accessing university technology, research and development agencies in India Unit 6:Role of micro, medium and small scale industry sector	05
MODULE 3: Start -up, quality, safety and procedural compliances in a bio enterprise	Unit 7: Intellectual Property Rights and trademark of biological resources Unit 8: quality, safety and procedural compliances • Bio safety and its implementations • Quality control in entrepreneurship • WHO Guidelines for setting up of a contract research organization. • Starting a research laboratory in India – guidelines and permits required	05
MODULE 4: Practice based component	**Practice based component:** 1. Lateral thinking and testing entrepreneurial 2. Activities : 1. Brainstorming in Group / market investigation to initiate business ideas for biologists. 2. Preparing Business proposal sketch. 3. Financial Planning. 4. Identifying investors. 5. Developing marketing strategies. 6. Interactions with successful entrepreneur, Banker/ Angel Investors/ Visit to a bio-startup. 7. Formulating and presenting Business model. 8. Preparation of final Business execution plan. 9. Submission of the learning process and outcome as Portfolio.	45

REFERENCES:

1. Garg, M.C. (2015) Entrepreneurial development. Guset User.
2. Kolchinsky, P. (2004) The entrepreneurs guide to a biotech startup. 4^{th} edition. www.evelexa.com

Additional reading:

1. Simon, S. 2009. Start with why: How great leaders inspire everyone to take action. Penguin Group (USA) Inc .
2. Welch, J. and Byrne, J.A. 2003. Straight from the gut. Business plus publishers.

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3) As Generic Elective

ELECTIVE COURSE/ GENERIC ELECTIVE: HEALTH AND NUTRITION	
COURSE CODE	**Elective courses: ZOO-VI-E-13** **Generic Elective: ZOO-VI-GE-1**
MARKS	100
CREDITS	04
CONTACT HOURS	THEORY : 60 HOURS (04 LEC/WEEK)
COURSE OBJECTIVES	This course is an introduction to the nutrients, their functions and role in maintaining good health of humans.
COURSE OUTCOME	CO1: Know about nutrients and their function CO2: Read and interprete food labels. CO3: Correlate role of lifestyle and food habits in causing diseases. CO4: Prepare Diet Plans for different age group individuals.

***ZOO-VI-GE-1:HEALTH AND NUTRITION**
(As Generic elective to students of other discipline)

MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: BASIC CONCEPT OF FOOD AND NUTRITION	UNIT 1: Overview of health and nutrition • Definition of health and nutrition • Scope of nutrition, food as a source of nutrients • Nutrients and energy, principles of meal planning • Adequate, optimum and balanced diet • Malnutrition and health. UNIT 2: Nutritional Biochemistry (Overview) • Carbohydrates, lipids, proteins - definition, classification, structure and properties • Significance of acid value, iodine value and saponification value of lipids • Essential and non-essential amino acids • Enzymes- definition, classification, properties (overview). • Coenzymes, vitamins (fat soluble and water soluble), structure and properties • Minerals- iron, calcium, phosphorus, iodine, selenium and zinc and their properties	**15**
MODULE 2: ROLE OF NUTRIENTS AND CHANGES IN NUTRIENT VALUES	UNIT 3: Functions of food components of food-nutrients • Overview of the Vitamins and minerals - dietary sources of macro and micronutrients. UNIT 4: Changes in nutrient values • Changes of nutrient value during cooking of the following food groups: cereals, pulses, vegetables and meats. • Methods of cooking and Nutrient loss - dry, moist, frying and microwave cooking. Canning of food.	**15**
MODULE 3: DIETARY PATTERN FOR HUMANS	UNIT 5: Nutrition and dietetics Physiological considerations, nutrient needs and dietary pattern for various groups- adults, pregnant and nursing mothers, infants, pre-school and school children, adolescents and geriatric nutrition. UNIT 6: Food based dietary guidelines, enhancing the nutritional quality of the diet, nutritional labeling.	**15**

MODULE 4: HEALTH AND DISEASES	UNIT 7: Major nutritional deficiency diseases- Protein energy malnutrition, Vitamin deficiency, iron deficiency anaemia, iodine deficiency disorders, their causes, symptoms, treatment, prevention and government programmes, if any. UNIT 8: Life style related diseases- obesity, hypertension, hyperurecimia, diabetes mellitus, polycystic ovarian disease (PCOD) - their causes and prevention through dietary/lifestyle modifications. UNIT 9: Food hygiene: Potable water- sources and methods of purification at consumer level. Brief account of food spoilage: Causes and preventive measures.	**15**

Pedagogy: 20 hrs group activities / research based activities to be assigned to students from the list given below:

1) Activity based:

a. Identify nutrient rich sources of foods, their seasonal availability and price.
b. Comparative Study of nutrition labels of selected foods (Oils, Juices, Jams, Butter, Noodles, Flour, Ghee, Biscuits, Chocolates)
c. Comparison of food labels of special diets with other products (Juices for diabetic patients, low carb soft drinks, Oils for health heart, sugar free Biscuits /Cornflakes).
d. Preparation of Diet Plans (Infants, Child, adolescents, lactating mothers, Aged, Sportsperson).

2) Research Based:

e. Survey of Common diet related problems on campus/locality: Obesity, Anaemia, Vitamin deficiency.

REFERENCE BOOKS:

1) *Mudambi, SR and Rajagopal, MV. (2007). Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; New Age International Publishers.*
2) *Srilakshmi B. (2002). Nutrition Science; New Age International (P) Ltd.*
3) *Srilakshmi B. (2007). Food Science; Fourth Ed; New Age International (P) Ltd.*
4) *Swaminathan M. (2009). Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.*
5) *Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; Oxford & IBH Publishing Co. Pvt Ltd.*
6) *Wardlaw GM, Hampl JS. (2007). Perspectives in Nutrition; Seventh Ed; McGraw Hill.*
7) *Lakra P, Singh MD. (2008). Textbook of Nutrition and Health; First Ed; Academic Excellence.*

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PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE(Autonomous)
DEPARTMENT OF ZOOLOGY
COURSE STRUCTURE: PROGRAMME BSC ZOOLOGY (4th Revision w.e.f June 2019)

SEMESTER	CORE COURSES		ELECTIVE COURSES			
I	**ZOO-I.C-1** Animal Diversity : Non Chordates	**ZOO-I.C-2** Cell and Molecular Biology	--------	--------	--------	--------
II	**ZOO-II.C-3** Diversity and Biological Systems of Chordates	**ZOO-II.C-4** Fundamentals of Animal and Human Genetics	--------	--------	--------	--------
III	**ZOO-III.C-5** Human Physiology		**ZOO-III.E-1** Vertebrate Endocrinology	**ZOO-III.E-2** Basic microbiology and Fundamentals of Animal Biotechnology	**ZOO-III.E-3** Environmental Toxicology	**ZOO-III.E-4/** ** **ZOO-III.SE-1** Waste Management Techniques
IV	**ZOO-IV.C-6** Biochemistry and Metabolic Regulation		**ZOO-IV.E-5** Animal cell culture and Applications	**ZOO-IV.E-6** Aquaculture and Fisheries	**ZOO-IV.E-7** Immunology	**ZOO-IV.E-8** Parasitology
V	**ZOO-V.C-7** Developmental Biology		**ZOO-V.E-9** Molecular Genetics and Forensic Science	**ZOO-V.E-10** Economic Zoology	**ZOO-VI.E-11** Basic and Applied Entomology	**ZOO-V.E-12** Fish Preservation and Processing
VI	**ZOO-VI.C-8** Wildlife Biology		**ZOO-VI.E-13** Health and Nutrition ***ZOO-VI.GE-1** Health and Nutrition	**ZOO-V.E-14** Ecology and Ethology	**ZOO-VI.E-15** Laboratory Techniques in Pathology	**ZOO-VI.E-16/** ** **ZOO-III.SE-2** Bio Entrepreneurship
***Generic Elective(GE) / ** Skill Enhancement (SE) courses**						

Parvatibai Chowgule College of Arts and Science
Autonomous

Accredited by NAAC with Grade 'A' (CGPA Score 3.41 on a 4 Point Scale)
Best affiliated College-Goa University Silver Jubilee Year Award

DEPARTMENT OF ZOOLOGY
PROGRAMME BSC ZOOLOGY

SWAYAM COURSES APPROVED BY THE BOS AS EXTRA CREDIT COURSES FROM JUNE 2020

<table>
<tr><th>Sr No</th><th>Semester</th><th>Course Title</th><th>Topic</th><th>In lieu/ extra credit</th></tr>
<tr><td>1</td><td>II</td><td>Genetic and genomics</td><td>Entire syllabus</td><td>Extra credit</td></tr>
<tr><td>2</td><td>III</td><td>Fundamentals of biotechnology</td><td>Entire syllabus</td><td>Extra credit</td></tr>
<tr><td>3</td><td>IV</td><td>Tissue engineering</td><td>Entire syllabus</td><td>Extra credit</td></tr>
<tr><td>4</td><td>IV</td><td>Cell culture technology</td><td>Entire syllabus</td><td>Extra credit</td></tr>
<tr><td>5</td><td>III/IV- SEC</td><td>Municipal waste management</td><td>Entire syllabus</td><td>Extra credit</td></tr>
<tr><td>6</td><td>VI</td><td>Applied Entomology</td><td>Entire syllabus</td><td>Extra credit</td></tr>
<tr><td>7</td><td>IV</td><td>Evolutionary Biology</td><td>Entire syllabus</td><td>Extra credit</td></tr>
<tr><td>8</td><td>VI</td><td>Diet Mangament In Health And Disease</td><td>Entire syllabus</td><td>Extra credit</td></tr>
<tr><td>9</td><td>VI</td><td>Business studies</td><td>Module 2</td><td rowspan="2">May be considered as one CA (continuous assessment) for ZOO-VI.E-16 Bioentrepreneurship</td></tr>
<tr><td>10</td><td>VI</td><td>Senior secondary (Business studies)</td><td>Module 2</td></tr>
</table>

Dr. Nandini Vaz Fernandes
HOD Zoology

COURSE CURRICULUM

OF

PROGRAMME BSC ZOOLOGY

(Revised w.e.f: June 2020)

OF

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
(Autonomous)

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
(Autonomous)
PROGRAMME BSC ZOOLOGY
COURSE CURRICULUM (Revised w.e.f: June 2020)

COURSE STRUCTURE: PROGRAMME BSC ZOOLOGY						
SEMESTER	**CORE**		**ELECTIVE**			
I	**ZOO-I.C-1** Animal Diversity : Non Chordates	**ZOO-I.C-2** Cell and Molecular Biology	--------	--------	--------	--------
II	**ZOO-II.C-3** Diversity and Biological Systems of Chordates	**ZOO-II.C-4** Fundamentals of Animal and Human Genetics	--------	--------	--------	--------
III	**ZOO-III.C-5** Human Physiology		**ZOO-III.E-1** Vertebrate Endocrinology	**ZOO-III.E-2** Basic microbiology and Fundamentals of Animal Biotechnology	**ZOO-III.E-3** Environmental Toxicology	**ZOO-III.E-4** /****ZOO-III-SE-1** Waste Management techniques (Sem III & IV)
IV	**ZOO-IV.C-6** Biochemistry and Metabolic Regulation		**ZOO-IV.E-5** Animal cell culture and Applications	**ZOO-IV.E-6** Aquaculture and Fisheries	**ZOO-IV.E-7** Immunology	**ZOO-IV.E-8** Evolutionary Biology
V	**ZOO-V.C-7** Developmental Biology		**ZOO-V.E-9** Molecular Genetics and Forensic Science	**ZOO-V.E-10** Economic Zoology	**ZOO-VI.E-11** Basic and Applied Entomology	**ZOO-V.E-12** Fish Preservation and Processing
VI	**ZOO-VI.C-8** Wildlife Biology		**ZOO-VI.E-13** Health and Nutrition ***ZOO-VI-GE-1** Health and Nutrition	**ZOO-V.E-14** Ecology and Ethology	**ZOO-VI.E-15** Laboratory Techniques in Pathology	**ZOO-VI.E-16** / ****ZOO-IV-SE-2** Bio Entrepreneurship

SEMESTER I and II

SEMESTER	COURSE CODE	CORE COURSES	NUMBER OF CREDITS	CONTACT HOURS
Semester I	ZOO-I.C-1	Animal Diversity : Non Chordates	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-I.C-2	Cell and Molecular Biology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
Semester II	ZOO-II.C-3	Diversity and Biological Systems of Chordates	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-II.C-4	Fundamentals of Animal and Human Genetics	Theory = 03 Practicals =01	Theory = 45 Practicals =30

SEMESTER I

CORE COURSE : ANIMAL DIVERSITY: NON CHORDATES	
COURSE CODE:	ZOO-I.C-1
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To be familiar with the different non-chordate phyla. • To know the general and distinguishing characters of each of them. • To study how the different systems evolved in their complexity. • To compare and contrasts the life processes in different phyla.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: • CO1: Be familiar with identification of the non-chordates from chordates. • CO2: Identify the invertebrates and classify them upto the class level. • CO3: Understand the basis of life processes in the non-chordates. • CO4: Able to appreciate the process of evolution and understand how it progressed from simple, unicellular cells to complex, multicellular organisms.

