M.Sc. Syllabus

MSc. Analytical Chemistry

Parvatibai Chowgule College of Arts and Science

POST GRADUATE DEPARTMENT OF CHEMISTRY

SYLLABUS
FOR
POST GRADUATE DIPLOMA IN ANALYTICAL TECHNIQUES
(PGDAT)
ACADEMIC YEAR: 2016-2017

S. No.	COURSE CODE	COURSE NAME	CREDITS	MARKS
SEMESTER I				
1	DCHAT-01	BASIC ANALYTICAL CHEMISTRY	4	100
2	DCHAT-02	SEPARATION METHODS	4	100
3	DCHAT-03	QUALITY IN ANALYTICAL CHEMISTRY	4	100
4	DCHAT-04	FUNDAMENTALS OF MEDICINAL CHEMISTRY	3	75
5	DCHAP-01	LABORATORY ANALYTICAL CHEMISTRY	2	50
6	DCHAP-02	LABORATORY SEPARATION METHODS	2	50
7	DCHAI-01	INTERNSHIP	1	25
SEMESTER II				
8	DCHAT-05	ANALYTICAL CHEMISTRY: FORMULATIONS AND ANALYSIS	4	100
9	DCHAT-06	SPECTROSCOPIC METHODS	4	100
10	DCHAT-07	ELECTRO ANALYTICAL AND OTHER METHODS	4	100
11	DCHAT-08	BIOANALYTICAL AND FORENSIC SCIENCE	3	75
12	DCHAP-03	LABORATORY SPECTROSCOPIC METHODS	2	50
13	DCHAP-04	LABORATORY ELECTRO ANALYTICAL AND OTHER METHODS	2	50
14	DCHAI-02	INTERNSHIP	1	25

SEMESTER I

DCHAT-01: BASIC ANALYTICAL CHEMISTRY

UNIT I **15 hours**

General Introduction: Analytical Chemistry- meaning and analytical prospective, scope and function; language of analytical chemistry- analysis, determination and measurement, the analytical process and good laboratory practices; handling chemicals and other reagent; cleaning and marking of laboratory ware; evaporating liquids; measuring the volume; calibration of volumetric glass ware; measuring the mass; equipment and manipulation associated with weighing; filtration technique; ignition of solids; some important units of measurements; general principles of volumetric analysis; qualitative and quantitative methods of analysis with reference to volumetry; steps in a typical quantitative analysis; classifying analytical techniques; selecting an analytical method- accuracy, precision, sensitivity, selectivity, robustness and ruggedness; scale of operation, equipment; validation of analytical methods (with reference to chromatographic and spectrophotometric methods).

UNIT II **10 hours**

Sampling Technique and Analysis: Principles of sampling; the sampling step; methods of sampling for solid, liquid and gases; effects of sampling uncertainties; sampling hazards; sample pretreatment; preparing sample for analysis; solution and their concentrations; chemical stoichiometry; preparing laboratory samples; determining moisture in samples; decomposing and dissolving the sample; sources of error in decomposing and dissolution; decomposing samples using inorganic acids with open vessel; microwave decomposition; decomposing organic samples by combustion method and inorganic materials by fluxes.

UNIT III **10 hours**

Automation of Analytical Method: An overview of automated system; definition; distinction between automatic and automated system; advantages and disadvantages by automation; types of automated techniques; NM- discrete techniques; discrete techniques, centrifugal fast analyzer; segmented flow methods and basic equipment; special techniques and devices; applications; single channel and multi channel automatic chemical analyzers; industrial process analyzers; infrared process analyzers; automatic elemental analyzers.

UNIT IV **10 hours**

Computer Applications: Operation of a PC and run standard programs and packages like MS-WORD, EXCEL, ORIGIN, SIGMA PLOT, and CHEM SKETCH; to solve Chemistry numerical (numerical taken preferably from Physical Chemistry for plotting first and second derivative curves, linear plots); numerical from Analytical Chemistry, Chemical Kinetics, Electrochemistry, Spectroscopy and other related topics; writing the structures of inorganic and organic molecules, chemical equations and other interesting applications will be taught.

UNIT V **15 hours**

Statistical Treatment of Data: significant figures and computation rules; accuracy and precision; ways of expressing accuracy; methods of expressing accuracy; errors; types of errors; determinate and indeterminate errors; distribution of random errors; propagation of errors; frequency distribution curve; the normal error curve; statistical treatment of finite samples; measure of central tendency; mean, median, range, average deviation, standard deviation and variance; Student’s t /confidence interval of the mean; testing for significance; t test and F test; comparison of two means and two standard deviations; criteria for rejection of an observation; Q- test; control charts; least square method of deriving calibration plots.

REFERENCE BOOKS

1. Skoog, D. A., West, D. M., Holler, F. J., Crouch, S. R., Fundamentals of Analytical Chemistry; 8th Edition
2. Bassett J., Denney R., Jeffery G. H., Mendham J.; Vogel's Text Book of Quantitative Chemical Analysis; 4th Edition. ELBS
3. Christian, G. D., Analytical Chemistry; 6th Edition, John Wiley and Sons, NY
4. Kaur, H., Instrumental Methods of Chemical Analysis; Pragati Prakashan
5. Prichard, E., Quality in the Analytical Chemistry Laboratory; John Wiley and Sons, NY
6. Broun R. D., Introduction to Instrumental Analysis; McGraw-Hill
7. Kumari R; Computers and their Applications to Chemistry, Narosa Publication

DCHAT-02: SEPARATION METHODS

UNIT I **15 hours**

Basic Separation Techniques: General aspects of separation techniques; role of separation technique in analysis; classification and choice of separation method; distribution processes, discrete and continuous equilibrium, distribution behaviour and chemical structure; errors due to separation process; fractionation by evaporation, distillation and sublimation; basic principles of distillation; theory of fractional distillation; operation variables and their effect, relative volatility, reflux ratio, theoretical plates and HETP; batch and continuous process; columns- types and choice; applications; molecular distillation- theory, set up and applications; sublimation- apparatus and applications; dialysis- theory, membranes and their choice; techniques and applications; diffusion- barrier and thermal process; theory, techniques and application; floatation- theory, cell and their operation; collectors, ion- floatation, applications; ultra centrifuge- development, description of apparatus; sedimentation velocity; molecular weight determination.

UNIT II **10 hours**

Solvent Extraction Techniques: Introduction; basic principle; types, mechanism and efficiency of extraction; percentage extraction; role of complexing agents in solvent extraction; extraction equilibrium for chelates; factors affecting extraction- pH, oxidation state, modifiers, synergistic, masking and salting out agents; separation factor; technique of extraction- batch and continuous extraction; continuous and discontinuous counter current extraction; applications of extraction; solid phase extraction; numericals are expected.

UNIT III

Chromatographic Methods

Chromatography **03 hours**

Introduction; definitions; theories; principles and chromatographic techniques; terms and parameters used in chromatography; classification of chromatographic techniques; development of chromatograms; qualitative and quantitative analysis by chromatography.

Paper Chromatography: **02 hours**

Introduction; principle; theory; types; technique; choice of solvent; two dimensional paper chromatography; applications; circular paper chromatography.

Thin Layer Chromatography (TLC): **03 hours**

Definition; mechanism; efficiency of thin layer plates; methodology/technique; criteria for selection of stationary and mobile phases; choice of adsorbents; preparation of plates; spotting; development; identification and detection; reproducibility of R_f values; comparison of TLC with paper chromatography and column chromatography; HPTLC; thin layer ionophoresis and electrophoresis; applications.

Column Chromatography: **05 hours**

Definition; types; principle; elution in column chromatography experimental requirements; theory of development; migration rates of solutes; band broadening and column efficiency; variables affecting column efficiency; Van Deemter equation and its modern version; qualitative and quantitative analysis; applications.

Gas Chromatography: **05 hours**

Principle, comparison of GSC and GLC, instrumentation columns packed and tubular, study of detectors- thermal conductivity, flame ionization, electron capture; factors affecting separation; applications

High Performance Liquid Chromatography: **05 hours**

Instrumentation; mobile phase reservoirs and treatment systems; pumping systems; sample injection system; columns for high performance liquid chromatography; detectors- UV and fluorescence detectors, advantages and applications.

Partition Chromatography: **02 hours**

Introduction, theory, technique; movement of solute in chromatographic column; applications.

Ion Exchange Chromatography **03 hours**

Principles, classification of ion exchange materials, factors affecting ion-exchange equilibrium, ion exchange capacity, applications in analytical chemistry.

Exclusion Chromatography: **04 hours**

Definition; theory; principle; types; gel chromatography; mechanism; instrumentation and applications of gel permeation chromatography (GPC); ion exclusion; its mechanism and applications of ion exclusion technique; inorganic molecular sieves; principle; types of sieves; applications.

Supercritical Fluid Chromatography: **03 hours**

Introduction; important properties; instrumentation and applications.

REFERENCE BOOKS

1. Skoog, D. A., West, D. M., Holler, F. J., Crouch, S. R., Fundamentals of Analytical Chemistry; 8th Edition
2. Macros Y., Kertes A.S., Ion Exchange and Solvent Extraction of Metal Compounds; John Wiley, Inter science
3. Morrison, G. H., Frieiser, F., Solvent Extraction in Analytical Chemistry; John Wiley and Sons, NY

DCHAT-03: QUALITY IN ANALYTICAL CHEMISTRY

UNIT I **10 hours**

Introduction to Quality Control and Quality Assurance: Basic concepts; quality assurance; aspect of specification and tolerance; quality acceptance; sampling reality; cost aspect of quality decisions; quality control in raw materials, production, finished product; law related to quality control; case studies of quality control in various industries like agrochemicals, dyes, petrochemicals, pharmaceuticals, plastics and polymers.

UNIT II

Calibration and Validation

Calibration: **05 hours**

Calibration of various instruments used for drug analysis like UV-Visible Spectrophotometer, IR Spectrophotometer, Spectrofluorimeter, GC, HPLC and HPTLC.

Validation: **05 hours**

Validation of various instruments used for drug analysis like UV-Visible Spectrophotometer, IR Spectrophotometer, Spectrofluorimeter, GC, HPLC and HPTLC.

Regulations: **07 hours**

Regulatory requirements for analytical method validation; International Conference on Harmonization Guideline Q2A: Validation of analytical procedures linearity and range criteria and their role in instrumental method validation.

Quantification: **08 hours**

Role of quantification limit and specificity- Limit of Detection (LOD) and Limit of Quantification (LOQ); Robustness and method validation; Ruggedness of chromatographic method; Ruggedness of sample preparation procedure; Complete method validation package.

Qualification: **05 hours**

Analytical data protocol plan; Revision and change control; Overview of instrument qualification (IQ), operation qualification (PQ) and performance qualification (PQ) of analytical equipment.

UNIT III **20 hours**

Packaging and Regulatory Aspects: Introduction; types of packing materials; regulations acts in food and pharmaceutical industries; testing of material for packing; legal consideration in packing; regulatory aspects of food, drugs and cosmetics; the Drug and Cosmetic Act, 1940; the Drug and Cosmetic Rules 1945; prevention of food adulteration; the prevention of food adulteration Act, 1954; Fruit Product Order; Meat Product Order; I.S.I., Agmark and other standard for foods and cosmetic particularly with reference the testing of foods, drug and cosmetic and the raw material; the government authorities concerned with the testing- their qualification, duties, powers and procedure to be followed; record to be maintain under the Acts; C.G.M.P. and C.G.L.P.S. requirements of QC; procedure for WHO certification.

REFERENCES

1. Lachman; The Theory and Practice of Industrial Pharmacy Edition
2. ICH Q2A Guideline Validation of Analytical Methods Definition and Terminology
3. Schedule M
4. WHO Guideline
5. Swartz M. E. Analytical Method Development and Validation.
6. Wachter A. H., Pharmaceutical Process Validation, Informa Health Care.

DCHAT-04: FUNDAMENTALS OF MEDICINAL CHEMISTRY

UNIT I **10 hours**

Basic Concepts in Medicinal Chemistry: WHO approved definition of drug; modern theories of drug action; stereo chemical aspects of drugs; classification of drugs based on chemical structure; pharmacological action and mechanisms at molecular level; mechanism of drug action- physical and chemical; concepts of pro drugs and soft drugs; quantal dose; graded dose; efficacy; potency; therapeutic index (LD_{50}; CD_5); margin of safety; target of drugs action; concept of receptors; types of receptors; agonist, antagonist, partial and inverse agonist; ion channels; enzyme - specific and non specific; carrier molecules.

UNIT II **20 hours**

Drug Discovery: Drug discovery without lead; lead discovery- random screening; non random screening; computer aided drug design; drug metabolism studies; clinical observations; rational approaches to lead discovery; drug development- lead modification; identification of active part; pharmacophore; fundamental group modification; structure activity relationship; structure modification to increase potency and therapeutic index- homologation, chain branching; ring chain transformation; drug development process- pre-formulation; product development; preclinical studies; acute toxicity; sub acute toxicity; chronic toxicity; mutagenecity and reproductive studies; clinical research- Phase1, Phase2, Phase3; regulatory approval process; cost of drug development; intellectual property in drug discovery- introduction to patents; what can be patented; requirements for patentability; patent restrictions; how are patents obtained.

UNIT III **07 hours**

Pharmacokinetics and Pharmacodynamics: Drug absorption, disposition, elimination; important pharmacokinetic parameters in therapeutics and defining drug disposition; uses of pharmacokinetics in drug development process; novel drug delivery systems; physicochemical parameters: lipophilicity, partition coefficient, electronic ionization constant.

UNIT IV **08 hours**

Physical Properties of Drug Molecule and Drug Stability: Introduction and importance of physical properties; determination of specific and molar refraction; angle of rotation; specific rotation; measurement of optical activity and its importance; determination of dielectric constant and its importance; physical and chemical degradation of drugs; effect of light and temperature on drug decomposition; chemical stability; testing and storage of drugs.

REFERENCE BOOKS

1. Primo P., An Introduction to Medicinal Chemistry; CBS Publishers
2. Kar Ashutosh, Medicinal Chemistry; New Age International Publisher, 4^{th} Edition
3. Foye W. O., Principles of Medicinal Chemistry; Varghese Publisher
4. Ali, M., Text Book of Pharmaceutical Organic Chemistry; CBS Publishers
5. Silvermann, R., The Organic chemistry of drug design and drug action; Academic Press
6. Patrick G. L., An Introduction to Medicinal Chemistry; Oxford Press
7. Pandeya S. S., Dummeck I. R., An Introduction to Drug Design; New Age International

DCHAP-01: LABORATORY ANALYTICAL CHEMISTRY

UNIT I

Non Instrumental Analysis (to be completed in 18 hours)

1. Determination of chloride and sulphate using an adsorption indicator
2. Analysis of iodized table salt
3. Estimation of vitamin A in food products
4. To determine the percentage purity of Epsom salt by complexometric titration
5. Determination of the partial molar volume of glycine/methanol/sulphuric acid by determining the densities of the solutions of different compositions and graphical method

UNIT II

Water Analysis (to be completed in 12 hours)

1. Hardness of water sample
2. Alkalinity of water sample
3. Oil and grease in water sample
4. Dissolved oxygen in water sample
5. Concentration of phosphate in water sample
6. Concentration of total dissolved solid in water sample
7. Concentration of nitrite and nitrate ions in water sample

UNIT III

Analysis of Ores and Alloys (to be completed in 24 hours)

1. **Ore Analysis:** At least **three** of the following

a. Determination of iron from hematite/ magnetite
b. Determination of copper and iron from chalcopyrite
c. Determination of silica and manganese from pyrolusite
d. Determination of silica, aluminium and iron from bauxite
e. Determination of calcium and magnesium from dolomite

2. **Alloy analysis:** At least **two** of the following
   a. Determination of tin and lead from solder
   b. Determination of iron and chromium from mild steel
   c. Determination of copper and nickel from cupranickel
   d. Analysis of nickel-aluminium alloy
   e. Determination of copper and zinc in brass.

UNIT IV (to be completed in 18 hours)

1. To analyze the mixture of aromatic compounds by HPLC
2. Estimation of sugar by copper reduction
3. Estimation of chloride from the given sample by Nephelometric titration using standard $AgNO_3$ solution
4. Estimation of Phosphorus from given fertilizer by colorimetric method
5. To estimate Mg from talcum powder by complexometric titration

UNIT V (to be completed in 18 hours)

1. Investigation of complex formation (e.g. Fe^{3+} salicylic acid system: formula, stability, ΔG value calculation and pH effects)
2. Determination of iodine value of oil/fat
3. Estimation of the purity of a given azo dye by spectrophotometric method
4. Estimation of mercury in skin ointment

DCHAP-02: LABORATORY SEPARATION METHODS

1. To determine the amount of iron by solvent extraction technique in a mixture of Fe^{3+} + Al^{3+} and Fe^{3+} + Ni^{2+} using 8- hydroxyquinoline reagent.
2. UV spectrophotometric determination of aspirin in tablet by solvent extraction.
3. To analyze the mixture of alcohol and ketone, using gas chromatography by calculating the peak characteristics and resolution.
4. To analyze the mixture of aromatic compounds by HPLC.
5. Optimum flow rate for the determination of chloroform using Van Deemter equation.
6. Determination of aspirin, phenacetin and caffeine in a given mixture by using HPLC
7. Gas chromatographic analysis for a mixture of gases like O_2, N_2 and CO_2
8. Analysis of benzaldehyde and benzyl alcohol by HPLC.
9. Quantitative assay of ampicillin in a powder for injection by HPLC.
10. To analyze a mixture (benzene and toluene, anthracene and naphthalene) by HPLC.
11. HPLC analysis of Analgesics in a commercial sample/tablet, Ibuprofen.
12. To develop and validate the analytical method of any one drug using HPLC.
13. Solvent extraction separation of iron from marncrike using diethyl ether and its determination by spectroscopic method.
14. To separate ink pigments in red ink, blue ink and black ink by TLC.
15. To separate the mixture containing amino acids, arginine, glutamic acid, lysine and aspartic acid.
16. To separate methylene blue and malachite green dyes on alumina.
17. Separation of sugars by one dimensional descending paper chromatography.

REFERENCE BOOKS

1. Kitchner J. A., Findlay's Practical Chemistry, Revised, 5^{th} Edition
2. Vogel A. I.; Text Book of Quantitative Inorganic Analysis 6^{th} Edition
3. Das R. C. and Behera B.; Experimental Physical Chemistry
4. Viswanathan B., Raghavan P. S.; Practical Physical Chemistry
5. Kealey D., Blackie; Experiments in Modern Analytical Chemistry, Chapman and Hall
6. Rajbhoj S.W., Chondhekar T. K.; Systematic Experimental Physical Chemistry, Anjali Publication, Aurangabad.

SEMESTER II

DCHAT-05: ANALYTICAL CHEMISTRY: FORMULATIONS AND ANALYSIS

UNIT I

Pharmaceutical Industry, Registration and Assessment of Medicines 04 hours

History of pharmaceutical industry in India; classification of pharmaceutical products; prescription over the counter drugs; pharmacopeia- Indian, British and United States; salient features of Indian pharmacopeia- monographs, tests, standards; introduction; clinical trial applications; product license applications.

UNIT II

Dosage Forms and Formulations 07 hours

Different dosage forms- solid, semi solid, liquid with examples; routes of administration with advantages and limitation; introduction and examples of formulations- aerosols, capsules, creams, emulsions, eye drops, injections, mixtures, ointments, suppositories, tablets; quality control of formulated products; quality control of formulations- phases 1, 2 and 3 trials; sterility testing of pharmaceutical products; microbial contamination of formulated products; biological tests on animals.

UNIT III

Chemical Purity and Control 09 hours

Introduction; the source of impurities in pharmaceuticals; standardization of pharmaceutical chemicals and formulated products; validation; calibration; reference standards; pharmacopeial standards- identification, physical constant, assay, limit tests; general limit test for non-specific impurity; limit tests for non-metallic impurity; metallic impurity; acid radical impurities; control of organic impurity in organic medicinal substances; stability studies; bioequivalence and bioavailability; studies of pharmaceutical formulations.

UNIT IV

Role of FDA in Pharmaceutical Industry 05 hours

Definition of drug; drug cosmetics act; misbranded, adulterated and spurious drug; new drug cosmetics; blood bank; manner of labeling; GMP in brief (Schedule M); FDA; role of FDA; introduction to new drugs; brief summary of different phases of test and approval for formulation of a drug.

UNIT V 05 hours

Impurities in Pharmaceutical Raw Materials and Finished Products

Raw materials; method of manufacture; contamination- atmospheric particulate; cross contamination; errors of microbiological process; packing errors; chemical instability; container contamination; physical changes; temperature effects.

UNIT VI 10 hours

Standardization and Quality Control of Different Dosage Form

Introduction to different dosage forms with IP requirements; analytical methods for tablets (aspirin); additives used in tablet manufacture; capsules (Rifampicin); powders (Sodium benzoate); solutions (saline NaCl); suspensions ($BaSO_4$- limit test for impurities); mouth washes; ointments (salicylic acid); creams; injections (mannitol); ophthalmic preparations (sulphate amine); aerosols (salbutamol); blood products and reporting protocols.

UNIT VI

Test, Assay of Raw Materials and Finished Products 20 hours

Chemical tests and assays- limit test; characteristics of limit tests; specificity; sensitivity; control of personal errors; loss on drying(NaCl); limit test for lead, arsenic, chloride, and sulphate; moisture determination by KFR titration; assay of steroids and identification (IP); biological assays: introduction; prescription of biological assays; biological assay of insulin; tetanus antitoxin; determination of proteolytic activity; determination of A, B, O group and Rh factor; microbiological tests and assays: microbiological assay of antibiotics; standard preparations and units of activity; test, organisms and inoculums; method- cylinder or cup plate method; two level factorial; microbial limit test (preliminary testing, medium soya bean casein digest agar medium only and total microbial count only); test of sterility- membrane filtration method; physical tests and assays: disintegration tests (tablets, capsules and suppositories); dissolution tests for tablets, capsules; uniformity of weight of single-dose preparations; uniformity of content of single-dose preparations; friability of uncoated tablets, contents of packaged dosage forms; powder fineness; particle size by microscopy; particulate contamination; validation of analytical procedures.

REFERENCE BOOKS

1. Skoog, D. A., West, D. M., Holler, F. J., Crouch, S. R., Fundamentals of Analytical Chemistry; 8th Edition
2. Fifield F. W., Kealy D.; Principles and Practice of Analytical Chemistry, Backwell Science Ltd. London
3. Bassett J., Denney R., Jeffery G. H., Mendham J.; Vogel's Text Book of Quantitative Chemical Analysis; 6th Edition. ELBS
4. Christian G. D.; Analytical Chemistry, 5th Edition, John Wiley and Sons, NY
5. Kaur H.; Instrumental Methods of Chemical Analysis, Pragati Prakashan

DCHAT -06: SPECTROSCOPIC METHODS

UNIT I **08 hours**

Fundamental Principles of Spectroscopy: Introduction; region of electromagnetic radiation; properties of electromagnetic radiations; spectroscopy; ground and excited states; interaction of electromagnetic radiation with matter; atomic and molecular absorption; atomic and molecular spectra; units; radiation sources; wavelength selection.

UNIT II **16 hours**

Visible and Ultraviolet Spectroscopy: Introduction; laws of absorption; Beer-Lambert's Law and its limitations; absorbance and transmittance spectrum; presentation of spectral data (using two specific examples of organic and inorganic/coordination compounds) spectrophotometric titrations; applications of visible spectroscopy; Ultraviolet Spectroscopy: introduction; origin of ultraviolet spectra; terms associated with absorption measurements; theory of ultraviolet spectra; instrumentation; measurement of the spectrum; chromophores and auxochromes; bathochromic, hypsochromic, hyperchromic, hypochromic shifts; factors affecting ultraviolet absorption-conjugation and stereochemistry; applications of spectroscopy to organic compounds; general applications of ultraviolet spectroscopy; limitation of ultraviolet and visible spectroscopy.

UNIT III **10 hours**

Infra-red Spectroscopy: Introduction; principle; theory of molecular vibrations; vibrational frequencies; number of fundamental vibrations; factors influencing vibrations; vibrational selection rules; basic instrumentation; sampling techniques; finger print region; spectral features of some class of organic and inorganic compounds; important features in IR spectroscopy; applications of IR spectroscopy; simple numericals on IR spectroscopy.

UNIT V **08 hours**

Surface Analytical Techniques: Introduction, instrumentation and applications of ESCA (XPS), Auger Spectroscopy, SEM and TEM.

UNIT VI **08 hours**

Mass Spectrometry: Introduction, principle, theory, instrumentation; mass spectrum; molecular formula determination of simple organic molecules like alcohols, amines, alkenes, simple aliphatic and aromatic hydrocarbons, halogen compounds; McLafferty rearrangement; metastable ions/ peaks; Nitrogen Rule; general fragmentation modes; mass spectra features of some hydrocarbons; simple problems on mass spectrometry.

UNIT VII **10 hours**

Hyphenated Techniques: Mass spectrometry principle, instrumentation, ionization methods- GC-FTIR, GC-MS, TG-MS (use of stable isotopes), HPLC-MS, random mass spectroscopy; principle, instrumentation and analysis of micronutrients.

REFERENCE BOOKS

1. Nakanisha K.; Spectroscopy and Structure, John Wiley
2. Sharma Y. R.; Elementary Organic Spectroscopy
3. Kemp W.; Organic Spectroscopy, ELBS
4. Kalsi P. S.; Spectroscopy of organic compounds, New Age International
5. Cheney R.; Basic Principles of Spectroscopy, McGraw-Hill,
6. Rao C. N. R., Ferraro G. R., Spectroscopy in Inorganic Compounds, Academic Press,
7. Cheney R.; Basic Principles of Spectroscopy, McGraw-Hill

DCHAT-07: ELECTRO ANALYTICAL TECHINIQUES AND OTHER METHODS

UNIT I **08 hours**

Basic Concepts in Electrochemical Titrations: Introduction, electrochemical cell; introduction to potentiometric methods: reference electrodes- hydrogen gas electrode, saturated calomel electrode, silver/silver chloride; metallic electrodes- electrodes of first, second and third kind; introduction to pH measurement: instrumentation, determination of pH, applications.

UNIT II **06 hours**

Ion- Selective Electrodes: Introduction, electrodes for hydronium ion; non-half-cell ion-selective electrodes; glass membrane electrode, composition, asymmetric potential; acid and alkali errors; solid state and precipitate electrodes; liquid-liquid electrode; gas- and enzyme-sensing electrodes.