ZOO-I.C-1: ANIMAL DIVERSITY: NON CHORDATES		
MODULE	**TOPICS**	**CONTACT HOURS**
Module 1: Evolution of Animal Diversity and Diversity of lower non chordates	• Non chordate evolution and diversity • Taxonomy and phylogeny of animals • Invertebrate cladogram • Protista Classification and general characters upto class for the following phyla: • Porifera • Cnidaria • Platyhelminthes • Aschelminthes • Annelida	15
Module 2: Diversity of higher Non Chordates	Classification and general characters upto class for the following phyla: • Onycophora • Arthropoda • Mollusca • Echinodermata • Hemichordata	15
Module 3: Biological systems of Non Chordates 2	• Comparison of life processes such as nutrition, sensory and neural control and coordination, blood vascular system, exoskeleton, endoskeleton, locomotion and muscular system, respiration, excretion, reproduction and development of phylum Porifera to Hemichordata.	15

PRACTICAL COMPONENT OF ZOO-I.C-1: ANIMAL DIVERSITY: NON CHORDATES (DURATION -02 HRS /WEEK)		
Sr. No	Practical	No. of Practicals
1.	Identification of organisms from phylum protozoa to phylum Hemichordata	06
2.	Observation of permanent slides	03
3.	Mountings: Cockroach mouth parts, prawn appendages	02
4.	Field trip to terrestrial environment to study the invertebrates in their natural habitats	01

REFERENCE BOOKS:
1. Barnes R.D. (2000). Invertebrate Zoology.Hall Saunders International Edition, London.
2. Barrington E.J.W. 1979. Invertebrate structure and Function.John Wiley and Sons Inc.
3. Jordan, E. L. and Verma, P.S. (2000). Invertebrate Zoology. S. Chand & Co. Pvt. Ltd. New Delhi.
4. Marshall A.J.and W.D. Williams. 1974. Textbook of Zoology. Macmillan.
5. Pechenik J.A.(2002). Biology of the invertebrates. Tata McGraw hill Publishing company limited, New Delhi .

REFERENCE BOOKS FOR PRACTICALS:
1) Ziser. W.S (2014) Biology 1413 Introductory Zoology Lab Manual.Morton Publishing Co. Austin Community College.
2) Lal S.S. (2004) A textbook of practical zoology vertebrate. Rastogi publications, Meerut India.

CORE COURSE : CELL AND MOLECULAR BIOLOGY	
COURSE CODE:	ZOO-I.C-2
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• This course will give firm and rigorous foundation in the principles of modern molecular and cellular biology. • It discusses the fundamental processes that enable cells to grow, move and communicate and will cover topics such as cell architecture, cell chemistry, cell division, functions and cell cycle. • Students will also learn current molecular biological techniques that are used to study cell biology. • Laboratories will focus both on exercises that help illustrate cellular phenomena, as well as on the introduction of techniques and procedures commonly utilized in modern cell and molecular biology research.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: • CO1: Have an understanding of cell, it's organelles and their function. • CO2: Demonstrate deeper understanding of what 'life is and how it functions at cellular level. • CO3: Contrast cellular membrane structure and function, fine structure and function of cell organelles. • CO4: Perform a variety of molecular and cellular biology techniques.

<table>
<tr><th colspan="3">Z00-I.C-2 : CELL AND MOLECULAR BIOLOGY</th></tr>
<tr><th>MODULE</th><th>TOPICS</th><th>CONTACT HOURS</th></tr>
<tr><td rowspan="4">MODULE 1: TECHNIQUES OF CELL STUDY AND CELL CHEMISTRY (15 Hrs)</td><td>Unit 1: MICROSCOPY
• Light Microscopy
• Electron Microscopy.</td><td rowspan="4">15</td></tr>
<tr><td>Unit 2: CELL STUDY METHODS
• Cell Fractionation, Chromatography and electrophoresis.</td></tr>
<tr><td>Unit 3: MOLECULES IN CELL.
• Micromolecules in cells: Sugars, Fatty acids, aminoacids, Nucleotides.
• Macromolecules in cells: Nucleic acids, proteins, Polysaccharides, glycogen, fats.</td></tr>
<tr><td>Unit 4: CHEMICAL BONDS IN BIOMOLECULES
• covalent bonds, ionic bonds, noncovalent interactions</td></tr>
<tr><td rowspan="3">MODULE 2: CELL ARCHITECTURE (15 Hrs)</td><td>Unit 5: MEMBRANE STRUCTURE AND MEMBRANE PROTEINS
• lipid bilayer – composition and structural organization (amphipathic phospholipids, Fluidity of cell membrane)
• Membrane Proteins –structure and function (transmembrane proteins, peripheral membrane proteins)
• Phospholipids, sphingolipids, Cholesterol in cell membrane.</td><td rowspan="3">15</td></tr>
<tr><td>Unit 6: MOLECULAR STRUCTURE AND FUNCTION
• Plasma Membrane
• Cell matrix: Physical nature and Properties.
• Nucleus: Ultra Structure and function
• Mitochondria: Ultra Structure and functions
• Endoplasmic Reticulum: ultra structure, modifications, functions</td></tr>
<tr><td>UNIT 7: MOLECULAR STRUCTURE AND FUNCTION
• Golgi Complex, Ribosomes, Microsomes, Cytoskeleton</td></tr>
<tr><td rowspan="2">MODULE 3: CELLULAR TRANSPORT OF PROTEINS AND VESICLES (15 Hrs)</td><td>Unit 8: TRANSPORT ACROSS CELLL MEMBRANES
• Principle of transmembrane transport (transporters and channels, active and passive transport, osmosis)
• Transporters and their function- passive transporters, Pumps (Na^+, K^+, Ca)
• Ion Channels - ion channels activities, regulation of opening and closing of channels.
• Protein transport into organelles (nucleus, mitochondria,ER).</td><td rowspan="2">15</td></tr>
<tr><td>Unit 9: VESICULAR TRANSPORT.
• Vesicular transport – transport of soluble proteins, vesicle budding, vesicle docking, endocytic pathways.</td></tr>
</table>

PRACTICAL COMPONENT OF ZOO-I.C-2: CELL AND MOLECULAR BIOLOGY (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1)	Introduction to Lab techniques – Pipetting, preparation of buffers and solutions, Lab equipments (use and maintenance), acquaintance with general laboratory practices	02
2)	Cytochemistry: Localisation of Proteins, Carbohydrates & fats using different stains.	03
3)	Comparison of membrane permeability – Cellophane and Chick intestine.	02
4)	Osmotic studies – Using Human Red blood cells.	01
5)	Permament slides: - Mitotic stages - Meiotic stages (mounting from grasshopper testes) - Histology - Study of different cell types (animal cells)	03
6)	Technique of Agarose gel electrophoresis (Observation of technique)	01

REFERENCE BOOKS:

Essential books:

1) *Alberts B, Hopkins, Lewis J, Raff M, Robertis K, Walter P (2014): Essential Cell Biology, Fourth Edition, Graland Science Taylor & Francis Group, UK.*
2) *Lodish H, Berk A, Kaiser CA, Krienger M, Scott MP, Anthony, Bretscher A, Amon A. Scott MP (2013): Molecular Cell Biology, Seventh Edition, W. H. Freeman and Company New York.*

Supplementary Reading:

3) *Gupta PK (2003): Cell and Molecular Biology, Second Edition, Rakesh Kumar Rastogi for Rastogi Publications, Meerut, New Delhi, India.*
4) *Verma PS and Agarwal VK (2007): Cell Biology Genetics Molecular Biology Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.*

REFERENCE BOOKS FOR PRACTICALS:

1) *Alberts B, Hopkins, Lewis J, Raff M, Robertis K, Walter P (2014): Essential Cell Biology, Fourth Edition, Graland Science Taylor & Francis Group, UK.*
2) *Bolsover SR, Shephard EA, Hugh AW, Hyams JS (2011): Cell Biology, Third Edition, Wiley Blackwell, A John Wiley & Sons, Inc., Publications.*
3) *Verma PS and Agarwal VK (2007): Cell Biology Genetics Molecular Biology Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.*

SEMESTER – II

CORE COURSE: DIVERSITY AND BIOLOGICAL SYSTEMS OF CHORDATES	
COURSE CODE:	ZOO-II.C-3
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To be familiar with the different Chordate phyla. • To know the general and distinguishing characters of each of them. • To compare and contrast the major biological systems amongst them.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: • CO1: Be familiar with identification of the non-chordates from chordates with justification. • CO2: Identify the different chordates upto the order. • CO3: Understand the functioning and mechanism of the various biological systems in the chordates. • CO4: Able to appreciate the process of evolution of chordates from nonchordates and understand how it progressed from simple vertebrates to highly complex vertebrates.

ZOO-II.C-3: DIVERSITY AND BIOLOGICAL SYSTEMS OF CHORDATES		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Diversity of chordates(upto order)	1.1: Chordata: General plan of organization and Outline classification 1.2: General characters and classification of Protochordates 1.3: General characters and classification of Agnatha (upto class) 1.4: General characters and classification of Pisces, Amphibia, Reptilia, Aves, Mammalia upto orders	15
MODULE 2: Biological Systems I	3.1: Integument: Pisces, Amphibia, Reptilia, Aves, Mammalia 3.2:Locomotory apparatus: Pisces , Amphibia, Reptilia , Aves, Mammalia 3.3: Digestive system: Pisces , Amphibia, Reptilia , Aves, Mammalia 3.4: Respiratory system: Pisces , Lungs in Amphibia, Reptilia , Aves, Mammalia	15
MODULE 3: Biological systems - II	3.1: Circulatory system: Pisces , Amphibia, Reptilia Aves, Mammalia 3.2: Brain and cranial nerves: Pisces , Amphibia, Reptilia , Aves, Mammalia 3.3: Reproductive system: Pisces , Amphibia, Reptilia , Aves, Mammalia	15

PRACTICAL COMPONENT OF ZOO-II.C-3: DIVERSITY OF CHORDATES (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1.	Identification and Systematic classification of organisms from protochordates to mammalia	05
2.	Mounting of scales and chromatophores in fishes	01
3.	Observation of general viscera of chordate phyla	01
4.	Identification of Indian venomous and non venomous snakes with the help of keys provided (four each)	01
5.	Observation of pectin of eye (chick), skulls of representatives of pisces, amphibian, aves and mammals.	01
6.	Observation of permanent slides (amphioxus, doliolum, salpa) and observation of hyoid apparatus of chick; reptiles and mammals	01
7.	Field trip to wild life sanctuary	02

REFERENCE BOOKS:

1. Cleveland Hickman Jr., Roberts Larry, Susan Keen, Allan Larson and Eisenhour D (2014). Animal Diversity. McGraw Hill Science.
2. Kardong K(2011). Vertebrates: Comparative anatomy, evolution, function. McGraw-Hill Higher Education.
3. Kent G.C. and Carr R.K. (2000). Comparative anatomy of the vertebrates. McGraw-Hill Higher Education.
4. Young J.Z. (2006). The life of vertebrates. Radha Press Delhi, Indian Edition.

REFERENCE BOOKS FOR PRACTICALS:

1) Ziser. W.S (2014) Biology 1413 Introductory Zoology Lab Manual. Morton Publishing Co. Austin Community College.
2) Lal S.S. (2004) A textbook of practical zoology vertebrate. Rastogi publications, Meerut India.

CORE COURSE: FUNDAMENTALS OF ANIMAL AND HUMAN GENETICS	
COURSE CODE:	ZOO-II.C-4
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• This course is intended to provide solid understanding of concepts and principles of genetics as it applies to animals and humans. • Students will receive good foundation of chromosome structure, its aberrations and inheritance patterns of traits and disease which will help one to develop conceptual skills to address questions in genetic research.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: • CO1: Describe the basic structure of genes and chromosomes. • CO2: Relate an organism's genotype and phenotype and explain the role of genes in inheritance. • CO3: Associate knowledge of genetic principles to the phenomena which occur in humans with reference to genetic inheritance. • CO4: Construct and analyze pedigrees to determine mode of inheritance of disorders and traits.

ZOO-II.C-4: FUNDAMENTALS OF ANIMAL AND HUMAN GENETICS		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Transmission Genetics	UNIT 1: MODES OF INHERITANCE • Mendels laws of inheritance , test cross, back cross • Gene interactions: 9:3:3:1/12:3:1 / 9:3:4 /9:6:1 / 9:7 / 15:1 / 13:3. lethal genes, penetrance. • Inheritance of Multiple Alleles and Multiple genes UNIT 2: PATTERN OF INHERITANCE BY PEDIGREES • Construction of Pedigrees • Analysis of Pedigree analysis : autosomal dominant, autosomal recessive, X-Linked dominant, X-linked recessive, Y-linked, Mitochondrial inheritance • Sex limited and Sex influenced and multifactorial inheritance disorders in humans	15
MODULE 2: Chromosome Structure and Abnormalities in Humans	UNIT 3: CHROMOSOME STRUCTURE • Chromosome morphology- chromatid, Centromere, secondary constriction, chromomere • Heterochromatin and euchromatin • Chromosome structure and organization. • Human chromosomes and karyotype. UNIT 4: CHROMOSOMAL ABERRATION • Numerical aberrations: Types- Aneuploidies and Euploidies, Mosaicism, • Structural Abnormalities: Types-Deletions, inversions, Translocations, duplications.	15
MODULE 3: Gene Mutations, Sex Determination .	UNIT 5: GENETIC MUTATIONS. • characteristics of mutations • classification of mutations (Spontaneous, Induced) molecular basis of mutations • Mutagens – physical and chemical UNIT 6: SEX DETERMINATION. • Environmental Sex Determination – hormonal, egg size, incubation temperature. • Chromosomal sex determination - XX ♀and XO♂, XO ♀ and XX ♂, ZW♀ and ZZ♂, XX ♀and XY♂, Diploid female and Haploid male, single gene effect. • Molecular basis of sex determination: Geneic imbalance, Sex index, Intersex and gynandromorphs, X/A Ratio. • Sex determination by Y linked genes, Dosage compensation, X-inactivation	15

PRACTICAL COMPONENT OF ZOO-II.C-4: FUNDAMENTALS OF ANIMAL AND HUMAN GENETICS. DURATION - 02 HRS /WEEK		
Sr. No	Practical	No. of Practicals
1)	Verification of Mendel's laws - monohybrid cross	01
2)	Verification of Mendel's laws - dihybrid cross	01
3)	Manual Karyotyping of human chromosome plates: 1) Normal Male and Female 2) Downs syndrome	03
4)	Drosophila Culture technique	01
5)	Study of Mutants of Drosophila	01
6)	Exercises for Multiple alleles and Multiple genes	02
7)	Construction and analysis of pedigrees	03

REFERENCE BOOKS FOR THEORY:

1) Gardner EJ, Simmons MJ and Snustad DP (2013): Principles of Genetics, Eighth Edition, John Wiley Publication, Singapore.
2) De Robertis EDP, De Robertis EMF (2012): Cell and Molecular Biology, Eigth Edition. Wolter Kluwer Publication, Philadelphia.
3) Singh BD (2014): Fundamentals of Genetics. Second Edition, Kalyani Publishers, New Delhi.
4) Lewis R (2009): Human Genetics, Concepts and Applications, Seventh Edition. McGraw-Hill International Edition, New York.
5) Gangane SD (2009): Human genetics, Third Edition, Reed Elsevier India Pvt Ltd., Haryana India.
6) Gardner A, Davies T (2010): Human Geentics, Second Edition, Scion Publishing Ltd, UK.
7) Marcus A(2011): Genetics, MJP Publishers, Chennai.
8) Verma PS and Agarwal VK (2014): Cell Biology Genetics Molecular Biology Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.
9) Kothari ML, Mehta L, Roychoudhury SS (2009): Essentials of Human Genetics, Fifth edition, University Press Pvt. Ltd. Hyderabad.