UNIT III **15 hours**

Polarography and Voltametric Techniques: Introduction; principle; theory and polarography instrumentation; polarograms; polarographic wave current measurements; half wave potential; derivation of polarographic wave equation; polarographic current and concentration relationship; Ilkovic equation; factors influencing diffusion currents; measurement of polarographic wave height; oxygen interference; role of supporting electrolyte; polarographic wave maxima; advantages and limitations; applications of polarography; principle of voltametry; cyclic voltametry- principle; applications for reversible coupled chemical reactions; differential pulse and stripping voltammetry; Amperometric titrations- introduction, instrumentation, advantages and applications; Bioamperometric titrations.

UNIT IV **12 hours**

Electrogravimetry and Coulometric Techniques: Introduction; Faraday laws of electrolysis; electrical units terms used in electrogravimetry; polarization and its cause; decomposition potential and its significance; over voltage and factors influencing overvoltage; principles of electrogravimetry; instrumentation of electrolysis at constant current and at controlled potentials; applications; Coulometric Techniques: Introduction; electrolysis; electro deposition; controlled current electrolysis; controlled potential electrolysis; introduction, principle of coulometric techniques; general characteristics of coulometric method, coulometric titrations; internal generation of titrant; external generation of reagent; detection of end point in coulometric titration; constant current and controlled potential coulometry; advantages of coulometry; applications of coulometric titrations; stripping coulometry; voltage scanning coulometry.

UNIT V **10 hours**

Thermal Methods of Analysis: Thermogravimeric Analysis(TGA): Introduction; principles; instrumentation; types of thermo balances; sample holders; factors affecting the TG curves; applications; calculations on composition of compounds and percent decomposition; limitation and advantages of TGA; Derivative Thermogravimetry (DTG): Principle and application and its advantages; Differential Thermal Analysis (DTA): Principle; working; theory; instrumentation; factors affecting DTA curves and applications; simultaneous DTA-TGA curves; Differential Scanning Calorimetry (DSC): Introduction; principle; instrumentation; use of thermal analysis in determination of purity of sample. heat capacity; glass transition temperature; crystallization; melting; percent crystallinity determination; applications; Thermometric titration- introduction; theory; instrumentation and applications; Dilatometry- introduction; instrumentation; applications. (Numericals expected)

UNIT VI **03 hours**

High Frequency Titration and Karl Fischer Titration: Introduction; theory; instrumentation; advantages, disadvantage, applications; Karl Fischer Reagent- introduction; water content determination.

UNIT VII **06 hours**

Polarimetry and Refractometry: Introduction, plane polarized light, types of molecules analysed by polarimetry, theory and applications of optical activity; Abbe Refractometer-introduction, instrumentation and applications.

REFERENCE BOOKS

1. Christian G. D.; Analytical Chemistry, 5th Edition
2. Skoog D. A., West D. M., Holler F.J., Crouch S. R.; Fundamentals of Analytical Chemistry; 8th Edition
3. Kaur H; Instrumental Methods of Chemical Analysis, Pragati Prakashan
4. Bassett J., Denney R., Jeffery G. H., Mendham J.; Vogel's Text Book of Quantitative Chemical Analysis; 4th Edition, ELBS
5. Pietrzyk D. J., Frank C. W., Analytical Chemistry, 2nd Edition
6. Wendlandt W. W.; Thermal Analysis, 3rd Edition

DCHAT-08: BIOANALYTICAL AND FORENSIC SCIENCE

UNIT I **10 hours**

Food Analysis, Processing and Preservation: General methods for determination of moisture, carbohydrates; analysis of food like milk, tea, beverages (soft drinks, alcoholic drinks), edible oils and fats; test for common edible oils like ground nut, castor, cotton seed and mustard; detection of purity; rancidity of fats and oils; estimation of rancidity; analysis of preservatives, colouring matter, micronutrients; idea about food processing and preservations; methods of preservations like canning; concentration; freezing; drying; pasteurization; sterilization; irradiation.

UNIT II **15 hours**

Clinical Chemistry: Composition of body fluid; detection of abnormal levels of certain constituents leading to diagnosis of diseases; sample collection of physiological fluids; analysis of physiological fluids- blood, urine and serum; estimation of blood glucose, cholesterol, urea, haemoglobin and billirubin; urine-urea, uric acid, calcium phosphate; physiological and nutritional significance of water soluble and fat soluble vitamins; minerals; analytical techniques for vitamins including microbiological techniques.

UNIT III **05 hours**

Human-nutrition: Theory of enzymes, coenzymes, bacteria, fungi, carbohydrates, essential amino acids, proteins, and lipids DNA and RNA; estimation of enzymes, carbohydrates, essential amino acids, proteins and lipids.

UNIT IV **10 hours**

Toxicology, Narcotics and Psychotropic substances Act: Isolation, identification and determination of: narcotics- heroin, cocaine; stimulants- caffeine, amphetamines; depressants- barbiturates, benzodiazepines; hallucinogens- LSD; coca derivative; coca leaf; manufacture of medicinal cannabis; narcotic drug; opium, opium derivative, opium poppy, poppy straw; psychotropic substance; prohibition of control regulation offence and penalties.

UNIT V **05 hours**

Medicinal and Toilet Preparations Act: Definition of alcohol; medicinal preparation; toilet preparation; classification of medicinal and toilet preparations containing alcohol; denatured spirit; bonded and non bonded manufacture of narcotic, opium; exemption from duty.

REFERENCES

1. Mithal B. M., Textbook of Forensic Pharmacy; National Centre, Calcutta, 9th Edition
2. James C. S.; Analytical Chemistry of Foods, Blackie Academic and Chapman and Hill Publisher, Madras, 1st Edition.
3. Stewart G. F., Amerine M. A.; Introduction to Food Science and Technology Series, Academic Press
4. Shreves Chemical Process Industries; 5th Edition, George Austin McGraw-Hill
5. Holme D. J., Peck H.; Analytical Biochemistry, Longman
6. Allan Cury, Irvins Sunshine, Forensic Analysis; Academic Press Publication

DCHAP-03: LABORATORY SPECTROSCOPIC METHODS

UNIT I

Interpretation Exercise:

1. X-ray powder diffraction analysis of cubic compound and comparison with SEM and TEM
    a. Determination of Lattice constants and Geometry
    b. Particle Size
    c. Density
2. Interpretation of IR spectrum with reference to stretching vibration of: C = N; C = O; N-O; M-O (two examples each from organic and inorganic compound)
3. Identification of organic compounds by their IR spectra for three different functional groups.

4. Interpretation of NMR spectrum with reference to chemical shifts/ UV- vis
5. Interpretation of absorption spectra for:
    a. Verification of the position of ligands in spectrochemical series
    b. Calculation of spectral splitting parameters
    c. Determination of geometry of a given nickel metal ion coordination compound (octahedral, tetrahedral, square planar)
6. Statistical revaluation of spectrophotometric data
7. Analysis of K from NPK fertiliser by Flame Photometry/ AA
8. Analysis of Na from milk powder by Flame Photometry/AAS
9. Identification of organic compounds using combined spectral methods: Mass, UV, IR, PMR, CMR (minimum 6 experiments each of 6 hours duration, simple to complex)
10. To determine the amount of Al/Mg using 8-hydroxyquinoline as complexing agents by spectrophotometric method
11. Photometric titration of Ca and Mg with EDTA
12. Estimation of copper ion and zinc ion by AAS from food samples
13. To estimate the amount of D-glucose in given solution using anthrone reagent by visible spectroscopic method.
14. To estimate the percentage purity of nitrite in sodium nitrite by spectroscopic method
15. Determination of alcohol from beverages using potassium dichromate by spectrophotometric method

DCHAP-04: LABORATORY ELECTRO ANALYTICAL AND OTHER METHODS

1. To determine the percentage composition of two optically active substances D-sucrose and D- tartaric acid by Polarimetry
2. To study the kinetics of inversion of sucrose and determination of catalytic coefficient by Polarimetry
3. To study the variation of refractive index with composition of mixture containing CCl_4 and $CH_3COOC_2H_5$ by Refractometry
4. Analysis of vitamin C in juices and/or squashes by pH metry
5. To determine the step -wise neutralization of a polybasic acid by pH metric method
6. Determination of sulphate by Turbidimetry
7. To study the thermal decomposition of i) Calcium oxalate monohydrate and ii) Copper sulphate penta hydrate using simultaneous TG and DTA apparatus
8. To measure the thermodynamic parameter of nano sized material using DSC technique
9. To determine the molar refractions of methyl acetate, ethyl acetate, n-hexane and carbon tetrachloride and calculate the atomic refractions of H, C and Cl atoms
10. Determination of moisture content in organic compounds using Karl Fischer method
11. To study the thermal decomposition of cobalt oxalate and zinc oxalate.
12. Determination of phosphoric acid in cola beverages by pH titration
13. To determine refractive index of series of solutions of a salt and determine the concentration of salt in given unknown solution by Refractometry
14. To determine pH values of different mixtures of CH_3COONa and CH_3COOH in aqueous solution and determine the dissociation constant of acid
15. To estimate the amount of cadmium ion in unknown solution by polarography

REFERENCE BOOKS

1. Drago R.; Physical Methods in Inorganic Chemistry
2. Daniels F., Williams J.; Experimental Physical Chemistry
3. Das R. C., Behera B.; Experimental Physical Chemistry, Tata McGraw-Hill
4. Kitchner J. A.; Findlay's Practical Chemistry – Revised, 5th Edition
5. Bassett J., Denney R., Jeffery G. H., Mendham J.; Vogel's Text Book of Quantitative Chemical Analysis; 6th Edition. ELBS
6. Viswanathan B., Raghavan P. S.; Practical Physical Chemistry
7. Rajbhoj, S. W., Chondhekar, T. K., Systematic Experimental Physical Chemistry, Anjali Publication, Aurangabad

Parvatibai Chowgule College of Arts and Science

AUTONOMOUS

POST GRADUATE DEPARTMENT OF CHEMISTRY

M. Sc. ANALYTICAL CHEMISTRY
SYLLABUS

SEMESTER I

SEMESTER II

SEMESTER III

SEMESTER IV

2019 - 2020

M. Sc. ANALYTICAL CHEMISTRY COURSE STRUCTURE

Semester	CORE COURSES				ELECTIVE COURES		
I	CHIC-401: General Inorganic Chemistry	CHIC-402: Laboratory Course in Inorganic Chemistry	CHOC-401: Fundamentals of Organic Chemistry	CHOC-402: Laboratory Course in Organic Chemistry	CHAE-401: Analytical Techniques	CHAE-402: Electro analytical Techniques - I	CHIE-401: Topics in Inorganic Chemistry
					CHOE-401: Reaction Mechanisms in Organic Chemistry	CHPE-401: Topics in Physical Chemistry	
II	CHAC-401: Spectroscopy in Chemistry	CHAC-402: Laboratory Course in Analytical Chemistry	CHPC-401: General Physical Chemistry	CHPC-402: Laboratory Course in Physical Chemistry	CHAE-403: Electro analytical Techniques - II	CHIE-402: Environmental Control and Chemical Analysis	
					CHOE-402: Reagents in Organic Synthesis	CHPE-402: Diffraction Methods	
III	CHAC-501: Separation Techniques	CHAC-502: Spectral Methods in Analysis	CHAC-505: Experiments in Analytical Chemistry		CHAE-501: QA and Q C in Analytical Chemistry	CHAE-502: Bio analytical Chemistry	
					CHAE-504: Advanced Mass Spectrometry	CHAE-503: Calibrations and Validation	
IV	CHAC-503: Fundamentals of Chemical Analysis	CHAC-504: Techniques in Chemical Analysis			CHAE-505: Applied Analytical Chemistry	CHAE-506: Advanced NMR Spectroscopy	CHAM-509: Modules in Experimental Chemistry**
					CHAE-507: Chemometrics	CHAD-508: Dissertation*	CHAI-510: Internship Module**

M.Sc. ANALYTICAL CHEMISTRY COURSE STRUCTURE

SEMESTER	COURSES	CREDITS	HOURS
I	**CORE COURSES**		
	CHIC-401: General Inorganic Chemistry	4	60
	CHIC-402: Laboratory Course in Inorganic Chemistry	2	90
	CHOC-401: Fundamentals of Organic Chemistry	4	60
	CHOC-402: Laboratory Course in Organic Chemistry	2	90
	ELECTIVE COURSES		
	CHAE-401: Analytical Techniques	2	30
	CHAE-402: Electro analytical Techniques - I	2	30
	CHIE-401: Topics in Inorganic Chemistry	2	30
	CHOE-401: Reaction Mechanisms in Organic Chemistry	2	30
	CHPE-401: Topics in Physical Chemistry	2	30
II	**CORE COURSES**		
	CHAC-401: Spectroscopy in Chemistry	4	60
	CHAC-402: Laboratory Course in Analytical Chemistry	2	90
	CHPC-401: General Physical Chemistry	4	60
	CHPC-402: Laboratory Course in Physical Chemistry	2	90
	ELECTIVE COURSES		
	CHAE-403: Electro analytical Techniques - II	2	30
	CHIE-402: Environmental Control and Chemical Analysis	2	30
	CHOE-402: Reagents in Organic Synthesis	2	30
	CHPE-402: Diffraction Methods	2	30
III	**CORE COURSES**		
	CHAC-501: Separation Techniques	4	60
	CHAC-502: Spectral Methods of Analysis	4	60
	CHAC-505: Experiments in Analytical Chemistry	4	180
	ELECTIVE COURSES		
	CHAE-501: QA and Q C in Analytical Chemistry	2	30
	CHAE-502: Bio analytical Chemistry	2	30
	CHAE-503: Calibrations and Validation	2	30
	CHAE-504: Advanced Mass Spectrometry	2	30
IV	**CORE COURSES**		
	CHAC-503: Fundamentals of Chemical Analysis	4	60
	CHAC-504: Techniques in Chemical Analysis	4	60
	ELECTIVE COURSES		
	CHAE-505: Applied Analytical Chemistry	2	30
	CHAE-506: Advanced NMR Spectroscopy	2	30
	CHAE-507: Chemometrics	2	30
	CHAD-508: Dissertation*	8	360
	CHAM-509: Modules in Experimental Chemistry	4	180
	CHAI-510: Internship Module	4	180

M. Sc. PART - I
CHEMISTRY
SEMESTER I

CORE COURSES

Course Code: CHIC- 401
Course Title: General Inorganic Chemistry
Credits: 4
Marks: 100
Course Objectives:
The course provides an insight in to the fundamentals of Inorganic Chemistry.

UNIT I: Atomic Structure, Molecular structure and bonding 16 Hours
Atomic Structure: Recapitulation; Atomic parameters: Atomic and ionic radii, ionisation energy, electron affinity, electro negativity (Pauling, Allred-Rochow definition, Mulliken definition); Molecular structure and bonding: Lewis structures, Structure and bond properties, The VSEPR Model: Walsh diagrams (tri and penta-atomic molecules), Valence bond theory: hydrogen nmolecule, homonuclear diatomic molecules, polyatomic molecules, hybridisation. Molecular orbital theory: approximations of the theory (LCAO-MO), bonding and antibonding orbitals, homo nuclear and hetero nuclear diatomic molecules.

UNIT II: Solid State Chemistry 12 Hours
Packing of spheres: unit cell and description of crystal structure close packing of spheres, holes in closed-packed structures; structure of metals: polytypism, structures that are not closed packed, polymorphism of metals, atomic radii of metals, alloys; Ionic solids: characteristic structures of ionic solids, the rationalization of structures, the energetic of ionic bonding, consequences of lattice enthalpy; defects in crystals.

UNIT III: Molecular Symmetry 06 Hours
Symmetry elements and symmetry operations; equivalent symmetry elements and equivalent atoms; symmetry point groups with examples; point groups of very high symmetry; systematic procedure for symmetry classification of molecules and illustrative examples; dipole moment; optical activity and point groups.

UNIT IV: Coordination Chemistry 10 Hours
Coordination Chemistry- Recapitulation; shapes of coordination compounds; bonding in coordination compounds- valence bond theory and crystal field theory; magnetism in coordination compounds; colour of coordination compounds; reaction mechanisms in transition metal complexes in brief.

UNIT V: Organometallic Chemistry 06 Hours
Organometallic Chemistry: Definitions, classification of organo-transition metal complexes, the EAN, 18-electron and 16-electron rules; Synthesis, structure, bonding and important reactions of metal carbonyls, metal nitrosyls, dinitrogen and dioxygen complexes.

UNIT VI: Bioinorganic Chemistry 06 Hours
Metal ions in biological systems, deficiency of trace metal ions (Fe, Zn, Cu and Mn); proteins and their functions- Heme proteins, synthetic oxygen carriers, electron transfer proteins-cytochromes, metalloproteins as enzymes-carboxypeptidase and Vit B12 coenzyme, chlorophyll and its use in photosynthesis.

UNIT VII: Boron Chemistry **04 Hours**

Introduction; borane, carboranes, borazine and its derivatives; compounds of phosphorus: phosphazenes; metal-metal clusters.

TEXT BOOKS:

1. Basic Inorganic Chemistry; F. A. Cotton and G. Wilkinson, 3rd Edition, John Wiley and Sons, Singapore
2. Inorganic Chemistry; D. F. Shriver and P.W. Atkins, Oxford University Press
3. Concise Inorganic Chemistry; J. D. Lee, 5th Edition, Chapman and Hall
4. Solid State Chemistry and Its Applications; A. R. West, John Wiley and Sons, Singapore

REFERENCE BOOKS:

1. Principles of Solid State Chemistry; H. V. Keer, New Age Intl. Ltd, New Delhi
2. Inorganic Chemistry: Principles of Structure and Reactivity; J. E. Huheey, E. A. Kiter, 4th Edition, Addison-Wesley Publishing House
3. Advanced Inorganic Chemistry; F. A. Cotton and G. Wilkinson, 3rd Edition, Wiley Eatern, New Delhi
4. Theoretical Inorganic Chemistry; 2nd Edition; M. C. Day and J. Selbin, Van Nostrand-Reinhold, New York
5. Nature of Chemical bond; L. Pauling, 3rd Edition, Cornell University Press
6. Solid State Chemistry; 2nd Edition, D. K. Chakrabarty, New Age Publishers
7. Coordination Chemistry; D. Banerjea, Tata McGraw-Hill, New Delhi

Course Code: CHIC- 402
Course Title: Laboratory Course in Inorganic Chemistry
Credits: 2
Marks: 50
Course Objectives:

This course deals with the preparation of different coordination compounds and its purity.

Learning outcome:

Students will be able to understand the chemistry of coordination compounds.

Preparation and Characterisation of following Complexes

1. $[Co(NH_3)_6]Cl_3$ and estimation of Cobalt ion in the complex volumetrically
2. $K_3[Cr(SCN)_6].4H_2O$
3. $K_3[Cr(C_2O_4)_3]$ and estimation of oxalate in the complex volumetrically
4. Potash alum from scrap aluminium (at micro scale level); to calculate the percent purity and yield

Quantitative Estimations

5. Estimation of Nitrite by volumetric method
6. Estimation of Calcium in Calcite ore
7. Estimation of Copper in Gun Metal alloy or Devarda's alloy iodometrically
8. Estimation of Nickel as Ni-DMG complex using solvent extraction.
9. To verify the formulae of the complexes like $K_4[Fe(CN_6)]$, $K_3[Fe(CN)_6]$
10. Titrate the Zn (II) by $K_4[Fe(CN_6)]$ and verify the composition of the complex $K_3Zn_3[Fe(CN)_6]_2$
11. Preparation and characterisation study of Metal Oxides by XRD.
12. Spectrophotometric determination of Cr and Ni, individually
13. Estimation of Cu/ Fe/ Zn by AAS method.

Note: Minimum 80 laboratory hours are to be covered in this course

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REFERENCE BOOKS:

1. Vogel's Text Book of Quantitative Chemical Analysis; 3rd and 4th Edition
2. Handbook of preparative Inorganic Chemistry; G. Brauer, Volume: 1 and 2

Course Code: CHOC- 401
Course Title: Fundamentals of Organic Chemistry
Credits: 4
Marks: 100
Course Objectives:
1. To develop knowledge of students on molecular orbital theory.
2. To introduce the concepts of topicity, pro stereoisomerism and chemo-, regio- and stereo selectivity in organic reactions.
3. To focus on various type of reactions in organic synthesis.

Learning Outcomes:
1. To enable students to identify the presence or absence of aromaticity in organic compounds.
2. To enable students to understand and apply various concepts in stereochemistry.
3. To enable students to propose plausible mechanism of organic reactions.

UNIT I: Stereochemistry 18 hours
Configurational Nomenclature: R and S; D and L; E and Z; cis and trans; syn and anti nomenclature; chirality in molecules with two and more chiral centres; conformational analysis of open chain compounds; Erythro and threo nomenclature; structure conformation and stereochemistry of monocyclic cycloalkanes (cyclopropane, cyclobutane, cyclopentane, cyclohexane, cycloheptane and cyclooctane) with simple substituents; Topicity and Prostereoisomerism: Topicity of ligands and faces; homotopic, enantiotopic and diastereotopic ligands and faces; chemoselective, regioselective and stereoselective reactions; stereochemistry of cis and trans-decalins; conformation and reactivity of cyclohexane and substituted cyclohexanes; introduction to stereochemistry compounds containing N, S and P.

UNIT II: Molecular orbitals and delocalized chemical bonding 10 Hours
Qualitative description of molecular orbitals of simple acyclic and monocyclic systems; frontier orbitals; importance of FMOs in organic reactions; conjugation, cross conjugation, resonance, hyper conjugation and tautomerism, alternant and non-alternant hydrocarbons, aromaticity in benzenoid and non-benzenoid compounds; Huckel's rule; annulenes, aromatic, non-aromatic and anti aromatic compounds.

UNIT III: Structure and Reactivity 07 Hours
Acidity and basicity- different concepts, HSAB concept and factors affecting it; effect of structure and medium on acid and base strength, concept of super acids and superbases, Electrophilicity and nucleophilicity, ambident nucleophiles and electrophiles, concepts and examples; tautomerism- concept, tautomeric equilibrium, relation with isomerism; types of tautomerism including ring chain tautomerism and valence tautomerism; prototropic shift in different systems.

UNIT IV: Reaction Mechanism 16 Hours
Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes; types of mechanisms, types of reactions, thermodynamic and kinetic requirements; kinetic and thermodynamic control; the Hammond postulate and principle of microscopic reversibility, methods of determining reaction mechanisms like Identification of products; determination of the presence of intermediates (isolation, detection, trapping and addition of suspected intermediate); isotopic labeling;

stereochemical evidence; kinetic evidence and isotope effect (sufficient reactions to exemplify each method be studied)

UNIT V: Addition to Carbon-Carbon Multiple bonds **04 Hours**

Mechanism and stereochemistry of addition reactions involving electrophiles, nucleophiles and free radicals; addition of HX (HCI, HBr, HI, HOH, R-OH, HCI, NH_3, H_2SO_4 etc.) and halogens like Br_2 to carbon-carbon double and triple bonds in open chain and cyclic compounds; addition of H_2 to C-C multiple bonds; Hydroboration-oxidation and oxymercuration / demercuration.

UNIT VI: Elimination Reaction **05 Hours**

The E_2, E_1 and E_{1cb} mechanisms; orientation of the double bond, Saytzeff and Hofmann rule; effects of changes in the substrate, base, leaving group and medium on: overall reactivity, comparison between E_1, E_2 and E_{1cb} elimination vs substitution; mechanism and orientation in pyrolytic syn elimination (various examples involving cyclic and acyclic substrates to be studied).

TEXT BOOKS:

1. Advanced Organic Chemistry Reaction, Mechanism and Structure; J. March, 4th Edition, Wiley
2. Stereochemistry of Organic Compounds- Principles and Application; D. Nassipuri, 2nd Edition, Wiley Eastern Limited
3. Mechanism and Structure in Organic Chemistry; E. S. Gould et al.
4. Stereochemistry of Carbon Compounds; E. L. Eliel, Tata MacGraw Hill

REFERENCE BOOKS:

1. Stereochemistry and Chemistry of Natural products; I. L. Finar, ELBS, Longmans
2. Stereochemistry; V. M. Potapov, MIR Publishers, Moscow
3. Organic Chemistry; F. A. Carey
4. Organic Chemistry; S. H. Pine, 5th Edition, McGraw-Hill International
5. Advanced Organic Chemistry; F. A. Carey and R.J. Sundberg, Vol I and II, Plenum Press
6. Fundamentals of Organic Reaction Mechanisms; M. Hamis and Carl C. Wamser, John Wiley and Sons
7. Organic Chemistry- A Concise Approach; F. M. Menger, D.J. Goldsmith and L. Mendell
8. Organic Laboratory Techniques; R. J. Fessenden and J. S. Fessenden, Brookes/Cole Publishing Company

Course Code: CHOC- 402
Course Title: Laboratory Course in Organic Chemistry
Credits: 2
Marks: 50
Course Objectives:

1. To apply certain theoretical concepts experimentally.
2. To provide hands on experience of basic laboratory techniques required for organic syntheses.

Learning Outcomes:

1. To enable Students to gain the understanding of stoichiometric requirements during organic syntheses.
2. To enable students to understand safe and good laboratory practices, handling of laboratory glassware, equipment and chemical reagents.

3. To enable students to learn common laboratory techniques including reflux, distillation, steam distillation, vacuum distillation and aqueous extraction.

1. Laboratory Techniques

A. Introduction to safety techniques: First aid; Fire extinguishers; usage of hazardous chemicals

B. Simple distillation: Ethanol-water mixture using water condenser, Nitrobenzene and aniline using air condenser.

C. Steam distillation: Naphthalene from its suspension in water or Clove oil from cloves or separation of *o*-and *p*- nitrophenols.

D. Crystallisation: Concept of induction of crystallization

i. Crystallisation of phthalic acid from hot water using fluted filter paper and stem less funnel;

ii. Acetanilide from boiling water; iii. Naphthalene from ethanol (any one)

iv. Decolorisation and crystallization of brown sugar (sucrose) with animal charcoal using gravity filtration.

E. Sublimation: Simple and vacuum sublimation of camphor and succinic acid

2. Organic Synthesis (any 10 experiments)

i. Aliphatic electrophilic substitution: Preparation of iodoform from ethanol and acetone

ii. Aromatic electrophilic substitution: Preparation of p-bromoacetanilide

iii. Oxidation: i) Benzoic acid from toluene ii) Cyclohexanone from cyclohexanol
iii) Borneol to camphor using Jones reagent (any one)

iv. Reduction: p-nitrophenyl methylcarbinol from p-nitro acetophenone by $NaBH_4$ and purification of the product through distillation under reduced pressure

v. Bromination of an alcohol using KBr/ $KBrO_3$ (at micro scale level)

vi. Grignard reaction: Triphenylmethanol from benzoic acid ester or benzophenone

vii. Aldol condensation: Dibenzal acetone from Benzaldehyde

viii. Acetoacetic ester condensation: Preparation of ethyl-n-butylacetoacetate or ethylacetoacetate

ix. Cannizzaro reaction using 4- chlorobenzaldehyde as substrate

x. Friedel Crafts reaction using toluene and succinic anhydride

xi. Solvent-free preparation of coumarin by the Knoevenagel condensation under micro wave irradiation.