REFERENCE BOOKS FOR PRACTICALS:

1) Gangane SD (2009): Human genetics, Third Edition, Reed Elsevier India Pvt Ltd., Haryana India.
2) Marcus A(2011): Genetics, MJP Publishers, Chennai.
3) Gardner A, Davies T (2010): Human Genetics, Second Edition, Scion Publishing Ltd, UK.
4) Lewis R (2009): Human Genetics, Concepts and Applications, Seventh Edition. McGraw-Hill International Edition, New York.

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PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE (Autonomous)
PROGRAMME BSC ZOOLOGY
COURSE CURRICULUM(Revisedw.e.f: June 2020)

COURSE STRUCTURE: PROGRAMME BSC ZOOLOGY						
SEMESTER	**CORE**		**ELECTIVE**			
I	**ZOO-I.C-1** Animal Diversity : Non Chordates	**ZOO-I.C-2** Cell and Molecular Biology	--------	--------	--------	--------
II	**ZOO-II.C-3** Diversity and Biological Systems of Chordates	**ZOO-II.C-4** Fundamentals of Animal and Human Genetics	--------	--------	--------	--------
III	**ZOO-III.C-5** Human Physiology		**ZOO-III.E-1** Vertebrate Endocrinology	**ZOO-III.E-2** Basic microbiology and Fundamentals of Animal Biotechnology	**ZOO-III.E-3** Environmental Toxicology	**ZOO-III.E-4** /****ZOO-III-SE-1** Waste Management techniques (Sem III & IV)
IV	**ZOO-IV.C-6** Biochemistry and Metabolic Regulation		**ZOO-IV.E-5** Animal cell culture and Applications	**ZOO-IV.E-6** Aquaculture and Fisheries	**ZOO-IV.E-7** Immunology	**ZOO-IV.E-8** Parasitology
V	**ZOO-V.C-7** Developmental Biology		**ZOO-V.E-9** Molecular Genetics and Forensic Science	**ZOO-V.E-10** Economic Zoology	**ZOO-VI.E-11** Basic and Applied Entomology	**ZOO-V.E-12** Fish Preservation and Processing
VI	**ZOO-VI.C-8** Wildlife Biology		**ZOO-VI.E-13** Health and Nutrition ***ZOO-VI-GE-1** Health and Nutrition	**ZOO-V.E-14** Ecology and Ethology	**ZOO-VI.E-15** Laboratory Techniques in Pathology	**ZOO-VI.E-16 / **ZOO-IV-SE-2** Bio Entrepreneurship

SEMESTER –III and IV

SEMESTER	COURSE CODE	COURSES	CREDITS	CONTACT HOURS
Semester III	ZOO-III.C-5	Human Physiology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-III.E-1	Vertebrate Endocrinology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-III.E-2	Basic microbiology and Fundamentals of Animal Biotechnology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-III.E-3	Environmental Toxicology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-III.E-4 / **ZOO-III-SE-1 Waste Management techniques (Sem III & IV)	Waste Management techniques	Theory = 01 Practice =03	Theory = 15 Practice =45
Semester IV	ZOO-IV.C-6	Biochemistry and Metabolic Regulation	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-IV.E-5	Animal cell culture and Applications	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-IV.E-6	Aquaculture and Fisheries	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-IV.E-7	Immunology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-IV.E-8	Parasitology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	**ZOO-III-SE-1 Waste Management techniques (Sem III & IV)	Waste Management techniques	Theory = 01 Practice =03	Theory = 15 Practice =45

SEMESTER –III

CORE COURSE :HUMAN PHYSIOLOGY	
COURSE CODE:	ZOO-III.C-5
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• The primary goal of this course is to offer an in-depth presentation of the function of the major organs and organ systems of the human body. • The course is designed to expand physiological concepts presented in prerequisite courses.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: • CO1: Describe and explain the normal function of the cells, tissues, organs, and organ systems of the human body. • CO2: Develop understanding of the functional relationships of anatomical structures to one another. • CO3: Know the disorders associated with the different systems. • CO4: Understand and associate malfunctions in the body to various organs and organ systems.

ZOO-III.C-5: HUMAN PHYSIOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Physiology Of Digestion And Respiration	UNIT 1: *DIGESTIVE SYSTEM* • Structural organization, histology and functions of gastrointestinal tract and its associated glands; • Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins. UNIT 2: *RESPIRATORY SYSTEM* • Histology of trachea and lung; • Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; • Transport of oxygen in the blood oxygen- hemoglobin &myoglobin , dissociation curve and the factors influencing it Carbon monoxide poisoning; Carbon dioxide transport in the blood; • Buffering action of blood and haemoglobin Control of respiration	15
MODULE 2: Physiology Of Excretion And Circulation	UNIT 3: *EXCRETORY SYSTEM* • Structure of kidney and its histological details, Renal blood supply; Mechanism urine • Formation and its regulation, Regulation of acid-base balance. UNIT 4: *CIRCULATORY SYSTEM* • An outline structure of heart and working of heart. • Origin and conduction of cardiac impulses functions of AV node; Cardiac cycle; nervous and chemical regulation of heart rate; Blood pressure and its regulation; Electrocardiogram • Components of blood and their functions; Haemopoiesis.	15
MODULE 3: Physiology Of Nervous System, Muscles And Reproductive System	UNIT 5: *NERVOUS SYSTEM* • Structure of neuron, resting membrane potential , Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; • types of synapsis, Synaptic transmission and, Neuromuscular junction; Reflex action & its types - reflex arc • Physiology of hearing and vision UNIT 6: *MUSCLE* • Histology of different types of muscle; • Ultra structure of skeletal muscle; • Molecular and chemical basis of muscle contraction; • Characteristics of muscle twitch; Motor Unit, summation & tetanus UNIT 7: *REPRODUCTIVE SYSTEM* • Histology of male and female reproductive systems. • Puberty, Physiology of male and female reproduction.	15

PRACTICAL COMPONENT OF ZOO-III.C-5: HUMAN PHYSIOLOGY (DURATION -02 HRS /WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1)	Enumeration of red blood cells / WBC using haemocytometer	02
2)	Estimation of haemoglobin using Sahli's haemoglobinometer	01
3)	Determination of activities of digestive enzymes (Amylase, Pepsin, Trypsin and Lipase)	02
4)	Temporary preparation of Striated muscle fibers and nerve cells.	02
5)	Urine analysis (for organic, inorganic and abnormal components)	03
6)	Examination of sections of mammalian tissues:Lung, Kidney, Gonads, Intestine, Muscles, Spinal cord, Bone and cartilage	02

REFERENCE BOOKS:

Essential books:

1. *Singh HD(2011):Textbook of Human Physiology, S Chand Publishers, New Delhi.*
2. *Widmaier, Raff, &Strang(2008), Vander's Human Physiology: The Mechanisms of Body Function, 12thedition, McGraw Hill,. ISBN 978-0-07-337810-7*
3. *Tortara G J and DerricksonBH(2009). Principles of Anatomy and physiology, 12th Edition. John Wiley & sons, Inc.*
4. *Guyton Ac and Hall JE(2011). Testbook of Medical Physiology, 12th Edition, Harcourt Asia Pvt Ltd, WB Saunders Company.*

Supplementary Reading:

5. *Openstax College (2013). Anatomy and Physiology. Vol II. Mainstreet MS, Houston Texas(Ebook)*
6. *Forciea B (2012). An eText of Human Anatomy and Physiology(Ebook).*
7. *WingerdB(2008). The Human Body, Essential Anatomy and Physiology. University Readers, SanDiego CA.*

REFERENCE BOOKS FOR PRACTICALS:

1. *Openstax College (2013). Anatomy and Physiology. Vol II. Mainstreet MS, Houston Texas(Ebook*
2. *Forciea B (2012). An eText of Human Anatomy and Physiology(Ebook).*
3. *WingerdB(2008). The Human Body, Essential Anatomy and Physiology. University Readers, SanDiego CA.*

ELECTIVE COURSE: VERTEBRATE ENDOCRINOLOGY	
COURSE CODE:	ZOO-III.E-1
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To study the endocrine organs of vertebrates • To understand the underlying principles of hormone functions • To gain an insight into the current and important issues in endocrinology
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: • CO1: Be familiar with all the endocrine organs of human body. • CO2: Associate hormones to body growth, metabolism, reproduction and development. • CO3: To understand the underlying principles and disorders associated with hormone functions • CO4: Learn techniques of histology and tissue identification.

ZOO-III.E-1: VERTEBRATE ENDOCRINOLOGY

MODULE	TOPICS	CONTACT HOURS
MODULE 1: Anatomy and histology	Unit 1: • Aim and scope of endocrinology, • techniques in endocrinology - histology, histochemistry, immunocytochemistry, in situ hybridisation, radio immune assay, surgical techniques, • Regulation of hormone secretion: feedback mechanisms - positive, negative, short loop, long loop	15
	Unit 2: • Anatomy and histology of endocrine glands- • Pituitary, Pineal gland, Thyroid, Parathyroid, • Thymus, Adrenal, Endocrine pancreas, GI tract, • Endocrine hypothalamus, Gonads, Placenta	
MODULE 2: Hormones	Unit 3: • Classification of hormones • Hormone structure • Biological actions of hormones	15
	Unit 4: • Mechanisms of hormone action • Receptor and it regulation • Steroid and peptide hormones actions	
	Unit 5: Hormones and Homeostasis - Calcium and glucose	
MODULE 3: Pathological conditions	Unit 6: Biosynthesis and secretion of hormones - steroid hormones, thyroid hormones	15
	Unit 7: Growth factors - neurotropic growth factors, hematopoietic growth factors, other peptide growth factors	
	Unit 8: Endocrine disorders - goitre, gigantism, dwarfism, cretinism, diabetes mellitus, insepidus	

PRACTICAL COMPONENT OF ZOO-III.E-1: Vertebrate Endocrinology (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1)	Histological slides ofEndocrine hypothalamus, Gonads, Placenta pituitary, Pineal gland, thyroid gland, Parathyroid,Thymus, adrenal gland, pancreas, ovary, testis	04
2)	Display of Pituitary and gonads in fishes/chick	03
3)	Preparation of histological slides using microtomy	05

REFERENCE BOOKS:

1. David, N.O. and J.A. Carr (2013) Vertebrate Endocrinology. Academic press publications 5th edition.
2. Hadley, M. and Levine, J (2006) Endocrinology. Benjamin Cummings 6th edition.
3. Kovacs, J.W. and S.R. Ojeda (2011) Textbook of endocrine physiology 6th edition. Oxford university press.
4. Yadav, P.R. (2004) Endocrinology. Discovery Publishing House, New Delhi.
5. Hadley, M (1992) Endocrinology, Third edition, prentice Hall, New Jersey.
6. Matsumoto, A. and S. Ishi, (1992)(eds). Atlas of endocrine organs, vertebrates and Invertebrates springierverlag, Germany.
7. Norris D. O., Vertebrate Endocrinology, Elsevier Academic Press.
8. Turner, C.D and Bagnara, J.T., (1994) General Endocrinology, 6th Edition, WB Saunder's company, Philadelphia (Saunder's International Students edition).
9. 5. Wilson J.D and Foster D.W (1992) William's textbook of endocrinology, 8th edition, WB saunders company, Philadelphia.
10. Yadav, P.R (2004) Endocrinology. Discovery Publishing House, New Delhi.

ELECTIVE COURSE: BASIC MICROBIOLOGY AND FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY	
COURSE CODE:	ZOO-III-E-2
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To provide a comprehensive survey of microbiology with basic information on bacteria and learn the fundamentals of biotechnological techniques.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: • CO1: Gain working knowledge of basic bacterial laboratory techniques and use of microorganism in biotechnology. • CO2: Perform techniques of bacterial isolation and identification. • CO3: Have knowledge about various molecular techniques of gene manipulation. • CO4: Should be able to Perform techniques of isolate DNA, bring about transformation and identification of recombinants.