REFERENCE BOOKS:

1. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall
2. Organic Experiments; K.L. Williamson, D. C. Heath
3. Experimental Organic Chemistry; Vol I and II, P. R. Singh, D. S. Gupta and K. S. Bajpai, Tata McGraw Hill
4. Laboratory Manual in Organic Chemistry; R. K. Bansal, Wiley Eastern
5. Green Chemistry, Samuel Delvin, IVY Publishing House, Delhi
6. Organic Chemistry Laboratory; O. R. Rodig, C.E. Bell Jr. and A.K. Clark, Saunders College Publishing, New York
7. Organic Analytical Chemistry; Jag Mohan, Narosa Publishing House, New Delhi
8. Vogel’s Textbook of Practical Organic Chemistry; A. R. Tatchell, John Wiley

ELECTIVE COURSES

Course Code: CHAE- 401
Course Title: ANALYTICAL TECHNIQUES
Credits: 2
Marks: 50
Course Objectives:
This course emphasises on providing knowledge about fundamentals of chromatography and chromatographic techniques and to understand the principle of separation.
Learning outcomes:
Student will be in a position

1. To know the fundamentals of chromatographic separations.
2. To address modern challenges across the chemical, biological, and physical sciences and to isolate and examine chemical and biological species as pure substances.

UNIT I: Introduction to Chromatographic Techniques **04 Hours**
Introduction; definitions; theories; principle of chromatographic technique; terms and parameters used in chromatography; classification of chromatographic methods; development of chromatogram; qualitative and quantitative analysis by chromatography

UNIT II: Thin Layer Chromatography **06 Hours**
Thin Layer Chromatography (TLC): Definition; mechanism; efficiency of thin layer plates; methodology; criteria for selection of stationary and mobile phases; choice of adsorbents; preparation of plates; spotting; development; identification and detection; reproducibility of R_f values; comparison of TLC with paper chromatography and column chromatography; applications.

UNIT III: High Performance Thin Layer Chromatography **02 Hours**
Introduction; instrumentation; methodology; quantitative and qualitative analysis; applications

UNIT IV: Partition Chromatography **03 Hours**
Introduction; theory; technique of partition chromatography; movement of solute in chromatographic column; applications

UNIT V: Paper Chromatography **02 Hours**
Introduction; principle; theory; types; technique; choice of solvent; two dimensional paper chromatography; circular paper chromatography; applications.

UNIT VI: Column Chromatography **05 Hours**
Definition; types; principle; elution in column chromatography experimental requirements; theory of development; migration rates of solutes; band broadening and column efficiency; variables that affect column efficiency; Van Deemter equation and its modern version; qualitative and quantitative analysis; applications

UNIT VII: Ion-exchange chromatography **08 Hours**
Introduction; definitions, principle; synthesis and types of ion exchange resins; requirements for ion exchange resin; basic features of ion exchange reactions; factors affecting ion exchange equilibrium; packing of column; analysis of elute; resin properties- ion exchange capacity; resin selectivity; factors affecting the selectivity; applications.

TEXTBOOKS:

1. Fundamentals of Analytical Chemistry; D. A. Skoog, D. M. West and F. J. Holler, 7th Edition, Sounders College Publishing

REFERENCE BOOKS:

1. Analytical chemistry, G. D. Christian, 5th Edition, John Wiley, New York
2. Principles of Instrumental Analysis, F. J. Holler, D. A. Skoog, S. R. Crouch, 6th Edition, Thomson Books/Cole
3. Analytical Chemistry: Principles, J. H. Kennedy, 2nd Edition, Saunders College Publishing
4. Vogel's Textbook of Quantitative Inorganic Analysis; J. Mendham, R. C. Denney, J. D. Barnes and M. Thomas, 6th Edition, Pearson Education Asia
5. Instrumental Methods of Analysis; H. H. Willard, L.L. Merritt, J. A. Dean, F. A. Settle CBS Publishing New Delhi, 7th Edition
6. Instrumental Methods of Chemical Analysis; G. W. Ewing, 5th Edition, McGraw-Hill
7. Analytical Chemistry: Principles and Techniques; Hargis, L. G, Prentice Hall, New Jersey
8. Basic Concepts of Analytical Chemistry; S. M. Khopkar, Wiley Eastern

Course Code: CHAE- 402
Course Title: Electro analytical Techniques- I
Credits: 2
Marks: 50
Course Objectives:
This course is a rigorous examination of theory and practice of electro analytical chemistry. The main objective is to incorporate the electrochemical measurements using a combination of problem-based learning approach to develop critical thinking skills.
Learning outcomes:
Students completing this course will:

1. Comprehend the factors that must be controlled to obtain reliable and reproducible data from electro analytical experiments
2. Capable of identifying the most appropriate electro analytical technique for a specific analysis

UNIT I: Introduction to potentiometer **12 Hours**
Electrochemical cell; reversible and irreversible cells; EMF series; standard electrode potential; Nernst equation; calculation of cell potential; introduction to potentiometer and potentiometric methods; metallic electrodes- electrodes of first and second kind; reference electrodes- hydrogen gas electrode, calomel, and silver/silver chloride; different types of potentiometric titration; different method for determination of equivalent point; applications.

UNIT II: Ion selective potentiometry: **06 Hours**
Membrane electrodes- classifications and properties; principle, design; theory of ion selective electrodes; membrane potential; selectivity; crystalline liquid membrane and enzyme electrodes; crystalline liquid membrane, enzyme membrane and glass membrane electrodes; solid-state sensors; membrane gas-sensor.

UNIT III: Polarography **08 Hours**
Introduction; basic principle; deposition potential; dissolution potential, polarization of electrode; instrumentation of polarography, advantages and limitations of dropping mercury electrode; polarographic wave, half wave equation (derivation expected), Illkovic equation; supporting electrolytes; interference of oxygen; half wave maxima; applications of polarography; numericals

UNIT IV: Chronomethods **04 Hours**
Introduction, principle, methodology; application of chrono potentiometry, chrono amperometry, and chrono coulometry.

TEXTBOOKS:

1. Fundamentals of Analytical Chemistry; D. A. Skoog, D. M. West and F. J. Holler, 7^{th} Edition, Sounders College Publishing
2. Instrumental Methods of Chemical Analysis; B. K. Sharma.

REFERENCES BOOKS:

1. Analytical chemistry, G. D. Christian; 5^{th} Edition, John Wiley, New York
2. Principles of Instrumental Analysis; F. J. Holler, D. A. Skoog, S. R. Crouch, 6^{th} Edition, Thomson Books/Cole
3. Analytical Chemistry: Principles; J. H. Kennedy, 2^{nd} Edition, Saunders College Publishing
4. Vogel's Textbook of Quantitative Inorganic Analysis; J. Mendham, R.C. Denney, J.D. Barnes and M. Thomas, 6^{th} Edition, Pearson Education Asia
5. Instrumental Methods of Analysis; H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle CBS Publishing New Delhi, 7^{th} Edition
6. Instrumental Methods of Chemical Analysis; G. W. Ewing, 5^{th} Edition, McGraw-Hill
7. Polarographic Methods in Analytical Chemistry; A. M. Bond.

Course Code: CHIE- 401
Course Title: Topics in Inorganic Chemistry
Credits: 2
Marks: 50
Course Objectives:
The course provide an overview of important topics in Inorganic Chemistry

UNIT I: Chemistry of transition and inner transition elements 10 Hours
Transition elements: metallic character, oxidation states, atomic and ionic size, colour, melting and boiling points, ionisation energy, density, magnetic properties, catalytic properties, important compounds and complexes, biological importance, difference between first row and subsequent row elements; inner-transition elements: lanthanides and actinides: occurrence, properties, oxidation states, electronic structure, colour and spectra, magnetic properties, lanthanide contraction, compounds of lanthanides and actinides, separation techniques.

UNIT II: Main group elements and their compounds 10 Hours
Carbon group: allotropes of carbon, C60 and compounds (fullerenes), intercalation compounds of graphite, carbon nano tubes, carbides; compounds of silicon: silanes, silicates and silicones, Zeolites; Nitrogen group: nitrogen activation, oxidation states of nitrogen and their inter conversion PN and SN compounds; Oxygen group: metal selenides and tellurides, oxyacids and oxoanions of S and N; ring, cage and cluster compounds of P- block elements, halogen group: interhalogens, pseudohalogen, synthesis, properties and applications; structure, oxyacids and oxoanions of halogens; compounds of noble gases.

UNIT III: Chemistry of certain Anions 05 Hours
Oxide; hydroxide; alkoxide ions; polynuclear oxo anions; halogen containing anions; sulphide and hydrosulfide anions.

UNIT IV: Acids and Bases 05 Hours
Bronsted acidity, periodic trends in Bronsted acidity, Lewis acidity, classification of Lewis acids and bases, heterogeneous acid-base reactions.

TEXT BOOKS:

1. Inorganic Chemistry; D. F. Shriver and P. W. Atkins, Oxford University Press
2. Concise Inorganic Chemistry; J. D. Lee, 5^{th} Edition, Chapman and Hall

3. Basic Inorganic Chemistry; F. A. Cotton and G. Wilkinson, 3^{rd} Edition, John Wiley and Sons.

REFERENCE BOOKS:

1. Inorganic Chemistry: Principles of Structure and Reactivity; J. E. Huheey, E. A. Kiter, 4^{th} Edition, Addison-Wesley Publishing House
2. Advanced Inorganic Chemistry; F. A. Cotton and G. Wilkinson, 3^{rd} Edition, Wiley Eastern, New Delhi
3. Chemistry of the Elements; N. N. Greenwood and A. Earnshaw, Pergamon Press, Exetr, Great Britain
4. Advanced Inorganic Chemistry; F. A. Cotton, G. Wilkinson, Hurillo and Bochmann, 6^{th} Edition, Wiley Inter science.

Course Code: CHOE- 401
Course Title: Reaction Mechanisms in Organic Chemistry
Credits: 2
Marks: 50
Course Objectives:

1. To introduce electrophilic substitution reactions and mechanisms.
2. To introduce mechanistic concepts of nucleophilic addition to carbonyl group.

Learning Outcomes:

1. To enable students to understand and propose plausible mechanism of organic reactions.
2. To enable students to choose appropriate reagents to carry out substitution reactions.

UNIT I: Aliphatic Nucleophilic Substitution **12 Hours**

The S_N2, S_N1, mixed S_N1 and S_N2 and SET mechanisms; neighbouring group mechanism, neighbouring participation by π and σ bonds, anchimeric assistance; classical and non classical carbocations, phenonium ions, norbornyl system, common carbocation rearrangements; the S_Ni mechanism; nucleophilic substitution at an allylic, aliphatic and vinylic carbon; reactivity effects of substrate structure, attacking nucleophiles, leaving group and reaction medium.

UNIT II: Aliphatic Electrophilic Substitution **03 Hours**

Bimolecular mechanisms: S_E2 and S_Ei; S_E1 mechanism, electrophilic substitution accompanied by double bond shifts; effects of substrates; leaving group and the solvent polarity on the reactivity.

UNIT III: Aromatic electrophilic and nucleophilic substitution **12 hours**

Introduction to general mechanisms involved, reactivity of arenes, product distribution; ipso attack and orientation in benzene with more than one substituent, Friedel-Crafts and related reactions- alkylation, acylation, formylation (Vilsmeier reaction, Gattermann-Koch reaction), Fries rearrangement and Prins reaction; diazotization, nitrosation, nitration, sulphonation, mercuration; introduction to addition-elimination mechanisms and elimination-addition mechanism in aromatic nucleophilic substitution; Ullmann reaction; Schiemann reaction; Von Richter reaction, Sommelet-Hauser rearrangement, Smiles rearrangement.

UNIT IV: Addition to Carbon-Oxygen Multiple Bonds **03 Hours**

Mechanism of condensation reactions involving enolates- Aldol, Knoevenegel, Claisen, Darzen, Stobbe, Perkin and Benzoin reactions; hydrolysis of esters and amides; aminolysis of esters.

TEXT BOOKS:

1. Advanced Organic Chemistry Reaction, Mechanism and Structure; J. March, 4th Edition, Wiley
2. Organic Chemistry; S. H. Pine, 5th Edition, McGraw-Hill International
3. Advanced Organic Chemistry; F. A. Carey and R. J. Sundberg, Vol. I and II, Plenum Press

REFERENCE BOOKS:

1. Organic Chemistry; F. A. Carey
2. A Guidebook to Mechanisms in Organic Chemistry; P. Sykes, 6th Edition, Pearson Education
3. Organic Chemistry; Clayden, Greeves, Warren and Wothers, Oxford University Press.
4. Mechanism and Structure in Organic Chemistry; E.S. Gould et al.

Course Code: CHPE- 401
Course Title: Topics in Physical Chemistry
Credits: 2
Marks: 50
Course Objectives:

1. To study of chemical reactions and physical behaviour that may occur under the influence of visible and ultraviolet light.
2. To understand basic concept of magnetism.
3. To understand the mechanism of the polymerization and its applications.

Learning outcomes:

1. Students will be able to understand the chemistry of the magnetic behaviour of materials.
2. Understand the chemistry of polymers and its applications.