ZOO-III-E-2: BASIC MICROBIOLOGY AND FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Microbiology	1: Introduction to Microorganisms-Bacteria o Structure and Identification of bacteria(morphological types) o Nutritional types o Nutritional requirements	15
	2: Isolation and Culture of Bacteria: o Cultivation of bacteria o Different methods of isolation and maintenance of pure cultures o Culture characteristics	
	3: Use of microorganisms in biotechnology-An overview: o Production of valuable substances o Fuel Production, recovery of minerals and oils o Microorganisms in bioassays o Food and agriculture sector o Medicine and health	
MODULE 2: Tools in Biotechnology	4: Scope and importance of Biotechnology o Definition o Contribution and importance of biotechnology	15
	5: Nucleic Acid Enzymology: o Restriction enzymes, Ligases, Alkaline phosphatase o Polynucleotide kinase, Terminal Transferases, S1 Nuclease o Polymerases, Reverse transcriptase	
	6: Gene Cloning vectors: o Plasmids, Bacteriophage, cosmids o Shuttle and expression vectors	
MODULE 3: Genetic Engineering	7: Techniques in genetic engineering: o Gene transfer methods o Methods of Labeling Nucleic acids o Nucleic acid Hybridization o Polymerase chain reaction	15
	8: Recombinant DNA technology: o Procedure / Technique	
	9: Blotting Techniques: o Southern Blotting o Northern Blotting o Western Blotting	
	10: DNA sequencing techniques: o Chemical Degradation method o Chain termination method o Automated Sequencing	

PRACTICAL COMPONENT OF ZOO-III-E-2: BASIC MICROBIOLOGY &FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY DURATION - 02 HRS /WEEK		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1)	Preparation of culture media for bacteria (Plates, Slants, deeps, Broth).	03
2)	Staining of Microorganisms (Gram staining, negative staining).	02
3)	Isolation of pure colonies of Bacteria (streak plate method – 3 Quadrant And 5 Quadrant methods)	03
4)	Identification of Products of metabolic pathways of microbial cells.	02
5)	Bacteriological testing of Milk.	01
6)	DNA sequencing - Analysis of prints.	01

REFERENCE BOOKS:

Essential books:

1) *Pelczar MJ, Chan ECS, Krieg NR(2009). Microbiology. Tata Mc Graw Hill, New York.*
2) *Dubey RC and Maheshwari DK (2012). A test book of Microbiology. S Chand Publishers, New Delhi.*
3) *Prave P, Faust U, Sittig W and SukatshDA(2004). Fundamentals of Biotechnolgy.*
4) *Purohit SS(2008). BiotechnologyFundamentals and applications. Agrobios, Jodhpur India.*
5) *RangaMM(2012): Animal Biotechnology. Agrobios, Jodhpur India.*

Supplementary reading:

6) *Black JG(2005). Microbiology principles and explorations. John Wiley and sons Inc.*
7) *Sullia SB and ShanthramS(2006). General Microbiology. Oxford and IBH Publishing Co Pvt Ltd, NewDelhi.*

REFERENCE BOOKS FOR PRACTICALS*:*

1) *Gunasekaran P(2009). Lab Manual in Microbiology. New Age International Ltd. Publishers, New Delhi.*

ELECTIVE COURSE: ENVIRONMENTAL TOXICOLOGY	
COURSE CODE:	ZOO-III-E-3
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To study the different environmental pollutants and their toxicity. • To know the physiological effects of toxicant exposure.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: • CO1: Distinguish, classify and characterize a variety of environmental pollutants based on their biological and physical properties. • CO2: Identify the main sources and types of environmental pollutants and assess their potential environmental fate. • CO3: Understand mechanisms of detoxification of various varieties of toxicants. • CO4: Know the procedures/protocols used to assess physicochemical parameters and environmental contaminants.

ZOO-III-E-3: ENVIRONMENTAL TOXICOLOGY		
MODULE	**TOPIC**	**CONTACT HOURS**
MODULE 1: Introduction To Toxicology	**1.1Introduction To Toxicology:** o Definition and History of Toxicology and Toxicity o Disciplines of Toxicology o Biouptake,Bioaccumulation,Biotransfer and Biological Magnification, Relationship to Other Sciences, Scope and importance of Toxicology **1.2: Classes Of Toxicant:** • Define Toxicant and Toxins, their classification • Toxicants in Air, Water and Soil • Toxicants in Domestic and Occupational Settings • Synthetic drugs: Solvents; Therapeutic drugs, Drugs of abuse,Combustion products,Cosmetics • Movement and fate of Toxicants in the environment	15
MODULE 2: Environmental Impact Mitigation	**2.1: Toxicity Of Heavy Metals:** • Toxicity of Arsenic, Lead, Mercury, • Cadmium,Copper, Zinc, Aluminium,Iron and Manganese; Sources and portals of heavy metal pollutants; Toxicity of substances on Human and Animals **2.2: Agro-Chemical Pesticides And Their Environmental Impact Mitigation** • Definition and Classification • Organochlorine Insecticides, Organophosphate Insecticides, Carbamates, Pyrethroid Insecticides, Dinitrophenols, Herbicides, Fungicide • Control of Pesticide Pollution; Integrated Pest management.	15
MODULE 3: Food Additives AND Toxicity tests.	**3.2: Food Additives:** • General account of Food Additives: • Incidental or Indirect additives • Intentional or Direct additives: a.Antioxidants b. Emulsifiers c. Enzymes d. Flavouring agents e. Colourand preservatives f. Artificial sweetening agents i)Saccharine ii)Urea derivatives • Types of toxicity tests; Test types based on number and species; Test types based on exposure of toxicant; Test types based on length of exposure acute ,sub acute, chronic)	15

PRACTICAL COMPONENT OF ZOO-III.E-3:ENVIRONMENTAL TOXICOLOGY (DURATION-02 HRS/WEEK)		
Sr.No.	**Practical**	**No.ofPracticals**
1.	To determine the effect of temperature on the toxicity of a pollutant	01
2.	To determine the effect of pH on the toxicity of a pollutant.	01
3.	To evaluate qualitatively the presence of pesticide residues in vegetable samples.	02
4.	Estimation of total dissolved solids in given water sample.	01
5.	To determine Lc^{50} of a pollutant on mosquito larvae .	01
6.	Effect of pesticides on Oxygen consumption in fish	02
7.	Estimation of Phosphorus in given water sample by Spectrophotometer	01
8.	Estimation of Boron from given water/soil sample by spectrophotometer	01
9.	Determination of Nitrates from given water sample.	01
10.	Field trip (case study of polluted water body)	01

REFERENCE BOOKS FOR THEORY:

1. Ernst Hodgson(2004) A Text Book of Modern Toxicology ,A John Wiley and sons Inc,Publication.
2. Gupta P.K.(2010) Modern Toxicology, Pharma Med Press, Hyderabad.
3. Omkar(2007) Concepts of Toxicology ,Vishal Publishing Co, Jalandhar
4. Pandey K,Shukla J.P. and Trivedi S.P. (2011)Fundamentals of Toxicology,New Central Book Agency(P) Ltd.
5. P.D.Sharma (2011)Environmental Biology and Toxicology (Third edition),Rastogi Publications,Meerut-250002.

REFERENCE BOOKS FOR PRACTICALS:

1. Wooley, A (2008) A Guide to Practical Toxicology: Evaluation, Prediction, andRisk IInd Edition, Informa Healthcare U.S.A.,Inc.New York.
2. Rao K.S. (1998) Practical Ecology, Anmol Publications Pvt. Ltd. New Delhi.
3. Subramanian M.A. (2004) Toxicology Principles and Methods(Second RevisedEdition),M.J.P. Publishers, Triplicane Chennai.
4. Sunita Hooda and SumanjeetKaur(1999)Laboratory Manual for Environmental Chemistry, S. Chand and Comp. Ltd. New Delhi.

SKILL ENHANCEMENT COURSE: WASTE MANAGEMENT TECHNIQUES	
COURSE CODE	Elective: ZOO-III.E- 4 / Skill Enhancement Course(SEC): ZOO-III-SE-1
MARKS	100 [25 -Theory; 75- Practice Based]
CREDITS	04
CONTACT HOURS	Theory: 15 HOURS [01 Lectures Per Week] Practice based: 45 HOURS.
COURSE OBJECTIVES	• To familiarize students with the techniques of waste management. • To encourage students to get hands on experience on techniques of managing waste. • To help students understand the importance of reducing, reusing and recycling
COURSE OUTCOME	Upon successful completion of the course, students will be able to: • CO1: Understand concept of types of waste, its transport and disposal. • CO2: Perform composting techniques / procedures. • CO3: Identify means of reducing waste production. • CO4: Plan and conduct research in areas of waste management

ZOO-III.E- 4: WASTE MANAGEMENT TECHNIQUES (as zoology elective) ZOO-III-SE-1: WASTE MANAGEMENT TECHNIQUES(as Skill Enhancement Course)		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Introduction to waste management	UNIT 1: Overview of types of waste, collection, transport, treatment and disposal of waste. UNIT 2: Waste generated- sources, and management, Storage and collection of different kinds of wastes. UNIT 3: Need for Waste management and effect on the community. UNIT 4: Waste treatment methods:Physicochemical Treatment of Solid and Hazardous Waste, Chemical treatment processes, Biological Treatment of Solid and Hazardous Waste, 3 Rs- Reuse Reduce and Recycle.	05
MODULE 2:Composting Techniques	UNIT 5: Soil structure and its maintenance. UNIT 6: Organic composting- Methods, Procedure - Microorganisms, materials used, design and maintenance, Biogas. UNIT 7: Vermicomposting- Earthworms – biology- life cycle and feeding. Types – morphological and ecological grouping – Epigeic, Anecic and Endogeic species, Nutrient value of worm cast/vermicompost, requirements of vermicomposting.Maintenance of composting – Collection of vermicompost Small Scale Earthworm farming for home gardens. Marketing the products of vermiculture. Predator/pathogen control.	05
MODULE 3:Waste management techniques	UNIT 8: Sewage disposal; Medical waste management. Sources, measures and health effects; disposal options UNIT 9:Bioremediation, ground water contamination and remediation Landfill designing and Incineration. UNIT 10: Radioactive and E- waste management-Sources, measures and health effects. UNIT 11:Relevant Regulations **-**Municipal solid waste (management and handling) rules(SWM 2000 and amendments of 2016; SO.1357(E) Sec. 3(II). - Hazardous waste (management and handling) rules 2015(Chapter II and IV; schedule I,II,III & IV. -Biomedical waste handling rules, 2016 (GSPCB-Schedule I & II) -Plastics waste management rukes 2016 (Part-II, Sec.-3, sub-sec.(i)]	05
MODULE 4: PRACTICE BASED	Practice of the following: The students of this course are expected to work on these different waste management practice activities: 1) Leaf composting on campus 2) Vermicomposting 3) Awareness on waste segregation. 4) Waste collection Drives. 5) Research on waste management. 6) Case studies/ mini projects. The report of the same will be submitted as portfolio.	45

REFERENCE BOOKS:

1. *Edwards CA, Hendrix P and Arancon N (2014) Biology and Ecology of Earthworms, Springer Publishers.*
2. *Karaca A (2011) Soil Biology: Biology of Earthworms. Springer Publishers.*
3. *Edwards CA, Arancon NQ and Sherman RL (2011) Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management, CRC Press, USA.*
4. *Ranganathan LS (2006) Vermibiotechnology– From Soil Health to Human Health. Agrobios, India.*
5. *Ismail SA (2005) The Earthworm Book. Edition, Other India Press, Apusa, Goa, India.*
6. *Ismail SA (1997) Vermicology: The Biology of Earthworms. Orient Longman, India.*
7. *A. D.Bhide and B.B.Sundaresan, "Solid Waste Management –Collection, Processing and disposal" Mudrashilpa Offset Printers, Nagpur, 2001.*
8. *Biomedical waste (Management and Handling) Rules, 1998.*

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SEMESTER IV:

CORE COURSE: BIOCHEMISTRY AND METABOLIC REGULATION	
COURSE CODE:	ZOO-IV.C-6
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To understand the basic principles that govern the functioning of living systems • To know the structure of biomolecules and the role they play in governing life processes through the pathways • To be familiar with enzymes and their activities
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: • CO1: Understand better the chemical basis in life. • CO2: Know the basic principles that govern the functioning of living systems • CO3: Be familiar with enzymes and their activities • CO4: Appreciate better the interactions between the biological molecules.

ZOO-IV.C-6: BIOCHEMISTRY AND METABOLIC REGULATION		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Fundamentals of biochemistry and Carbohydrate metabolism	1.1 Principles of pH, buffer, thermodynamics 1.2Enzymes: classification, properties of enzyme, enzyme kinetics, MichaelisMenten Equation, enzyme inhibition 1.3 Carbohydrate structure, aerobic and anaerobic glycolysis, Citric acid cycle, glycogenesis, glycogenolysis, Pentose phosphate pathway, 1.4 Diabetes mellitus	15
MODULE 2: Lipid and Protein metabolism	2.1: Lipid: -structure and classification, -fatty acid synthesis -fatty acidoxidation(saturated and unsaturated), - metabolism of glycerophospholipids, sphingolipids, cholesterol - disorders: fatty liver types (NAFL, AFL) 2.2 Protein: - structure(primary, secondary, tertiary) and classification -amino acid biosynthesis, nucleotide biosynthesis, - amino acid catabolism, urea cycle, Fate of carbamoyl P, - Hyper uricemia	15
MODULE 3: Nucleotide metabolism and integration of metabolism	3.1Biosynthesis of purine and pyrimidine (de novo and salvage pathway) 3.2 Degrdationof purine and pyrimidine 3.3 Interconversions between the three principal components 3.4 Metabolism in starvation: Carbohydrate, lipid, proteins (The feed/fast cycle)	15

PRACTICAL COMPONENT OF ZOO-IV.C-6: BIOCHEMISTRY AND METABOLIC REGULATION (DURATION -02 HRS /WEEK		
Sr. No	Practical	No. of Practicals
1)	Principle and working of spectrophotometer	01
2)	Estimation of reducing sugars DNSA method	01
3)	Estimation of protein – Folin Lowry's method	01
4)	Estimation of fatty acids by titration method	01
5)	Separation of lipids by thin layer chromatography	02
6)	Colorimetric estimation of liver glycogen of chick by Anthrone method	02
7)	Effect of substrate concentration on amylase activity	02
8)	Estimation of DNA by DPA method	02

REFERENCE BOOKS:

1. David, L.N. and Cox, M. Michael (2008) Lehninger principles of biochemistry. W.H. Freeman and Company, New York.
2. Delvin, T.M. (1997). Textbook of biochemistry with clinical correlations. Wiley liss.
3. Harvey, A.R. and Ferrier, D. (2011). Lippincott's Illustrated Reviews Biochemistry. Wolters Kluwer, Lippincott Williams and Wilkins. 5th Edition.
4. Pratt, W.C. and K. Cornely 2003 Essential Biochemistry Wiley Publications third edition.

REFERENCE BOOKS FOR PRACTICALS:

Plummer, M. and D.T. Plummer (1988) Introduction to practical biochemistry.Tata McGraw Hill Education ,UK.