UNIT I: Magneto chemistry **15 Hours**

Introduction; types of magnetism (dia, para, ferro, antiferro and ferrimagnetism), electron spin and magnetic moment; theory of diamagnetism; Langevins theory and paramagnetism; magnetic susceptibility and its measurements by Guoy’s and Quink’s method; application to simple compounds; ranking’s transition metal complexes; ferromagnetism; domain theory; hysteresis in magnetism; ferrimagnetisms; applications of magnetic materials; magnetic anisotropy, magnetic exchange interactions, Neel temperature, magnetic transition; ceramic magnetic materials.

UNIT II: Photochemistry **08 Hours**

Absorption and emission of radiation of photochemical interest (derivation of Einstein’s equation is not expected); Frank-Condon principle; laws of photochemistry; Jablonski diagram illustrating fluorescence and phosphorescence; long range energy transfer, short range energy transfer; flash photolysis and lasers; photo reduction; photo oxidation; photosensitised reactions and photosynthesis; mechanism of chemiluminescence.

UNIT III: Polymers **07 Hours**

Introduction; types of polymers, molecular weight distributions and determination of chain length and conformation, thermodynamics of polymers; degree of polymerization from kinetic data, mechanism of free radical and condensation polymerization; electrically conducting polymers, applications of polymers.

TEXT BOOKS:

1. Magnetic susceptibility; L. N. Muley, Inter science Publishers, New York
2. Fundamentals of Photochemistry, K. K. Rohatgi-Mukherjee, Wiley Eastern, New Delhi
3. Polymer Science and Technology; Joel R. Fried, Prentice- Hall of India Private Limited

REFERENCE BOOKS:

1. Polymer Science, V. R. Gowarikar, V. N. Viswanathan, Wiley Eastern, New Delhi
2. Instrumental Methods of Chemical Analysis; B. K. Sharma

SEMESTER II

CORE COURSES

Course Code: CHAC- 401
Course Title: Spectroscopy in Chemistry
Credits: 4
Marks: 100
Course Objectives:

1. Course deals with the identification and characterization of samples.
2. Organic compounds can be identified using spectroscopic methods.

Learning outcome:

Upon completion of the course students will be able to

1. Know the basic concepts in spectroscopy
2. Understand the different spectroscopic methods in chemistry

UNIT I: General Introduction **06 Hours**

Interaction of electromagnetic radiation with matter and characterization; electronic spectra, molecular structure; quantization of energy; regions of spectrum; atomic and molecular spectra; representation of spectra; radiation sources; monochromators; signal-to-noise; resolving power; width and intensity of spectral transitions;

UNIT II: Atomic Absorption and Emission Spectroscopy **10 Hours**

Flame Emission Spectrometry; Distribution between Ground and Excited States-Most Atoms are in the Ground State, instrumentation, flame and electrothermal atomizers; ICP-AES theory, plasma sources, atomization and ionization, interferences in plasma and flame; Theory of Atomic Absorption Spectroscopy (AAS); theory and instrumentation; Internal Standard and Standard Addition Calibration; application

UNIT III: Electronic spectroscopy **08 Hours**

Theory of electronic spectroscopy; chromophore and auxochrome; instrumentation of spectroscopy; deviation from Beer-Lambert Law; applications of electronic spectroscopy; Fischer-Woodward rule; conjugated dienes, trienes, polyenes; α, ß- unsaturated carbonyl compounds; aromatic hydrocarbons; stereochemical factors.

UNIT IV: Infrared Spectroscopy **08 Hours**

Infrared absorption and molecular structure; near- Infrared spectrometry; molecular vibrations, factors influencing vibrational frequencies; instrumentation FT-IR and sampling techniques; characteristic vibrational frequencies of various functional groups and frequency shifts associated with structural changes.

UNIT V: NMR Spectroscopy **10 Hours**

Introduction and theory of NMR; instrumentation; chemical shift, factors influencing chemical shift; solvents used in NMR; theory of spin- spin splitting and simple spin systems, AB, A2B3, A2B2; factors influencing coupling constant; introduction and principle to C13; off resonance decoupled spectra.

UNIT VI: Mass Spectrometry **10 Hours**

Basic principles; instrumentation; isotope abundances; molecular ion; Metastable ions; fragmentation processes; fragmentations associated with simple components like alcohols, amines, alkenes, simple aromatic and aliphatic hydrocarbons, aldehydes, ketones, halogen compounds.

UNIT VII: Structure determination UV-VIS, IR, NMR, Mass spectra: **08 Hours**

Structure elucidation using UV-VIS, IR, NMR, Mass spectra

TEXTBOOKS:

1. Analytical Chemistry; G. D. Christian; John Wiley 5th Edition.
2. Vogel's Textbook of Quantitative Inorganic Analysis; J. Mendham, R. C. Denney, J. D. Barnes and M. Thomas, 6th Edition, Pearson Education Asia
3. Spectrometric Identification of Organic Compounds; R. M. Silverstein, and F. X. Webster, 6th Edition, Wiley- India

REFERENCE BOOKS:

1. Instrumental Methods of Chemical Analysis; G. W. Ewing, 5th Edition McGraw-Hill
2. Instrumental Methods of Chemical Analysis; H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle CBS Publishing New Delhi 7th Edition
3. Analytical Chemistry: Principles; J. H. Kennedy, Saunders College Publishing, 2nd Edition
4. Spectroscopy of Organic Compounds; P. S. Kalsi, New Age International 2nd Edition
5. Organic Chemistry; R. T. Morrison, R. N. Boyd, Prentice Hall India 4th Edition
6. Organic Spectroscopy; William Kemp, Palgrave 3rd Edition
7. Fundamentals of Molecular Spectroscopy; C. N. Banwell, E. M. McCash, Tata McGraw-Hill, New Delhi, 4th Edition

Course Code: CHAC- 402
Course Title: Laboratory Course in Analytical Chemistry
Credits: 2
Marks: 50

Course Objectives:

1. Provides an overview of the different analytical techniques in analysis.

Learning Outcomes:

Students will be able to:

1. Handle and use various analytical instruments.
2. Perform qualitative and quantitative analysis.

UV-visible Spectrophotometer:

1. Estimation of Iron from Pharmaceutical sample (capsule) by thiocyanate method
2. Estimation of Iron from Pharmaceutical sample (capsule) by 1, 10 phenanthroline method
3. Estimation of K_2CrO_4
4. Verification of law of additivity of absorbances ($K_2Cr_2O_7$ and $KMnO_4$)
5. Estimation of phosphoric acid in cola drinks by molybdenum blue method
6. Estimation of nitrite in water sample (sulphonyl Amine)

Flame Spectrophotometer:

7. Estimation of Na from milk sample
8. Estimation of K from fertilizer

Thermal Studies:

9. TG-DTA studies of $CuSO_4.5H_2O$
10. TG-DTA studies of $CaC_2O_4.H_2O$
11. DSC study on Pharmaceutical product

Volumetric Method:

12. Estimation of Ca in pharmaceutical sample
13. Estimation of Al and Mg in antacid sample

Ion Exchange Chromatography:
14. Separation and estimation of Ni and Co
15. Separation and estimation of chloride and bromide

Solvent Extraction:
16. Extraction of Cu as copper dithiocarbamate (DTC) using solvent extraction and estimation by spectrophotometric method.

REFERENCE BOOKS:

1. Analytical Chemistry; G. D. Christian, 5th Edition, John Willey and Sons
2. Vogel's Textbook of Quantitative Inorganic Analysis; 6th Edition, Pearson Education, Asia
3. Collection of Interesting Chemistry Experiments; A. J. Elias, University Press
5. Quantitative Analysis; 6th Edition, Day and Underwood, Prentice Hall
6. Analytical Chemistry for Technicians; 3rd Edition, Kenkel, Lewis Publishers

Course Code: CHPC- 401
Course Title: General Physical Chemistry
Credits: 4
Marks: 100
Course Objectives:

1. It will help to understand the mechanism of reactions in nature.
2. To understand the concept of micro objects and its solutions with the help of quantum chemistry.
3. To provide a knowledge about thermodynamics and equilibrium systems in detail.

Learning outcomes:

1. Students will be able to apply the knowledge of thermodynamics.
2. Students will be able to propose the mechanism of different reaction taking place in environment.

UNIT I: Quantum Chemistry **20 Hours**
Historical development of quantum theory, Principal of quantum mechanics, wave particle duality, uncertainty principles; operators, functions, Eigen value equations; Schrodinger equation, application to simple system viz. free particle, particle in one dimensional, two dimensional and three dimensional box (quantization, separation of variables, degenerate wave functions); Hydrogen like atoms, Schrodinger equation and its solutions; atomic orbital wave function and interpretation; Hückel MO theory, Secular equations, Secular determinant, delocalization energy, charge density, pi-bond order, free valence, applications to C_2H_4, C_3H_5(radical), C_4H_6, C_4H_4, C_6H_6, C_6H_8.

UNIT II: Thermodynamics **10 Hours**
Thermodynamic properties- Gas laws, Real gasses, Boyle temperature; state and path properties; intensive and extensive properties, exact and inexact differentials, intrinsic energy, enthalpy, entropy, free energy and their relations and significances; Maxwell relations; thermodynamic equations of state; Joule-Thomson effect; Joule-Thomson coefficient for van der Waals' gas, Joule-Thomson effect and production of low temperature; adiabatic demagnetization, Joule-Thompson coefficient, inversion temperature; Third law of thermodynamics; need for the third law; Nernst heat theorem, apparent exceptions to third law, application of third law, use of thermodynamic functions E, H, S and G in predicting direction of chemical change.

UNIT III: Entropy and Third law of Thermodynamics **04 Hours**
Entropy and probability and its relation to partition function and numerical (calculation of entropy)

UNIT IV: Phase equilibria **08 Hours**
Phase rule, discussion of two component systems forming solid solutions with and without maximum or minimum in freezing point curve; Systems with partially miscible solid phases; Three component systems- graphical representation; three component liquid systems with one pair of partially miscible liquids, influence of temperature; systems with two pairs and three pairs of partially miscible liquids; the role of added salts.

UNIT V: Chemical Kinetics **10 Hours**
General introduction to various types of order of reaction including fractional order, comparative study of transition state and collision state theory (derivation not required); free radical reactions, complex reactions such as acetaldehyde decomposition and reaction between H_2 and Br_2; homogeneous reactions and acid-base catalysis; elementary enzyme reactions; autocatalysis and oscillatory reaction; decomposition of ozone, heterogeneous catalysis, Eyring equation.

UNIT VI: Electrochemistry **08 Hours**
EMF series, decomposition potential and overvoltage, electrogravimetry, basic principles, completeness in deposition; separation with controlled potentials; constant current electrolysis; composition of electrolyte; potential buffers; physical characteristics of metal deposits; electroplating and electro less plating; electro synthesis; potentiostatic and dynamic related numerical problems
NOTE: Numerical to be solved in possible units

TEXT BOOKS:
1. Physical Chemistry; P.W. Atkins
2. Quantum Chemistry; Ira N. Levine.

REFERENCE BOOKS:
1. Physical Chemistry; J. M. Castellan.
2. Chemical Kinetics; K.J. Laidler, Tata McGraw Hill
3. Quantum Chemistry; R. K. Prasad
4. Electrochemical Methods; A. J. Bond

Course Code: CHPC- 402
Course Title: Laboratory Course in Physical Chemistry
Credits: 4
Marks: 100
Course Objectives:
This course gives an overview of the different techniques and instruments used in physical chemistry laboratory.
Experiments:
1. To study the kinetics of hydrolysis of ethyl acetate and to determine: Energy of activation; Entropy of activation and Free energy change.
2. To study the kinetics of the reaction between $K_2S_2O_8$ and KI and to determine: Energy of activation; Entropy of activation and Free energy change
3. To determine the order of reaction between potassium $K_2S_2O_8$ and KI by graphical, fractional change and differential methods.
4. To determine the degree of hydrolysis of salt obtained from weak base and strong acid using conductometer.
5. To determine the composition of a mixture of acetic acid, monochloroacetic acid and hydrochloric acid by conductometric titration.

6. To determine the dissociation constants of a dibasic acid (malonic acid) and determine the equivalence point from derivative plot.
7. To determine the dissociation constants of a tribasic acid (phosphoric acid) and determine the equivalence point from derivative plot.
8. To determine formal redox potential of Fe^{2+} /Fe^{3+} and Ce^{3+}/Ce^{4+} system and determine the equivalence point from derivative plot.
9. To study three component system of $C_6H_5CH_3$; C_2H_5OH and H_2O and obtain tie line.
10. To study three component system of CH_3COOH; $CHCl_3$ and H_2O and obtain tie line.
11. To determine the molecular weight of high polymer (polyvinyl alcohol) by viscosity measurement.
12. To determine the molecular weight of high polymer (Polystyrene) by viscosity measurement.
13. To determine CMC of soap by Conductometric measurements

REFERENCE BOOKS:

1. Practical Physical Chemistry; A. Finlay and J. Akitchener, Longman
2. Experimental Physical Chemistry; F. Daniels, J. H. Mathews, Longman
3. Practical Physical Chemistry; A. M. James, J. A. Churchil
4. Experimental Physical Chemistry; D. P. Shoemaker and C.W. Garland, McGraw-Hill
5. Advanced Physical Chemistry; J. B. Yadav, Goel Publishing House, Meerut
6. Systematic Experimental Physical Chemistry; S. W. Rajbhoj, T. K. Chondhekar, Anjali Publication, Aurangabad

ELECTIVE COURSES

Course Code: CHAE- 403
Course Title: Electro analytical Techniques -II
Credits: 2
Marks: 50
Course Objectives:
This course focuses on providing the basic understanding of the fundamental principles of voltammetry with rotating disk-ring electrodes, stripping voltammetry, amperometry. Experimental demonstrations will be designed to improve the basic understanding of these techniques.
Learning outcomes:
After taking this course, the students should be able to
1. Understand the basic concepts of potentiometry and electrodes.
2. Understand what physical or chemical properties of a material can be studied with the commonly used electroanalytical techniques.

UNIT I: Voltammetry **12 Hours**
Introduction; fundamental, excitation signals and instrumentation of voltammetry; working electrodes and modified electrodes; voltammograms; hydrodynamic voltammetry, applications- oxygen sensor and enzyme-based sensor; cyclic voltammetry, pulse voltammetry- differential pulse voltammetry and square wave voltammetry, stripping voltammetry- anodic and cathodic stripping method, voltammetry with microelectrodes, applications of voltammetry.

UNIT II: Karl Fischer Titration **04 Hours**
Introduction; theory; Karl Fischer reagent; types; criterion in selection; methodology for determination of water content in samples and general sample requirement.

UNIT III: Amperometric titrations **05 Hours**
Titrations with two indicator electrodes, instrumentation, electrical circuit, indicator electrodes, reference electrodes, titration procedure, amperometric and potentiometric titrations, advantages and disadvantages of amperometric titrations, applications.

UNIT IV: Coulometry **09 Hours**
Introduction, current measuring device, hydrogen-oxygen coulometer, silver coulometer, iodine coulometer; coulometry at controlled potential; coulometry at constant current; variation in coulometric techniques, coulometric titration of chloride in biological fluids, applications.

TEXT BOOKS:

1. Fundamentals of Analytical Chemistry; D. A. Skoog, D. M. West and F. J. Holler, 7th Edition, Sounders College Publishing.
2. Analytical Chemistry; G. D. Christian, 5th Edition, John Wiley, New York.
3. Vogel's Textbook of Quantitative Inorganic Analysis; J. Mendham, R. C. Denney, J. D. Barnes and M. Thomas, 6th Edition, Pearson Education Asia

REFERENCES BOOKS:

1. Principles of Instrumental Analysis; F. J. Holler, D. A. Skoog, S. R. Crouch, 6th Edition, Thomson Books/Cole
2. Analytical Chemistry: Principles; J. H. Kennedy, 2nd Edition, Saunders College Publishing
3. Instrumental Methods of Chemical Analysis; B. K. Sharma; Goel Publishing House.
4. Instrumental Methods of Chemical Analysis; H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle; 7th Edition, CBS Publishing New Delhi
5. Instrumental Methods of Chemical Analysis; G W Ewing, 5th Edition, McGraw-Hill.

Course Code: CHIE- 402
Course Title: Environmental Control and Chemical Analysis
Credits: 2
Marks: 50
Course Objectives:
1. To describe the sources, effects and mitigation of various types of pollution.
2. To introduce the analysis of greenhouse gases, pesticides, explosives, cosmetics and paints.

Learning Outcomes:
1. To enable students to identify the sources, effects and propose control methods of various types of pollution.
2. To enable students to describe the analysis of greenhouse gases, pesticides, explosives, cosmetics and paints.

UNIT I: Air Pollution **05 hours**
Sources and sinks of gases pollutants; classification and effects of air pollutants on living and nonliving objects; air pollution problems in India; sampling methods for gaseous, liquid and solid pollutants; pollution problems in industrial area; global air pollution problems; green house effect; acid rain; ozone depletion and their consequences on environment; major air pollution disasters; method to control the air pollution; electrostatic precipitation; wet and dries scrubber, filters, gravity and cyclonic separation,

adsorption, absorption and condensation of gaseous effluent; analysis of CO, CO_2, NO_2, SO_2, H_2S.

UNIT II: Water Pollution **10 hours**

Introduction; types; sources and classification of water pollutants; industrial water pollution; constituents of aquatic environment; oxygen contents of water and aquatic life; oxygen electrode and its use; mercury pollution and estimation of organo mercurials; effects of water pollutants on life and environment; method to control water pollution; toxic elements in water; pesticides in water; potable and sanitary water; analytical procedures for analyses of industrial waste water and treatment; aerobic and anaerobic aeration of water; principle of coagulation; flocculation; softening; disinfection; demineralization and fluoridation; dissolved oxygen (DO); Chemical oxygen demand (COD); Biochemical oxygen demand (BOD); Total organic carbon (TOC) and their measurements.

UNIT III: Soil Pollution **04 Hours**

Composition of soil; water and air in soil; classification of pollutants and their characteristics, sources, prevention and control; organic and inorganic components in soil; Nitrogen and NPK in soil; wastes and pollutants in soil; biochemical effect of pesticides; instrumental techniques in environmental chemical analysis; sources of pesticides residue in the soil; pesticides degradation by natural forces, effect of pesticide residue on life; analytical techniques for pesticides residue analysis.

UNIT IV: Analysis of Explosives **03 Hours**

Introduction; general methods; heat of explosion; hygroscopicity; qualitative tests of explosives; quantitative analysis of explosive mixtures; dynamites, blasting caps and electric detonators; solid and liquid propellants; preliminary inspection of sample.

UNIT VI: Analysis of Paints and Pigments **03 Hours**

Introduction; pigment separation; binder and thinner of latex paints; binder and thinner of solvent type coatings; identification of binder; identification and analysis of pigments; identification and analysis of thinner; primers; tests on total coating.

UNIT VII: Chemical Analysis of soaps, detergents and pesticides **05 Hours**

Introduction; soap and synthetic detergent analysis - matter insoluble in alcohol; free alkali; free acid; combined alkali and total anhydrous soap; saponification value; presence of silica as alkaline silicate; ISI specification of detergents; insecticides and pesticides analysis- analysis of BHC, DDT, Malathion, Parathion, 2, 4-dichloro phenoxy acetic acid; herbicides- dalapon, paraquat, Banalin, Butacarb; fungicides- Boardeaux mixture.

TEXT BOOKS:

1. Environmental Chemistry; A. K. De, New Age International Publishers

REFERENCE BOOKS:

1. Standard Methods of Waste and Waste Water Analysis; A. K. De
2. Environmental Chemistry; S. M. Khopkar
3. Environmental Chemistry; B. K. Sharma
4. Introduction to Air Pollution, P. K. Trivedi
5. Environmental Pollution Analysis, S. M. Khopkar
6. Standard Methods of Chemical Analysis; F. J. Welcher, Volume 3, Part-B
7. Cosmetics; W. D. Poucher, Volume I, II, III
8. Environmental Chemistry; Garry. W. Vanloon, 3rd Edition, Oxford University Press

Course Code: CHOE- 402
Course Title: Reagents in Organic Synthesis
Credits: 2
Marks: 50
Course Objectives:
1. To introduce mechanistic aspects of various oxidation processes used in organic syntheses.
2. To introduce mechanistic aspects of various reduction processes used in organic syntheses.

Learning Outcomes:
1. To enable students to choose appropriate oxidizing agent for oxidation of a particular functional group.
2. To enable students to choose appropriate reducing agent for reduction of a particular functional group.

UNIT I: Reduction reactions **12 Hours**
Catalytic hydrogenation- different catalysts used, solvents and equipment, functional group reductions and homogeneous catalytic hydrogenation; reductions by hydride-transfer reagents and related reactions- MPV reduction, $NaBH_4$, $NaB(CN)H_3$, Trialkyl borohydrides, LAH and lithium hydridoalkoxyaluminates, mixed LAH-$AlCl_3$ reagents, DIBAL and Reductions with borane and dialkylboranes; enzymatic reduction involving liver alcohol dehydrogenase/ NADH and Bakers' yeast; other methods of reduction- Wolff-Kishner, Raney Ni desulphurisation, di-imide, low-valenttitanium species, trialkyltin hydrides and trialkyl silanes.

UNIT II: Oxidation reactions **14 Hours**
Oppenauer oxidation, aromatization and dehydrogenation, oxidation of hydroxyl group with Triphenylbismuth carbonate, O_2/Pt catalyst, silver carbonate/celite, sodium bromate/CAN and NaOCl/CH_3COOH; chromium and manganese compounds: oxidation of alcohols, aldehydes, C-C double bonds and C-H bonds in hydrocarbons; peracids and other peroxides: Types of peracids and preparation, oxidation of C-C double bonds in acyclic and cyclic systems, carbonyl compounds, amines and sulfides, allylic C-H bonds and oxidation withmolecular oxygen; Other methods of oxidation involving periodic acid, Na/K metaperiodate, lead tetra acetate, mercuric acetate, selenium dioxide, ruthenium tetroxide, osmium tetroxide, DMSO, thallium nitrate, DDQ, Prevost's reagent and Woodward conditions, ozonolysis, catalytic oxidation over Pt; photosensitised and palladium-catalysed oxidation of alkenes.

UNIT III: Green Chemistry Concepts **04 Hours**
Principles of green chemistry; phase transfer catalysis; microwave synthesis, Green reagents for oxidation and reduction processes, ultrasound synthesis.

TEXT BOOKS:
1. Some Modern Methods of Organic Synthesis; W. Carruthers, Cambridge University Press, Cambridge
2. Advanced Organic Chemistry, Reaction, Mechanism and Structure; J. March, Mc Graw Hill Int. Books Co
3. Advanced Organic Chemistry; F. A. Carey and R. J. Sundberg, Vol I and II, Plenum Press

REFERENCE BOOKS:
1. Modern Synthetic Reactions; Herbert O. House, W. A. Benjamin, INC, 2nd Edition
2. Green Chemistry- Environment Friendly Alternatives; Rashmi Sanghi and M. M. Srivastava, Narosa Publishing House, New Delhi

3. Green Chemistry- Frontiers in Benign Chemical Synthesis and Processes; Paul T. Anastas and Tracy C. Williamson, Oxford University Press, Oxford

Course Code: CHPE- 402
Course Title: Diffraction Methods
Credits: 2
Marks: 50
Course Objectives:
The objective of the course is to give an overview of the diffraction methods in solid state chemistry and to solve structural problems. The second parts of this course the students learn how to use excel to solve problems in X-ray Diffraction and also use excels in Chemistry.
Learning outcomes:
Students will be in a position to interpret the XRD spectra.

UNIT I: X-ray diffraction **10 Hours**
Cubic and hexagonal close packing, radius ratio rule, inter dependence of ionic radii and coordination, crystal geometry, lattice energy; Bravais Lattice, types of unit cells and their characteristics; Principles, instrumentations, scope and limitations of the methods, X-ray scattering factors, Bragg's Law; the powder method, Single- crystal X-ray diffraction

UNIT II: Information from X-ray analysis **10 hours**
Calculations of unit cell dimensions from powder diffraction patterns of cubic, tetragonal and orthorhombic systems, reciprocal lattice concept; X-ray intensity calculations to decide the ionic configurations

UNIT III: Problem solving through Excel **10 hours**
Introduction to spreadsheet based software; Microsoft Excel; development of spreadsheets for some simple test cases viz. Gaussian curve (study of effect of standard deviation and centre of Gaussian); development of spreadsheets for plotting trigonometric functions like sin, cos and their linear combinations (Fourier synthesis); precise lattice parameter measurements; crystal structure determination- cubic; FCC, BCC and Hexagonal

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TEXT BOOKS:
1. Solid State Chemistry and its Applications; A. R. West, John-Wiley and Sons, Chinchester
2. Physical Chemistry; P. W. Atkins, 8th Edition

REFERENCE BOOKS:
1. X-ray diffraction: A practical Approach; C. Suryanarayana and M. Grant, Norton Plenum
Press, New York
2. Elements of X- ray Diffraction; B. D. Cullity, Addison Wisley

M. Sc. PART - II
ANALYTICAL CHEMISTRY
SEMESTER III

CORE COURSES

Course Code: CHAC- 501
Course Title: Separation Techniques
Credits: 4
Marks: 100
Course Objectives:

1. The main objective of this course is to give a theoretical and practical introduction to the techniques of separation.
2. To address modern challenges across the chemical, biological, and physical sciences as it is often necessary to isolate and examine chemical and biological species as pure substances.

Learning outcomes:
The student will be in a position:

1. To be able to describe the methods of separation and its application.
2. To be able to acquire technical knowledge of, and some practical experience with, analyses in gas and liquid chromatography, and in capillary electrophoresis

UNIT I: Basic Separation Technique: 04 Hours
General aspects of separation techniques- role of separation technique in analysis; classification; choice of separation method; distribution processes; discrete and continuous equilibrium; distribution behaviour; chemical structure; errors resulting from separation process.

Fractionation: 05 Hours
Basic principles of distillation; theory of fractional distillation; fractionation by evaporation, distillation and sublimation; operation variables and their effect; relative volatility, reflux ratio, theoretical plates and HETP; batch and continuous process; columns- types and choice; applications; molecular distillation- theory; setup and applications; sublimation- apparatus, applications; field-flow fractionation.

UNIT II: Solvent Extraction 05 Hours
Basic principles; efficiency of extraction, extraction equilibrium; classification- liquid-liquid extraction; solid-liquid extraction: solid-phase extraction and micro extraction; accelerated and microwave assisted extraction; applications of solvent extraction.

UNIT III: Chromatographic Techniques- general introduction 02 Hours
Definition; theories; principle of chromatographic technique; terms and parameter used in chromatography; classification of chromatographic method; development of chromatograms; qualitative and quantitative analysis by chromatography.