<table>
<tr><td colspan="2">ELECTIVE COURSE:
ANIMAL CELL CULTURE AND APPLICATIONS</td></tr>
<tr><td>COURSE CODE:</td><td>ZOO-IV-E-5</td></tr>
<tr><td>MARKS:</td><td>100 [75 –Theory ; 25- Practicals]</td></tr>
<tr><td>CREDITS:</td><td>04 [03 –Theory; 01- Practical]</td></tr>
<tr><td>CONTACT HOURS:</td><td>THEORY : 45 HOURS (03 LEC/WEEK)
PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)</td></tr>
<tr><td>COURSE OBJECTIVES:</td><td>• This course is an introduction to the theory, standard practices, and methodologies of animal cell culture.
• The laboratory emphasizes the principles and practices of initiation, cultivation, maintenance of cell lines.</td></tr>
<tr><td>COURSE OUTCOME:</td><td>Upon successful completion of the course, students will be able to:
• CO1: Operate, calibrate, and maintain standard equipment found in an animal cell culture laboratory;
• CO2: Prepare and sterilize media and solutions used in cell culture.
• CO3: Understand concepts and applications of mammalian cell culture.
• CO4: Perform primary cell culture of suspension and adherent cells.</td></tr>
</table>

ZOO-IV-E-5: ANIMAL CELL CULTURE AND APPLICATIONS		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: LAB REQUIREMENTS FOR CELL CULTURE	1: Historical background of Cell culture:	15
	2: Biology of cells in culture: Origin and characteristics, Differentiation, kinetics of cell growth, Genetics of Cultured cells, Problems associated with cell culture	
	3: Lab requirements for animal cell culture: o Lab facilities and setup for cell culture o Major and minor equipments o Environmental conditions o Substrates for Culturing and sub culturing	
	4: Animal tissue culture media o Natural media – biological fluids, tissue extracts o Chemically defined media- characteristic and composition o Media supplements – L Glutamine, serum. Advantages and disadvantages of serum in media / serum free media	
MODULE 2: CELL CULTURE TECHNIQUES	5: Primary cell culture: o Mechanical disaggregation o Enzymatic disaggregation o Protocol for primary cell culture	15
	6: Secondary cell culture/ Sub culturing: o Protocol for sub culturing of suspension culture o Protocol for sub culturing of adherent o Established cell lines	
	7: Scale up of animal cell culture: o Techniques of Scale up of suspension cultures o Techniques of Scale up of Monolayer cultures	
MODULE 3: CELL CULTURE APPLICATIONS	8: Cell Hybridoma Technology : o Steps of cell Hybridoma technology o Procedure o Production of monoclonal antibodies o Applications of monoclonal antibodies	15
	9: Valuable Products through cultured cells: Production of Tissue plasminogen, growth factor, Erythropoietin, Factor VIII, Interferons.	
	10: Other Application: Vaccines through cultured cells, Cytotoxicity testing, Fluorescent In-Situ Hybridization for disease detection, Cell culture in biomedical research.	

PRACTICAL COMPONENT OF ZOO-IV-E-5: DURATION -02 HRS /WEEK ANIMAL CELL CULTURE AND APPLICATIONS		
Sr. No	**Practical**	**No. of Practicals**
1.	Packing and sterilization of glass and plastic wares for cell culture & Lab Precautions and Biosafety measures	02
2.	Preparation of reagents and media for cell culture. ▪ Reagents ▪ Media / Buffers	02
3.	Setting up of primary cell culture - Methods used for cell disaggregation – Mechanical and Enzymatic - Quantification of cells (Viable cell count) by Tryphan blue exclusion dye. - Suspension culture - Adherent cell culture - Chicken embryo fibroblast culture	07
4.	Biological waste disposal methods	01

REFERENCE BOOKS:

1) *RangaMM(2012). Animal Biotechnology. Agrobios India Ltd. Jodhpur.*
2) *Mathur S(2006). Animal Cell and Tissue Culture. Agrobios India Ltd. Jodhpur.*
3) *Masters W(2005). Animal Cell Culture. Oxford University Press Inc., NewYork*
4) *GangalS(2010). Principles and practices of Animal Tissue Culture. Second Edition. University Press PVT. LTD., Hyderabad India.*
5) *Freshney I R(2007). Culture of animal Cells: A manual of Basic Techniques. 5th edition, John Wiley & Sons Inc Pte Ltd*

REFERENCE BOOKS FOR PRACTICALS:

1) *E Book- Fletcher L, Goss E. Phelps P and Wheeler A(2014). Introduction to Biotechnology – Laboratory Manual.*
2) *Harisson M A and Rae IF(1997):General Techniques of Cell Culture Handbook in Practical animal cell biology.Cambridge University Press.*
3) *Ebook- Cell Culture basics. From www.invitrogen.com/ cellculture basics.*

ELECTIVE COURSE : AQUACULTURE AND FISHERIES	
COURSE CODE:	ZOO-IV.E-6
MARKS:	100[75- Theory; 25- Practicals]
CREDITS:	04 [03-Theory;01- Practical)
CONTACT HOURS	Theory :45 Hours(03 LEC/WEEK) Practicals: 30 Hours(01 PRACTICAL/WEEK)
COURSE OBJECTIVES:	• To improve the understanding of conservation and sustainability of living resources • To improve the social and economic benefits derived from aquaculture and fisheries. • To study the role of aquaculture in rural development in solving nutritional security and unemployment. • Empowerment of fishery and entrepreneurship development
COURSE OUTCOMES:	Upon successful completion of the course, students will be able to: • CO1: Understand conservation and sustainability of aquaculture resources. • CO2: Acquainted with various techniques of aquaculture. • CO3: Know strategies of improving the social and economic benefits derived from aquaculture and fisheries. • CO4: Initiate business enterprise in area of aquaculture.

<table>
<tr><th colspan="3">ZOO-IV.E-6: AQUACULTURE AND FISHERIES</th></tr>
<tr><th>MODULE</th><th>TOPIC</th><th>CONTACT HOURS</th></tr>
<tr><td>MODULE 1:</td><td>1.1:Inland Fisheries:
• Riverine ;Reservoir fisheries; Lakesterine fisheries; Cold water fisheries
1.2: Marine Fisheries:
• Estuarine fisheries:The catadromous fishes (Polynemousindicus,P.tetradactylus) and anadromous fishes(Hilsa ilisha,Pamapama,Polynemousparadiseus)
• Coastal fisheries or Inshore fisheries: Elasmobrach fishery and Teleost fishery
• Offshore and Deep sea fisheries: Pomfrets(Pampus,Stromateus) Eleutheronematetradactylus(rava).
1.3: Crustacean And Molluscan Fisheries:
• Prawn fisheries in Goa: Penaeid and Palaemonid groups.
• Crab fisheries in Goa
• Edible oyster fisheries in Goa
• Mussel fisheries in Goa</td><td>15</td></tr>
<tr><td>MODULE 2:</td><td>2.1: Integrated Fish Farming Systems:
• Principle of integrated Fish farming; Integration with animal husbandry and farming systems.
2.2:Induced Breeding:
• Selection of site; Design and Layout of fish farm; Freshwater and brackish water; pond construction; Pond maintenance; Prevention of fish diseases; Control of aquatic weeds, predatory and Weed fishes, Aquatic insect; Harvesting.
.4 :Fishing Methods:
• Marine Fishing Crafts and Gears used in Goa.
• Inland Fishing Crafts and Gears used in Goa</td><td>15</td></tr>
<tr><td>MODULE 3:</td><td>3.1: Fish Culture System:
• Overview of Mono culture, polyculture, composite culture, raceway culture, extensive, semi intensive, intensive, zero water exchange, Objective of fish culture, Pond preparation, Selection of species, Stocking of seed, Feed and feeding, Harvesting, Bionomics of fish culture
3.2: Cage And Pen Culture:
• Advantage of Fish culture in cages, Selection of species for cage culture, Installation of cage - shape ,size and types of cages, Pen culture, Maintenance of cage and pen</td><td>15</td></tr>
</table>

PRACTICAL COMPONENT OF ZOO-IV.E-6: AQUACULTURE AND FISHERIES (DURATION – 02 HRS/ WEEK)		
Sr. No.	**Practical**	**No. of Practicals**
1.	Morphometric and Meristic study : a key for fish Identification	04
2.	Identification of : -Important edible prawns, shrimps and crabs(anytwo) - Important Freshwaterand Marine edible fishes- oil sardine, sole fish, white sardine,mullet,Scianera	03
5.	Estimation of Fecundity by Frequency Polygon method from a Marine Fish	01
6.	Food and Feeding of Fish by analysis of gut content	01
7.	Field based: • To study different types of gear and craft • To study fish breeding • Study of aquarium and larvivorousfishes	03

REFERENCE BOOKS FOR THEORY:

1. Bal D.V.Rao Virbhadra,K (1984) Marine Fisheries, Tata McGraw- Hill Publishing Company Ltd. New Delhi.
2. Cushing D.H. (1975) Marine Ecology and Fisheries, Cambridge University Press.
3. Day,F. (1889) The Fauna of British India including Ceylon and Burma. Fishes.2Vols.,Taylor and Francis London.
4. Khanna S.S.(1984) An Introduction to Fishes, Central Book Depot Allahabad.
5. Pandey K and Shukla J.P.(2015) Fish and Fisheries. Rastogi Publications Meerut-250002
6. Sakhare B. Viswas (2007) Applied Fisheries.Daya Publishing House Delhi-110035
7. Santhanam R (1990) Fisheries Science,Daya Publishing House Delhi.
8. Santhanam R, Ramanathan N and Jagatheesan G(1990) Coastal Aquaculture in India, CBS Publishers and distributers,Delhi.
9. Shrivastava C.B.L.(1996) A Text Book of Fishery Science and Indian Fisheries. KitabMahal22 A,S.N.Marg,Allahabad.
10. Singh B.K.(2008) Applied Fisheries and Aquaculture.Swastik Publishers anddistributers,Delhi.

REFERENCE BOOKS FOR PRACTICALS:

1. Chandy.M (1970) Fishes,National Book Trust,India,New Delhi.
2. Day.F. (1889) The Fauna of British India including Ceylon and Burma. Fishes. 2Vols.,Taylor and Francis London.
3. R.J.Ranjit Daniels (2002) Freshwater Fishes of Peninsular India, Universities Press (India)Pvt.Ltd. Hyderabad.
4. SakhareViswasB. (2007) Applied Fisheries ,Daya Publishing House Delhi.
5. Sharma U and S.P.Grover (1982) An Introduction to Indian Fisheries,Dehradun India.
6. SrivasavaC.B.L.(1986) A Text Book of Fishery Science and Indian Fisheries ,KitabMahal Allahabad.

ELECTIVE COURSE: IMMUNOLOGY	
COURSE CODE:	ZOO-IV.E-7
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• Familiarize students and make them learn about the structural features of the components of the immune system as well as their functions, and understand the mechanisms involved in immune system development and responsiveness.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: • CO1: Understand the components of the immune system and their function. • CO2: Explain the mechanisms of immune response. • CO3: Know about the techniques used in detecting immunological diagnosis. • CO4: Perform immunoassays for disease detection.

ZOO-IV-E-7: IMMUNOLOGY

MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1:Introduction To Immunology	1: OVERVIEW OF IMMUNE SYSTEM: • Basic concepts in immunology • Components of the immune system	15
	2: INNATE AND ADAPTIVE IMMUNITY. • Innate immunity-Anatomical barriers/ layers of defense, cells and molecules involved in innate immunity • Adaptive immunity-cell mediated and humoral immunity, passive immunity (artificial and natural), Active(artificial and natural), Immune dysfunction	
MODULE 2: Antigens And Immunoglobulins	3: ANTIGENS. • Antigenicity and immunogenicity, Immunogens, adjuvants and haptens • Factors influencing immunogenicity • B and T cell epitopes	15
	4: IMMUNOGLOBULINS • Structure and function of different classes of Immunoglobulin. • Antigen-Antibody interactions • Immunoassays, monoclonal& polyclonal antibodies	
	5: MAJOR HISTOCOMPATIBILITY COMPLEX. • Structure and function of endogenous and exogenous pathways of antigen presentation	
MODULE 3: Immune Response	6: CYTOKINES AND COMPLEMENT SYSTEM • Properties and functions of cytokines, cytokine based therapies • Components and pathways of complement activation	15
	7: HYPERSENSITIVITIES, AUTOIMMUNITY AND TRANSPLANTATION • Gell and coombs' classification, types of hypersensitivities(overview) • Autoimmune responses against self antigens (SLEs), responses to alloantigens and transplant rejection (graft rejection, types and mechanisms of transplant rejection	
	8: VACCINES • Types of vaccines -inactivated, attenuated, toxoid, subunit, conjugate, experimental (DNA and recombinant vaccine), monovalent/polyvalent vaccines	

PRACTICAL COMPONENT OF ZOO-IV-E-7: IMMUNOLOGY (DURATION -02 hrs/WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1	Preparation of serum from goat blood.	02
2	Slide Agglutination Reaction(blood groups – A / AB / O with Rh)	02
3	Differential count of leukocytes	01
4	Detection of presence of antigen / antibody - Simple immunodiffusion	01
5	Antibody Titre determination - Ouchterlony immunodiffusion	02
5	Antigen –antibody reaction by immunoelectrophoresis	02
6	Elisa TEST- pregnancy test	01
7	Phagocytosis – WBC (demonstration)	01

REFERENCE BOOKS:

Essential books:

1) *Abbas KA, LechtmanHA(2007). Basic Immunology, Updated Edition 2006-2007: with STUDENT CONSULT. Access (Paperback).*
2) *David M, Jonathan B, David RB and Ivan R(2006). Immunology. VII Edition, Mosby, Elsevier Publication.*
3) *Abbas KA, LechtmanHA(2003). Cellular and Molecular Immunology. Saunders Publication.*
4) *Kindt TJ, Goldsby RA, Osborne BA and KubyJ(2006). Immunology. VI edition. W H Freeman and company.*

Ebooks:

5) *Frank SA(2002).Immunology and evolution of infectious diseases. Princeton University Press, Princeton and Oxford.*
6) *Zabriskie JB(2009). Essential Clinical Immunology. Cambridge University Press.*

REFERENCE BOOKS FOR PRACTICALS:

1) *Talwar GP and Gupta SK(2012).A handbook of practical and Clinical Immunology, CBS publishers.*

ELECTIVE COURSE: PARASITOLOGY	
PAPER CODE:	ZOO-IV.E-8
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To be familiar with the parasite host interactions. • To gain knowledge on diagnosis of parasite infections and also to learn about the preventive measures.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: • CO1: Know about the parasites and their lifecycles. • CO2: Get acquainted with dimensions of public health viz . a viz. parasitic diversity, epidemiology and community prophylaxis. • CO3: Be familiar with the parasite host interactions. • CO4: Gain knowledge on diagnosis of parasite infections and preventive measures.

ZOO-IV.E-8: PARASITOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Basic Principles of Parasitology and parasitic protozoans	1.1 Parasite systematics, Ecology and Evolution 1.2 Immunology and Pathology 1.3 Symbiosis and parasitism 1.4 Parasite host interactions Form, function, classification, life cycle, diagnosis and preventive measures *1.5 Trypanosomagambiens* 1.6 Amoebas –*Entamoebahistolytica* *1.7* Malaria organisms - *Plasmodium vivax* 1.8 Sexually transmitted parasite – *Trichomonasvaginalis*	15
MODULE 2: Parasitic Platyhelmithes and Nematodes	Form, function, classification, life cycle, diagnosis and preventive measures 2.1 Trematoda(liver fluke - *Fasciola hepatica*, intestinal fluke –*Fasciolopsisbuski*, lung fluke –*Paragonimuswestermani*); 2.2 Cestoda (Tape worm - *Taeniasolium*) 2.3 Hook worms- *Ancyclostoma duodena* 2.4Guinea worm- *Dracanculusmedinensis* 2.5Round worm*Ascarislumbricoids, Enterobiasvermicularis* 2.6 *Wuchereriabancrofti*	15
MODULE 3: Parasitic arthropods and Parasites of domestic livestock	Form, function, classification , life cycle, diagnosis and preventive measures: Copepods, Barnacles, Amphipods, Isopods, Flea, Ticks, Mites, Head and pubic lice	15

PRACTICAL COMPONENT OF ZOO-IV.E-8: PARASITOLOGY (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1)	Study of*Trypanosomagambiens, Entamoebahistolytica, Plasmodiumvivax, Trichomonasvaginalis, Fasciolahepatica,Taeniasolium, Ancyclostoma duodena, Dracanculusmedinensis, Ascarislumbricoids, Wuchereriabancrofti*, copepod, barnacle, amphipod, isopod from permanent slides with respect to parasitic adaptations.	06
2)	Preparation of peripheral blood smear from the perspective of detection of haemoparasites	01
3)	Study of parasites of domestic livestock(parasite, pathogenicity)	04
4)	Study of fish parasites	01

REFERENCE BOOKS:

1. Chatterjee, K.D. (2009) Parasitology (Protozoology and Helminthology) with two hundred fourteen illustrations. CBS, 13th edition.
2. Dey, N.C., Dey, T.K. and D.M. Sinha (1995) Medical Parasitology. New Central book agency private limited, Calcutta.
3. Paniker, J.C.K. (2007) Textbook of medical parasitology. Jaypee Brothers, New Delhi.
4. Schmidt, G.D. (1990) Essentials of Parasitology. Universal Book Stall, New Delhi.

REFERENCE BOOK FOR PRACTICALS :

1. Halton, D.W., Behnke, J.M. and I. Marshall (2005) Practical exercises in parasitology. Cambridge University Press.

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PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE (Autonomous)
PROGRAMME BSC ZOOLOGY
COURSE CURRICULUM(Revised w.e.f: June 2020)

COURSE STRUCTURE: PROGRAMME BSC ZOOLOGY						
SEMESTER	**CORE**		**ELECTIVE**			
I	**ZOO-I.C-1** Animal Diversity : Non Chordates	**ZOO-I.C-2** Cell and Molecular Biology	--------	--------	--------	--------
II	**ZOO-II.C-3** Diversity and Biological Systems of Chordates	**ZOO-II.C-4** Fundamentals of Animal and Human Genetics	--------	--------	--------	--------
III	**ZOO-III.C-5** Human Physiology		**ZOO-III.E-1** Vertebrate Endocrinology	**ZOO-III.E-2** Basic microbiology and Fundamentals of Animal Biotechnology	**ZOO-III.E-3** Environmental Toxicology	**ZOO-III.E-4** /****ZOO-III-SE-1** Waste Management techniques (Sem III & IV)
IV	**ZOO-IV.C-6** Biochemistry and Metabolic Regulation		**ZOO-IV.E-5** Animal cell culture and Applications	**ZOO-IV.E-6** Aquaculture and Fisheries	**ZOO-IV.E-7** Immunology	**ZOO-IV.E-8** Parasitology
V	**ZOO-V.C-7** Developmental Biology		**ZOO-V.E-9** Molecular Genetics and Forensic Science	**ZOO-V.E-10** Economic Zoology	**ZOO-VI.E-11** Basic and Applied Entomology	**ZOO-V.E-12** Fish Preservation and Processing
VI	**ZOO-VI.C-8** Wildlife Biology		**ZOO-VI.E-13** Health and Nutrition ***ZOO-VI-GE-1** Health and Nutrition	**ZOO-V.E-14** Ecology and Ethology	**ZOO-VI.E-15** Laboratory Techniques in Pathology	**ZOO-VI.E-16** / ****ZOO-IV-SE-2** Bio Entrepreneurship

SEMESTER V AND VI

SEMESTER	COURSE CODE	COURSES	CREDITS	CONTACT HOURS
SEMESTER V	ZOO-V.C-7	Developmental Biology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-V.E-9	Molecular Genetics and Forensic Science	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-V.E- 10	Economic Zoology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-V.E-11	Basic and Applied Entomology	Theory = 04	Theory = 60
	*ZOO-V.E-12	Fish Preservation and Processing	Theory = 04	Theory = 60
SEMESTER VI	ZOO-VI.C-8	Wildlife Biology	Theory = 04	Theory = 60
	ZOO-VI.E-13	Health and Nutrition	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-VI.E-14	Ecology and Ethology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-V.E-15	Laboratory Techniques In Pathology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-VI.E-16	Bio Entrepreneurship	Theory = 04	Theory = 60

SEMESTER V:

CORE COURSE:DEVELOPMENTAL BIOLOGY	
COURSE CODE:	ZOO-V.C-7
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To understand the processes of fertilization, polyspermy and activation of egg metabolism • To know the basics of animal development, specifically in sea urchin and chick • To be familiar with the processes that help in the establishment of basic plan of development
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: • CO1: Understand the basic plan of animal development. • CO2: Know the processes which occur during the course of development in invertebrates and vertebrates. • CO3: Have the basic knowledge of developmental biology. • CO4: Know the concepts associated with development of embryo.

ZOO-V.C-7: CORE COURSE:DEVELOPMENTAL BIOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Early embryonic development and early development of model organism: sea urchin	1.1: Introduction to cell division: mitosis and meiosis 1.2: Fertilization: structure of the gametes 1.3: Species recognition specificity of egg and sperm 1.4: Gamete fusion and the prevention of polyspermy 1.5: The activation of egg metabolism 1.6: Fusion of the genetic material 1.7: Rearrangement of the egg cytoplasm 1.8: Sea Urchin: cleavage, gastrulation, blastula formation 1.9: Fate maps and the determination of sea urchin blastomeres,gastrulation 1.10: Embryonic stem cells: Pluripotency and tutipotency	15
MODULE 2: Early development of model organism: chick	2.1: Chick: cleavage, gastrulation, primitive streak, epiboly 2.2: Development upto three days of incubation 2.3: Extra embryonic membranes of chick development, structure and functions of yolk sac, amnion, chorion and allantois	15
MODULE 3: Growth and regeneration	3.1: Nuclear transplantations and embryonic inductions 3.2: Size and proportion, aging, theories of ageing, postnatal disorders of growth and differentiation 3.3: Distribution of regenerative capacity, Planarian regeneration, regeneration of limb and tail in vertebrates 3.4: Hejmadi Mohanty’s experiment	15

PRACTICAL COMPONENT OF ZOO-V.C-7 (DURATION -02 HRS /WEEK)		
SR. NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1)	Observation of developmental stages of sea urchin: cleavage, blastula, gastrula (permanent slides)	01
2)	Study of morphogenetic movement *in vivo* in hens egg using vital staining technique by preparing window opening	02
3)	*In vitro* observation of different extra embryonic membrane in a six days old chick embryo	01
4)	Preparation of permanent slides of chick embryo: 24 hours, 36 hours,48 hours, 72 hours	06
5)	Effect of retinoic acid on regeneration of fin in fish	01
6)	Mounting of eye vesicles and limb buds of six day old chick embryo	01

REFERENCE BOOKS:

1. *Gilberts, S.F. (2013). Developmental Biology, Sinauer Associates, Sunderland.*
2. *Jain, P.C. (2013). Elements of developmental biology, Vishal Publications, Jalandhar*
3. *Slack, J.M.W. (2006). Essential developmental biology. Blackwell Publishing, U.K.*

REFERENCE BOOKS FOR PRACTICALS:

1. *Beffa – Mari, M. And J. Knight (2005) Key experiments in practical developmental biology. Cambridge University Press.*
2. *Tyler, M.S. (2000) Developmental biology, a guide for experimental study. Sinauer Associates, Inc. Publishers, Sunderland, MA.*

<table>
<tr><th colspan="2">ELECTIVE COURSE: MOLECULAR GENETICS AND FORENSIC SCIENCE</th></tr>
<tr><td>COURSE CODE</td><td>ZOO-V.E-9</td></tr>
<tr><td>MARKS</td><td>100 [75 – Theory; 25 – Practicals]</td></tr>
<tr><td>CREDITS</td><td>04 [03 – Theory; 01 – Practical]</td></tr>
<tr><td>CONTACT HOURS</td><td>THEORY : 45 HOURS (03 LECTURE/WEEK)
PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)</td></tr>
<tr><td>COURSE OBJECTIVES</td><td>• This course will ellucidate the functional aspects of the genetic material at molecular level, focusing on gene expression and gene regulation.
• It will also expose students to the basics of forensic science and understand diagnostic genetics.</td></tr>
<tr><td>COURSE OUTCOME</td><td>Upon successful completion of the course, students will be able to:
• CO1: Understand and explain the process of replication, transcription and translation
• CO2: Differentiate between the gene expression in prokaryotes and eukaryotes
• CO3: Understand the Branches of forensic science
• CO4: know the application of molecular tools in genetic diagnosis</td></tr>
</table>

ZOO-V.E-9: MOLECULAR GENETICS AND FORENSIC SCIENCE		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1 : Gene Expression and Gene Regulation	1.1 : DNA Replication: DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication 1.2: Transcription: transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors 1.3 : Translation: Genetic code, Process of protein synthesis, Difference between prokaryotic and eukaryotic translation, Post Transcriptional Modifications and Processing of Eukaryotic RNA 1.4: Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac-operon and trp-operon; Transcription regulation in eukaryotes: Activators,repressors, enhancers, silencers elements; Gene silencing	15
MODULE 2 : Basics of Forensic Science	2.1 : Definition, overview of Disciplines of Forensic science 2.2: Crime and Crime Scene management: Types of crime scenes – indoor and outdoor. Securing and isolating the crime scene. Crime scene search methods. Safety measures at crime scenes. Legal considerations at crime scenes. Documentation of crime scenes – photography, videography, sketching and recording notes. 2.3: Forms of forensic evidences: -Biological evidence: Bloodstains, hair, semen, DNA -Physical and trace evidence –pattern of blood stains, fingerprints, fibres, weapons - Documents- types of forensic documents (genuine /forged),methods of detecting forged documents(handwriting analysis, Analysis of paper and inks)	15
MODULE 3 : Diagnostic Genetics	3.1 : Cytogenetics/ Molecular Cytogenetics/ Biochemical/ Molecular methods of detecting genetic disorders - Adult and Newborn screening 3.2: Cytogenetics/ Molecular Cytogenetics/ Molecular methods of detecting genetic disorders – Prenatal and Preimplantation screening 3.3: Forensic testing - DNA fingerprinting, paternity testing, personal /individual identification	15

PRACTICAL COMPONENT OF ZOO–V.E-9: MOLECULAR GENETICS AND FORENSIC SCIENCE (DURATION -02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Isolation of DNA from peripheral blood/tissue (chick liver).	01
2	Microscopic examination of Hair a. Human scalp Hair b. Animal Hair	03
3	Sketching and Photography of various type of crime scene.	03
4	Presumptive Tests for Blood a. Phenolphthalin Assay	01
6	To perform ridge tracings and ridge counting	01
7	Analysis of DNA fingerprints	03

REFERENCE BOOKS :

1) *J. Prahlow (2010); Forensic Pathology for Police, Death Investigators, Attorneys, 17 and Forensic Scientists, DOI 10.1007/978-1-59745-404-9_2, C Springer Science + Business Media, LLC (Ebook available)*
2) *Robert Schleif (1993). Genetics and Molecular Biology. S E C O N D E D I T I O N. Department of Biology,The Johns Hopkins University, Baltimore, Maryland. The JohnsHopkins University Press 2715 North Charles Street Baltimore, Maryland 21218-4319, The Johns Hopkins Press Ltd., London (Ebook available)*
3) *Richard Saferstein (2011); Forensic Science,II Edition, Prentice Hall publishers, Sanfrancisco*
4) *Griffith A, Wesseler S, Lewontin R Gelbart W, Suzuki D and Miller J(2000). Introduction to Genetic Analysis. Eigth Edition.(Ebook available)*
5) *Tom Strachan and Read A (2010): Human Molecular Genetics. Fourth Edition. Garland Science Publisher, New York, NY 10017*

REFERENCES BOOKS FOR PRACTICALS:

1) J. Prahlow (2010); Forensic Pathology for Police, Death Investigators, Attorneys, 17 and Forensic Scientists, DOI 10.1007/978-1-59745-404-9_2, C Springer Science+Business Media, LLC (Ebook available.)

ELECTIVE COURSE: ECONOMIC ZOOLOGY	
COURSE CODE	ZOO-V.E-10
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	• To study the various aspects of economic zoology • To study the species of economic importance, classification • To gain an insight whether own business can be started based on studying the zoological species and their products
COURSE OUTCOME	Upon successful completion of the course, students will be able to: • CO1: Understand how zoological species contribute to economic sources. • CO2: Gain working knowledge of techniques of rearing organisms. • CO3: Get acquainted with maintenance of the species • CO4: Understand the underlying principles of harvesting products from species.

ZOO-V.E- 10 : ECONOMIC ZOOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1 : Scope of Economic Zoology	1.1 : Economic Zoology, History, Scope, 1.2 : Species of bionomic importance (Honey bee, Silkworm, lac insect, mackerel, domestic fowl, goat, sheep, cow, buffalo, pig, rats, mice) 1.3 : Source, properties, constituents and nutritive value of products of bionomic importance: eggs of poultry, milk, meat, honey, medicinal value of synthetic insulin (recombinant), significance of wool, silk, lac 1.4 : Organizations and their functions: agricultural and processed food products export development authority (APEDA), the marine products exports developmental authority (MPEDA), central silk board (CSB), central bee research and training institute (CBRTI), pharmaceutical and biotechnology industries (Lupin) and contract research organizations (Intox), and research institutes (NIN, Hyderabad)	15
MODULE 2 : Models in Economic Zoology	2.1 : Insects, products and applications : lac insects, honey bees, silkworms 2.2 : Vermiculture: Rearing and maintenance of earthworms 2.3 : Aquaculture : rearing and maintenance of prawns,oysters, edible and ornamental fishes 2.4 : Poultry : rearing and maintenance of domestic fowl, applications and products 2.5 : Business models of apiculture, sericulture, aquaculture and poultry	15
MODULE 3 : Pharma products and biological control	3.1 : Pharmaceuticals from animals and their Applications (antiserum), from transgenic animals (malaria vaccine, alpha 1 antitrypsin, lactoferrin, fibrinogen) 3.2 : Species used in biological control : *Casnoidea indica*, Trichogramma, *Poecilia reticulata / Gambusia affinis* 3.3 : Maintenance and breeding of animals for research: mice, rats, guinea pigs, rabbits, marmosets, guidelines given by committee for the purpose of control and supervision of experiments on animals (CPCSEA)	15

PRACTICAL COMPONENT OF ZOO-V.E-10 ECONOMIC ZOOLOGY (DURATION - 02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Vermicomposting	05
2	Preparation of dairy products from milk : cheese and butter	02
3	Laboratory observations of insects – Honeybee, Silk moth, Lac insect	01
4	Visit to dairy industry/poultry/ piggery/apiary/silk industry/ biotechnology industry/pharmaceutical industry/research institute	04

REFERENCE BOOKS :

1) *G. S. Shukla, V. B. Upadhyay (2008) Economic Zoology, Rastogi Publications, Meerut*
2) *H. Osborn (1908) Economic Zoology an introductory text book in zoology with special reference to its applications in agriculture, commerce and medicine The Macmillan Company*
3) *K. P. Shrivastava, Gs Dhaliwal (2015) Text Book of Applied Entomology Kalyani Publishers*
4) *P. K. Gupta (2011) Vermicomposting for Sustainable Agriculture, Agrobios India Ltd*
5) *S. Singh (1962) Bee-Keeping in India ICAR New Delhi p. 214*

REFERENCE BOOKS FOR PRACTICALS:

1) *A. K. Tripathi(2009)Mulberry Sericulture: Problems And Prospects Aph Publishing Corporation*
2) *C.L. Metcalf and W.P Flint (1962) Destructive and Useful Insects New York, N.Y. :McGraw-Hill*

ELECTIVE COURSE: BASIC AND APPLIED ENTOMOLOGY	
COURSE CODE	ZOO-V.E-11
MARKS	100 (60 hrs)
CREDITS	04
CONTACT HOURS	Theory: 45 HOURS [03 Lectures Per Week) and activities of 15 HOURS.
COURSE OBJECTIVE	• To develop a strong foundation in entomology, including understanding of the importance of insects to the human society. • To review important areas in insect biology such as morphology, physiology, ecology, behaviour, genetics, phylogeny, ontogeny and population biology. • To develop a sufficient background for advanced entomology.
COURSE OUTCOME	Upon successful completion of the course, students will be able to: • CO1: Be familiar with the identification of bio economical species. • CO2: Identify entrepreneurial opportunities in entomology. • CO3: Important insects and their products. • CO4: Insect pests of public health and veterinary importance and their management.

ZOO-V.E-11: BASIC AND APPLIED ENTOMOLOGY		
MODULE	**TOPIC**	**CONTACT HOURS**
MODULE 1 Fundamentals of Entomology	Unit 1: Class Insecta: • Salient features • Classification of insects up to orders – an overview Unit 2: Morphological studies: • of antenna, wings, legs, Mouth parts Unit 3: Techniques: • Collection of insects • Preservation of insects	15
MODULE 2 Bionomics and control of crop pests and medically important pests	Unit 4: Pest of agricultural importance: • Paddy pests, cashew pests, coconut pests, areca nut pests, stored grain pest, sugarcane pests, vegetable pests, fruit pests (two pests from each of the above) Unit 5: Insects of medicinal importance: • mosquitoes, housefly, sand fly, cockroaches, human lice, bed bug, rat fleas Unit 6:Termites: • social organization, termitaria and termite control measures	15
MODULE 3 Useful insects and pest management	Unit 7: Useful insects: • Honeybees (Apiculture); Mulberry silk worm(sericulture); lac insects (lac culture) Unit 8: Insect pest control methods: • biological, chemical (attractants, pheromones and hormones), Integrated Pest Management (IPM) Unit 9: Role of insects in ecosystem services	15
MODULE 4 Field based Study	<u>Field based study report:</u> • Identification and study of agricultural pests / pest of fruits / vegetables. • Insect collection techniques: light traps, sweep net, Berlese funnel. • Study of insects of college campus dragon fly/ pests of different plants • Visit to ICAR old Goa/ Gov.t of Goa agriculture department/national Malaria research Institute	15

REFERENCE BOOKS:

1) Aitwal, A.S (1993): Agricultural pests of India and South East Asia. Kalyani publication, New Delhi.
2) Awasthi,V.B (2007):Introduction to general and applied entomology ,2nd edition. Scientific publishers India Jodhpur.
3) David, B.V. and Ananthakrishnan, T.N (2006): General and applied entomology, 2nd edition Tata McGraw hill, New Delhi.
4) Reddy,D.S(2010) Applied entomology,2nd edition New Vishal publications

REFERENCE BOOKS FOR PRACTICALS:

1. Fenemore, P.G. and Prakash, A. (1995): Applied Entomology, Wiley Eastern Limited new age international.
2. Varasi, M.S. (1992): Text book of entomology, Himalaya Publishing House, 1st edition.

ELECTIVE COURSE: FISH PRESERVATION AND PROCESSING	
COURSE CODE	ZOO-V.E-12
MARKS	100 (60 hrs)
CREDITS	04
CONTACT HOURS	Theory: 45 HOURS [03 Lectures Per Week] and activities of 15 HOURS.
COURSE OBJECTIVES	• To familiarize the students with different methods of fish preservation and processing • To acquaint them with techniques and precautions for hygienic fish handling • The course content is locally relevant and prepares students for entrepreneurship and self employment
COURSE OUTCOME	Upon successful completion of the course, students will be able to: • CO1: gain understanding of the economic benefits of fishes. • CO2: They will also be able to understand the nutritional values of the fishes • CO3: Perform some protocols of Fish processing and preservation. • CO4: Aquaint oneself with the processes at fish processing industry

ZOO-V.E- 12 : FISH PRESERVATION AND PROCESSING		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Fishery Development	1.1 : Status of Development of the fishery and seafood processing industry. 1.2: Empowerment through Aquatic Products: (Background,Nutritionalsecurity,Role ofFisheries Fisheries Sector,Role of Tifac in Fisheries Sector,Objectives,Integrated Fisheries Project(IFP),Indian national centre for ocean information services (INCOIS), Catch per unit effort (CPUE), Maximum sustainable yield (MSY	15
MODULE 2: Fish Handling and preservation	2.1: Recent Scenario: Quality Changes and Shelf life of Chilled Fish,Theeffect of Hygiene duringhandling 2.2: Fish Handling Methods: Organoleptic test, Assessment of Fish Quality,Quality assessment of Fresh Fish,Quality Assessment of Fish Products,Physical methods,Assurance of Fresh Fish Quality, Post harvest Changes in Fish,How does a Fish Lose its Quality, fish as vectors of zoonotic diseases 2.3: Fish Preservation: Reasons for Spoilage of Fishes,Methods of Fish.	15
MODULE 3: Value of Fish	3.1:Economic Importance of Fish:Food value,Fish By-Products, surimi, Goan fish para, balchao 3.2: Postmortem changesin Fish,Bacteriological Changes, Lipid Oxidation and Hydrolysis, Chemical Composition,Lipids,Proteins,N- containing Extractives,Vitamins and Minerals, 3.3: Aquatic Resources and their utilization, value added product: chitin	15
MODULE 4 Field/activity based Study	Field Based study: Visit to Fish Processing Centre/ Fishing Co-operative Society / Fishery Institute/Fishery survey of India, Vasco (FSI) to study the following: 1) Quality control of fishes 2) Fish parasites (ecto and endo) 3) Fish filleting, 4) Fish preservation (salting/ pickling)	15

REFERENCE BOOKS :

1) Braj Kishore Singh (2008) Applied Fisheries and Aquaculture Swastik Publishers and Distributers Delhi,India

2) Pandey and Shukla (2015) Fish and Fisheries, IIIrd Revised Edition, Rastogi Publications Meerut, India

REFERENCE BOOKS FOR PRACTICALS:

1) Braj Kishore Singh (2008) Applied Fisheries and Aquaculture Swastik Publishers and Distributers Delhi,India

2) Pandey and Shukla (2015) Fish and Fisheries, IIIrd Revised Edition, Rastogi Publications Meerut, India

SEMESTER VI:

CORE COURSE: WILDLIFE BIOLOGY	
COURSE CODE	**ZOO-VI-C-8**
MARKS	100 [75 -Theory; 25-Field based report]
CREDITS	04
CONTACT HOURS	Theory: 45 HOURS [03 Lectures Per Week] Fieldbased work: 15 HOURS.
COURSE OBJECTIVES	• This course is designed to enable students to understand the basics of wildlife status, conservation, assessment and management.
COURSE OUTCOME	Upon successful completion of the course, students will be able to: • CO1: Apply the techniques used in assessment and monitoring of wildlife. • CO2: Understand the basics of wildlife status, conservation, assessment and management. • CO3: Know about the diversity, extent, range of wildlife population dynamics. • CO4: Know the rules, regulations and factors governing wildlife.

ZOO-VI-C-8: WILDLIFE BIOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Introduction To Wildlife	UNIT 1: Introduction to wildlife • Values of wildlife - Conservation ethics, Importance of conservation, Causes of depletion, World conservation strategies. UNIT 2: Evaluation and management of wildlife • Habitat analyses, Physical parameters: Topography, Geology, Soil and water. • Biological Parameters: food, cover, forage, browse and ground cover estimation. • Standard evaluation procedures: remote sensing and GIS.	15
MODULE 2: Population Estimation And Protected Areas	UNIT 3: Population estimation • Population density, natality, mortality, fertility schedules and sex ratio computation. • Analysis of scat and dropping of ungulates and carnivores. • Trichotaxonomy, pug marks and census method based on indirect evidences. UNIT 4: Protected areas • Protected Area network (PAN): National parks and wildlife sanctuaries. • Biogeographical features of important features of protected areas in India (any 3). • Tiger conservation - tiger reserves in India, challenges and management of tiger reserves.	15
MODULE 3: Management Of Wildlife	UNIT 5: Management of habitats • Setting back succession, grazing logging, mechanical treatment, advancing the succession process, artificial feeding grounds. • Cover construction, preservation of general genetic diversity, restoration of degraded habitats, UNIT 6: Management planning of wildlife in protected areas • Habitat carrying capacity, visitors carrying capacity, eco tourism / wild life tourism, concept of climax persistence, ecology of perturbance. • Role of national / state statutory bodies on governing wildlife (NBWL, IUCN, CITES, state wildlife boards and forest department). UNIT 8: Management ofcritical population • Radio- telemetry, care of injured and diseased animal, quarantine, common diseases of wild animals, capture and translocation of wildlife. • Captive management – a brief idea.	15

MODULE 4: Field based Practicals	Field based study report on: • Study of butterflies and their host plants on the campus / molluscs/ ants/ spiders / birds • Any two biodiversity monitoring by various field techniques for flora and fauna: • Trail / transect-quadrate monitoring for abundance and diversity estimation of mammals and birds (direct and indirect evidences) (on campus or fieldtrip) • Identification of animals through pug marks, hoofmarks, scats, pellet groups, nest, antlers, feathers, etc. • Local case study report of wild life conflict Use of compass, binoculars, spotting scope, range finders, Global Positioning System on field.	15

REFERENCE BOOKS:

1. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
2. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence. Cambridge University.
3. Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5th edition. The Wildlife Society, Allen Press.
4. Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences
5. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.

ELECTIVE COURSE: HEALTH AND NUTRITION	
COURSE CODE	**ZOO-VI-E-13**
MARKS	100 [75 –Theory ; 25- Practical]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES	• This course is an introduction to the nutrients, their functions and role in maintaining good health of humans.
COURSE OUTCOME	Upon successful completion of the course, students will be able to: • CO1: Know about nutrients and their function • CO2: Read and interprete food labels. • CO3: Correlate role of lifestyle and food habits in causing diseases. • CO4: Prepare Diet Plans for different age group individuals.

ZOO-VI-E-13: HEALTH AND NUTRITION		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: BASIC CONCEPT OF FOOD AND NUTRITION	UNIT 1: Overview of health and nutrition • Definition of health and nutrition • Scope of nutrition, food as a source of nutrients • Nutrients and energy • Adequate, optimum and balanced diet • Malnutrition and health. UNIT 2: Nutritional Biochemistry • Carbohydrates, lipids, proteins - definition, classification, structure and properties • Significance of acid value, iodine value and saponification value of lipids • Essential and non-essential amino acids • Enzymes- definition, classification, properties(overview). • Coenzymes, vitamins (fat soluble and water soluble), structure and properties • Minerals- iron, calcium, phosphorus, iodine, selenium and zinc and their properties	**15**
MODULE 2: NUTRIENTS AND DIETARY PATTERN FOR HUMANS	UNIT 3: Functions of food components of food-nutrients • Biochemical role and dietary sources of macro and micronutrients (carbohydrates, lipids and proteins, fat soluble vitamins-A, D, E and K , water soluble vitamins – thiamin, riboflavin, niacin, pyridoxine, folate, vitamin B12 and vitamin - C Minerals – calcium, iron and iodine). • Changes of nutrient value during cooking of the following food groups: cereals, pulses and vegetables. Nutrient loss - dry, moist, frying and microwave cooking. UNIT 4: Nutrition and dietetics • Physiological considerations, nutrient needs and dietary pattern for various groups- adults, pregnant and nursing mothers, infants, pre-school and school children, adolescents and geriatric nutrition.	**15**

MODULE 3: DIET RELATED DISEASES	UNIT 5:Health and diseases • Major nutritional deficiency diseases- protein energy malnutrition, Vitamin deficiency, iron deficiency anaemia, iodine deficiency disorders, their causes, symptoms, treatment, prevention and government programmes, if any. • Life style related diseases- obesity, hypertension, hyperurecimia, diabetes mellitus, polycystic ovarian disease (PCOD) - their causes and prevention through dietary/lifestyle modifications. • Social health problems: smoking, alcoholism, drug dependence and Acquired Immune Deficiency Syndrome (AIDS); • Common ailments- irritable bowel disease (IBD), constipation: causes and dietary management UNIT 6: Food hygiene • Potable water- sources and methods of purification at consumer level • Food and water borne infections: bacterial infection: cholera, typhoid, dysentery; viral infection: hepatitis, poliomyelitis, protozoan infection: Amoebiasis, Giardiasis; Parasitic infection: Taeniasis and Ascariasis their causative agent, symptoms, transmission and prevention. • Brief account of food spoilage: Causes and preventive measures	**15**

PRACTICAL COMPONENT OF 'HEALTH AND NUTRITION ZOO-VI-E-13: DURATION (30 HOURS – 02hrs/WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1.	To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric	03
2.	Estimation of lactose in milk	02
3.	Titrametic estimation of: • Ascorbic acid estimation in food • Calcium in food	02
4.	Observation of any two grain pests	01
5.	Project based: • Identify nutrient rich sources of foods, their seasonal availability and price • Study of nutrition labeling on selected foods	04

REFERENCE BOOKS:

1) Mudambi, SR and Rajagopal, MV. (2007). Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; New Age International Publishers.
2) Srilakshmi B. (2002). Nutrition Science; New Age International (P) Ltd.
3) Srilakshmi B. (2007). Food Science; Fourth Ed; New Age International (P) Ltd.
4) Swaminathan M. (2009). Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.
5) Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; Oxford & IBH Publishing Co. Pvt Ltd.
6) Wardlaw GM, Hampl JS. (2007). Perspectives in Nutrition; Seventh Ed; McGraw Hill.
7) Lakra P, Singh MD. (2008). Textbook of Nutrition and Health; First Ed; Academic Excellence.

ELECTIVE COURSE: ECOLOGY AND ETHOLOGY	
COURSE CODE	ZOO-V.E-14
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	• To study the distribution of organisms, their interrelations in populations and communities and interactions between biotic and abiotic components • To study impact of anthropogenic activities on ecosystem and study behaviour of organisms under natural conditions
COURSE OUTCOME	Upon successful completion of the course, students will be able to: • CO1: gain better understanding of concepts of ecology. • CO2: Acquainted with the basics of animal behaviours • CO3: Know strategies of biodiversity conservation, • CO4: Understand mechanisms of sustainable development.

ZOO-VI.E- 14 : ECOLOGY AND ETHOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1 : Basic Ecology	1.1 :Introduction to Ecology : What is Ecology? History of ecology, ecology today, scope of ecology, objective of study,subdivisions of ecology 1.2 : Ecosystem Ecology:kinds of ecosystem,Gaia hypothesis, energy flow within the Ecosystem, food chains, ecological pyramids, ecological niche nutrient and Cycling of trace elements: Cobalt (Co), Molybdenum (Mo) and Lead. 1.3: Population Ecology:survivorship curve and life tables,age distribution,biotic potential of population, growth models, population dispersal, regulation of population, co-operative and disoperative coactions and carrying capacity,predator –prey relationships,symbiosis	
MODULE 2 : Conservation Ecology and Basic Ethology	2.1: Community Ecology:characters of a community, classification of a community,community periodism, community stratification,community succession 2.3:Introduction to Ethology: the history of ethology, types of behavior – instinct and learning,economic andsocial aspect of behaviour, ethologists and their work – Lorenz, Tinbergen, Goodall, M.K. Chandrashekar, animal behaviour :an evolutionary approach 2.4: Concept of Ethology:stimuluous –response concept,reflexes, innate releasing mechanisms,fixed action pattern,ethogram releaser,motivation or drive with respect to hunger and sexual behaviour	
MODULE 3 : Advanced Ethology	3.1 : Approaches to studying behaviour, methods associated with neurophysiological approach,psychological and ethological approach. 3.2: Pheromones :introduction,types of pheromones,the primer pheromones,the imprinting pheromones 3.3:Hormones: effect of hormones on sexual behaviour,maternal behaviour,territorial marking, learning and memory 3.4:Patterns of behavior :feeding, aggressive and reproductive behavior, biological clocks 3.5:Communication behavior :introduction,communication signals,	

PRACTICAL COMPONENT OF ZOO–VI.E-14:ECOLOGY AND ETHOLOGY (DURATION -02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Field Based practicals: • Determination of population density in a natural/ hypothetical community by Quadrats method in intertidal zone. • Report on a visit to National Parks/ Biodiversity Parks/ Wild life sanctuary • Observation of random subjects for understanding human behaviour.	05
2	Study of an aquatic/mangrove ecosystem: Mmeasurement of the area,temperature,turbidity,determination of pH,and dissolved oxygen content (Winkler's method),and free CO_2	03
3	Ethology: • To study the habituation to light stimulus in earthworm/crabs/snails/ spider web • To demonstrate photactic and geotactic responses of the animal provided earthworm/crabs	02
4	Study of Life Tables and plotting of surviourship curves of different types from the hypothetical/real data provided.	02

REFERENCE BOOKS :

1. *Arora, Mohan. P. (2004) : Ecology , Himalaya Publishing House*
2. *Aubrey Manning and stamp Dawkins (1997) : An Introduction to Animal behaviour (fourth edition), Cambridge University Press.*
3. *Dash M. C. (2001) : Fundamental of Ecology , Tata Mc Graw – Hill publishing Company Limited New Delhi*
4. *Felicity Huntingford (1984) : The study of Animal behaviour , Chapman and Hall.*
5. *Hoshang S. Gundevia and Hare Govind Singh (2006) : A Text Book of Animal Behaviour, S. Chand & Company LTD. New Delhi-110055.*
6. *Juneja Kavita (2002) : Ecology , Anmol Publications PVT. LTD. New Delhi-110002 (India)*
7. *Mathur Reena (1994) : Animal Behaviour, Rastogi and Company, Meerut-250002 India.*
8. *Rana, S. V. S.(2003) : Essentials of Ecology and Environmental Science ,Prentice- Hall of India Private Limited , New Delhi-110001*
9. *Ranga, M. M.(2002) : Animal Behaviour Second Enlarged Edition , Agrobios (India)*
10. *Robert A. Wallace (1938) : Animal Behaviour Its Development, Ecology and Evolution , Goodyear Publishing Company, Inc. Santa Monica, California.*
11. *Sharma P.D.(2014-15) : Ecology and Environment, Rastogi Publications. Meerut (12th revised edition) -25002.*
12. *W.H. Thorpe (1979) : The Origins and rise of Ethology, Praeger Publishers.*

ELECTIVE COURSE: LABORATORY TECHNIQUES IN PATHOLOGY	
COURSE CODE	ZOO-VI.E-15
MARKS	100 [75 –Theory; 25- Practical]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC / WEEK) PRACTICAL: 30 HOURS (01 PRACTICAL / WEEK)
COURSE OBJECTIVES	• This course is an introduction to the various techniques used in pathological diagnosis.
COURSE OUTCOME	Upon successful completion of the course, students will be able to: • CO1: Perform basic techniques of cell/tissue processing • CO2: Be Familiar with procedures of tests done for disease detection • CO3: Process various body fluids and tissues for disease detection.. • CO4: Understand the clinical implication of the pathological tests.

ZOO-VI.E-15: LABORATORY TECHNIQUES IN PATHOLOGY

MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Blood Analysis	UNIT 1: Introduction to medical lab techniques and its importance UNIT 2: : Analyses of human Blood: • Ways of obtaining blood samples, precautions and complications. • Methods of estimation and clinical significance of: hemoglobin, Packed Cell Volume (PCV), RBC count, WBC count, Complete Blood Count (CBC), platelets, Erythrocyte Sedimentary Rate (ESR), Differential Leucocyte Count (DLC).	15
MODULE 2: Evaluation Of Excretory Material And Gametes	UNIT 3:.Urine Analyses • Physical characteristics, preservation of urine sample • Gross examination, chemical examination, abnormal constituents and its clinical implications. • Microscopy of urinary sediments UNIT 4: Stool Analyses • Stool tests for protozoan parasites and helminth eggs. • Clinical significance. UNIT 5: Semen analyses: • Constituents of semen • Gross and microscopic, cytochemical examination, clinical implications.	15
MODULE 3: Liver Function Cytology Imaging	UNIT 6: Clinical status of liver function - • Function of liver. • Tests of excretion by liver, evaluation of synthesis in liver, evaluation of enzyme activity. UNIT 7: Clinical cytological studies • Fine Needle Aspiration Cytology (FNAC), Ultrasound guided FNAC, aspiration of intra thoracic masses, • Techniques of preparing cell smears, staining techniques UNIT 8: Medical imaging • X-Ray, PET, CT Scan, MRI, Dexa Scan, Ultrasound, Doppler's Test (using photographs/reports etc).	15

PRACTICAL COMPONENT OF: LABORATORY TECHNIQUES IN PATHOLOGY ZOO-VI.E-15 - (30 HOURS – 02hrs/WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1.	Preparation of blood smears and staining techniques (Leishman's staining, Giemsa staining, Field's staining).	02
2.	Use of different types of anticoagulants, obtaining serum from blood, preparation of cell suspension (blood cells).	01
3.	RBC Count, WBC Count, Differential WBC Count	03
4.	Urine analysis – normal and abnormal constituents	02
5.	Blood sugar estimation using glucometer	01
6.	Estimation of hemoglobin (Sahli's method)	01
7.	Estimation of PCV	01
8.	Estimation of ESR (Wintrobe's / Westergreen method)	01

REFERENCE BOOKS:

1. Sood R (1999). Medical laboratory techniques, Jaypee publishers, New Delhi.
2. Park, K. (2007), Preventive and Social Medicine, B.B. Publishers
3. Godkar P.B. and Godkar D.P (2007). Textbook of Medical Laboratory Technology, II Edition, Bhalani Publishing House.
4. Cheesbrough M (2002)., A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses
5. Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd. New Delhi.

<table>
<tr><th colspan="2">ELECTIVE COURSE: BIOENTREPRENEURSHIP</th></tr>
<tr><td>COURSE CODE</td><td>ZOO-VI.E- 16</td></tr>
<tr><td>MARKS</td><td>100 [75 -Theory; 25- Fieldbased report]</td></tr>
<tr><td>CREDITS</td><td>04</td></tr>
<tr><td>CONTACT HOURS</td><td>Theory: 45 HOURS [03 Lectures Per Week]
Fieldbased work: 15 HOURS.</td></tr>
<tr><td>COURSE OBJECTIVES</td><td>To help students recognize the opportunities of enterprises in the field of life sciences
To encourage students to think independently and explore new vistas
To familiarize them with the basic skills required for a start-up</td></tr>
<tr><td>COURSE OUTCOME</td><td>Upon successful completion of the course, students will be able to:
CO1: understand concept of business Proposals
CO2: familiar with the methodologies and regulations required to start an enterprise
CO3: Identify opportunities available in life science for start-ups.
CO4: Generate Ideas and initiate a Business Plan.</td></tr>
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ZOO-VI.E- 16: BIOENTREPRENEURSHIP		
UNIT	**TOPICS**	**CONTACT HOURS**
MODULE 1: Entrepreneurship Development	Unit 1: Introduction to entrepreneurship: • entrepreneurial competencies and goal setting, bio entrepreneurship, building a bio-enterprise : balance management, capital, technology Unit 2: Introduction to innovation: • identifying business opportunities Unit 3: Raising funds: public and private	15
MODULE 2: Business plan And Guidelines and regulations for entrepreneurship in life sciences	Unit 4: Business model canvas Unit 5: Guidelines and regulations: • Certification and licensing, acts, regulations and guidelines, marketing and export process, accessing university technology, research and development agencies in India Unit 6:Role of micro, medium and small scale industry sector Unit 7: Innovations in research:writing project proposals to various funding bodies such as MHRD, UGC, DST, DBT, etc.	15
MODULE 3: Start -up, quality, safety and procedural compliances in a bio enterprise	Unit 8: Intellectual Property Rights and trademark of biological resources Unit 9: quality, safety and procedural compliances • Bio safety and its implementations • Quality control in entrepreneurship • WHO Guidelines for setting up of a contract research organization. • Starting a research laboratory in India – guidelines and permits required	15
MODULE 4: Field and project based component	Field and project based component: -Lateral thinking and testing entrepreneurial competencies of the students - Interactions with successful entrepreneur, Banker/ Angel Investor / workshops on entrepreneurship. -Visit to a bio-startup/ Formulating and presenting Business model	15

REFERENCES:

1. Garg, M.C. (2015) Entrepreneurial development. Guset User.
2. Kolchinsky, P. (2004) The entrepreneurs guide to a biotech startup. 4th edition. www.evelexa.com

Additional reading:

1. Simon, S. 2009. Start with why: How great leaders inspire everyone to take action. Penguin Group (USA) Inc .
2. Welch, J. and Byrne, J.A. 2003. Straight from the gut. Business plus publishers.

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