UNIT IV: Supercritical-Fluid; size exclusion; ion exclusion Chromatography: 08 Hours
Introduction; definitions; important properties of supercritical-fluids; instrumentation; theory; principle; types; applications; gel chromatography; mechanism of gel permeation chromatography (GPC)- instrumentation and applications of GPC; ion exclusion; its mechanism; applications of ion exclusion technique; inorganic molecular sieves; principle; types of sieves; applications.

UNIT V: Gas Chromatography 10 Hours
Introduction; principle; theory; instrumentation; study of detectors-thermal conductivity; ionization; flame ionization; electron capture; evaluation of gas chromatogram;

identification of chromatogram; plate theory; applications; comparison of GSC and GLC; applications.
Pyrolysis gas chromatography- introduction; definition; technique; instrumentation; applications; vapour phase chromatography- introduction; definition; technique; instrumentation; applications

UNITVI: High Performance Liquid Chromatography 10 Hours
Introduction; principle; instrumentation; pumps; column and column packing; column efficiency and selectivity; applications; comparison of HPLC and GLC; ion pair chromatography; characteristics of liquid chromatography; types of detectors- UV, RI, and fluorescence detectors; advantages; applications.

UNIT VII: Electrophoresis 08 Hours
Introduction; types and technique of paper electrophoresis; theory instrumentation; continuous, moving boundary, thin layer, density gradient, zone electrophoresis; factors influencing the mobility of ions; macromolecular size and charge; interaction with supporting electrolyte; pH and concentration discontinuities; temperature and supporting media; capillary electrophoresis; electrolysis; osmosis and reverse osmosis; electro osmosis; applications.

UNIT V: Hyphenated Techniques 08 Hours
Introduction; GC-FTIR; GC-MS; LC-MS; MS-MS (tandem) spectrometry (use of stable isotopes); ICP-MS, TG-MS

TEXT BOOK:

1. Analytical Chemistry; G. D. Christian, 5th Edition, John Wiley and Sons, NY

REFERENCE BOOKS:

1. Chemical Instrumentation: A Systematic approach; H. A. Strobel
2. Fundamentals of Analytical Chemistry; D. A. Skoog; D. M. West, F. J. Holler, 7th Edition
3. Instrumental Methods of Chemical Analysis; H. Kaur, Pragati Prakashan
4. Vogel's Text Book of Quantitative Chemical Analysis; 6th Edition
5. Instrumental Methods of Analysis; H. H. Willard, L. L. Merritt, J. A. Dean
6. Instrumental Methods of Chemical Analysis; B. K. Sharma, Goel Publishing House

Course Code: CHAC- 502
Course Title: Spectral Methods of Analysis
Credits: 4
Marks: 100
Course Objectives:

1. Will provide basic understanding about Characterization of the materials using XRD.
2. Will understand the concept of emission measurement for quantification of substance.
3. To provide a basic knowledge about Spectroscopy used for identification of inorganic compounds.

Learning outcomes:

1. Students will be able to understand the basics of emission, diffraction concepts.
2. Understand the different phenomenon of emission occurring in organism.

UNIT I: X-ray Absorption, Diffraction; Neutron Diffraction and Fluorescence Spectroscopy 15 Hours

Introduction; origin and interaction of X-ray with matter; X-ray spectrometer; theory of X-ray absorption; X-ray diffraction by crystal; comparison of X-ray absorption with X-ray diffraction; Bragg's law; determination of crystal structure (single crystal and powder); interpretation of X-ray diffraction pattern; calculation of lattice parameters; neutron diffraction- introduction; theory; instrumentation and applications; X-ray fluorescence-introduction; applications. X-ray photoelectron spectroscopy, EDAX.

UNIT II: Molecular Fluorescence and Phosphorescence Spectroscopy 10 hours

Introduction; definition of fluorescence and phosphorescence; meaning of luminescence and chemiluminescence; principles of fluorescence, chemical structure and fluorescence; theory of molecular fluorescence; instrumentation- single and double beam filter fluorimeters; relationship between intensity of fluorescence and concentration; factors influencing fluorescence and phosphorescence; basic differences in measurement of fluorescence and phosphorescence; advantages; limitations and precautions; spectrofluorometer; phosphorimeter; selection of excitation wavelength for analysis; reporting fluorescence spectra; applications of fluorimetric analysis- inorganic, pharmaceutical, agricultural, biochemical and biomedical materials.

UNIT III: Chemiluminescence 05 Hours

Introduction; principle; types; instrumentation; measurement of chemiluminescence; quantitative chemiluminescence; gas phase chemiluminescence analysis; chemiluminescence titrations, electro- chemiluminescence.

UNIT IV: Microscopy 12 Hours

Chemical microscopy- microscope; parts and optical path; numerical aperture and significance; techniques- Kofler's hot stage microscope; fluorescence, polarizing, interference and phase microscopy; applications and qualitative and quantitative study; electron microscopy- principle, operation, sample preparation, replicas, shadowing, application to analysis; electron probe analyzer, ion microscope; metallography-metallurgy, microscopic examination; specimen preparation and examination; interpretation of micrographs by SEM, TEM, AFM.

UNIT V: Electron Spin Resonance Spectroscopy 05 Hours

Introduction; instrumentation, difference between ESR and NMR, Hyperfine interactions and qualitative analysis, study of free radicals, study of inorganic compounds, transition elements, structural determination.

UNIT VI: Mossbauer Spectroscopy 08 Hours

Introduction; Mossbauer effect; principle; theory; instrumentation; line width; centre shift; quadrupole interaction; magnetic interaction; information on spin and oxidation states; structure and bonding; spin transition from spectra of different Mossbauer active nuclei in various environments; application of Mossbauer effect to the investigations of compounds of iron and tin.

UNIT VII: Raman spectroscopy 05 Hours

Explanation of light scattering by molecules, mechanism of Raman effect, Raman effect in solids ,liquids, gases; Nature of Raman spectra, Raman effect and molecular structure, Raman activity of molecular vibrations.

TEXT BOOKS:

1. Fundamentals of Molecular Spectroscopy; C. N. Banwell and E. M. McCash, Tata McGraw-Hill, New Delhi, 4th Edition
2. Instrumental Methods of Analysis; B.K. Sharma, Goel Publishing House

REFERENCE BOOKS:

1. Elements of X- ray Diffraction; B. D. Cullity, Addison Wisley
2. Diffraction Method; Wormald, Oxford University, Press
3. Neutron Scattering in Chemistry; Baun, G. E. Butleworth, London
4. Mossbauer Spectroscopy; N. N. Greenwood, T.C. Gibbs, Chapmann Hall
5. Chemical Application of Mossbauer Spectrsoscopy; V. I. Goldanski and R. H. Harber, Academic Press
6. Spectroscopy in Inorganic Compounds; CNR Rao, Ferraro G. R., Academic Press
7. Basic Principles of Spectroscopy; Cheney R. Mac Grows Hill

Course Code: CHAC- 505
Course Title: Experiments in Analytical Chemistry
Credits: 4
Marks: 100
Course Objectives:

1. This course provides in depth knowledge of separation, purification and characterisation. Students are able to carry out, record and analyse the result of analytical experiments.

This course consists of Seven Units of experiments in various areas of Analytical Chemistry. Each Unit is equivalent to 30 hours duration.

UNIT I
Analysis of Pharmaceutical Tablets/Samples:

1. Estimation of calcium from given drug sample
2. Estimation of Ibuprofen / Paracetamol
3. Estimation of sulphadiazine / sulphonamide
4. Estimation of vitamin B_2 by Fluorimetry
5. Estimation of aluminium from given drug sample
6. Estimation of magnesium from given drug sample
7. Analysis of Fe in pharmaceutical preparation (colorimetrically)

UNIT II
Simple Chromatography:

1. Separation of alpha amino acids by paper chromatography
2. Determination of various impurities by thin layer chromatography
3. Separation of leaf pigments: chlorophyll ‘a’ and ‘b’ xanthophylls
4. Determination of R_f value of glycine by ascending paper chromatography
5. Separation of sugars, amino acids by paper and thin layer chromatography
6. Separation of a mixture of o- and p- nitro anilines on an alumina column
7. To study the presence of lactose in milk by descending paper chromatography

UNIT III
Ion exchange Chromatography and Solvent Extraction Method:

1. To determine the capacity of a cation exchange resin
2. To determine the capacity of an anion exchange resin
3. To estimate the sodium ion from fertilizer sample using cation exchange resin
4. To separation and estimate the cobalt and nickel ions using an anion exchange resin
5. To determine the Ni ion as Ni-DMG complex
6. To determine the Fe ion as Fe-oxine complex

UNIT IV
Gas Chromatographic Analysis:

1. Optimum flow rate for the determination of chloroform using Van Deemter equation
2. Quantitative analysis of a mixture of chloroform and carbon tetrachloride
3. Gas chromatographic analysis for a mixture of gases like O_2, N_2 and CO_2

HPLC Analysis:

1. HPLC analysis of benzaldehyde and benzyl alcohol
2. Quantitative assay of ampicillin in a powder for injection by HPLC
3. To analyze a mixture of two hydrocarbons by HPLC
4. HPLC analysis of Analgesics in a commercial sample/tablet, Ibuprofen
5. To develop and validate the analytical method of any one drug using HPLC

UNIT V

Spectrophotometric Method:

1. To determine pk value of methyl red indicator at room temperature
2. To determine the stoichiometry and stability constant of ferric salicylic acid complex by Job`s method and mole ratio method
3. To estimate the amount of D-glucose in given solution
4. To determine the indicator constant and isobestic point of an indicator
5. To determine the amount of each para nitro-phenol and meta nitro-phenol from the given mixture by spectrophotometric titration using standard NaOH solution at λ_{max} = 280 nm
6. To record UV absorption spectrum of acetone in n-hexane and identify the various transition
7. Estimation of aspirin and caffine from APC tablet by UV-Visible spectrophotometry
8. Determination of phosphate from fertilizer

UNIT VI

Electrochemical Method:

1. pH-metric determination of hydrolysis constant of aniline hydrochloride
2. pH-metric determination of the acid-base dissociation constant and isoelectric point of amino acid
3. Potentiometric determination of dissociation constants of tribasic acid
4. Potentiometric estimation of bicarbonate and carbonate
5. Potentiometric determination of dissociation constant of Cu-ammonia complex
6. Potentiometric titration of Zn^{2+} against $[Fe(CN)_6]^{4-}$ and determination of the empirical formula of the complex formed

UNIT VII

Interpretation Exercise:

1. X-ray powder diffraction analysis of cubic compound:
    a. Determination of Lattice constants and crystallite Size
    b. Density
2. Interpretation of Mossbauer spectrum with reference to determination of: isomer shift; quadruple splitting; internal magnetic field; general comment
3. Interpretation of IR spectrum with reference to stretching vibration of: C=N; C=O; N-O; M-O
4. Interpretation of NMR spectrum with reference to calculation of chemical shifts and general comments
5. Interpretation of absorption spectra for:
    a. Verification of the position of ligands in spectrochemical series
    b. Calculation of spectral splitting parameters
    c. Determination of geometry of a given compound (octahedral, tetrahedral, square planer)

6. Statistical revaluation of spectrophotometric data

REFERENCE BOOKS:

1. Vogel's Text Book of Quantitative Chemical Analysis; 6th Edition
2. Comprehensive Experimental Chemistry; V. K. Ahluwalia, New Age Publications,
3. Experimental Physical Chemistry; F. Daniels and J. Williams
4. Experimental Physical Chemistry; R. C. Das and B. Behera
5. Practical Physical Chemistry; B. Viswanathan and P. S. Raghavan
6. An Introduction to Practical Biochemistry; D. T. Plummer, 3rd Edition, Tata Mc Graw Hill, New Delhi
7. Laboratory Manual in Biochemistry; J Jayaraman, New age International Publishers
8. Practical Biochemistry; R. A. Fursule, V. L. Maheshwari, P. H. Agarkar
9. Advanced Physical Chemistry; J. B. Yadav, Goel Publishing House, Meerut
10. Systematic Experimental Physical Chemistry; S. W. Rajbhoj, T. K. Chondhekar, Anjali Publication, Aurangabad

ELECTIVE COURSES

Course Code: CHAE- 501
Course Title: Q A and Q C in Analytical Chemistry
Credits: 2
Marks: 50
Course Objectives:

1. To introduce basics of quality control and quality assurance.
2. To describe the types of packaging and regulatory aspects in food and pharmaceutical industries.

Learning Outcomes:

1. To enable students to understand the basics of quality control and quality assurance
2. To enable students to describe the types of packaging and regulatory aspects in food and pharmaceutical industries.

UNIT I: Introduction to chemical, apparatus and unit of operation 05 Hours

Selecting and handling reagents and chemicals; cleaning and marking of laboratory ware; measuring volume; calibrating volumetric flask; laboratory note; safety in laboratory.

UNIT II: Introduction to Quality Control and Quality Assurance 05 hours

Basic concepts; quality assurance; aspect of specification and tolerance; quality acceptance; sampling reality; cost aspect of quality decisions; quality control in raw materials; production; finished product; law related to quality control; case studies of quality control in various industries like agrochemicals, petrochemicals, pharmaceuticals, dyes, plastics and polymers.

UNIT III: Quality Assessment 05 hours

Internal methods of quality assessment; external methods of quality assessment; evaluating quality assurance data- prescriptive approach and performance-based approach

UNIT IV: Development of a Standard Method 05 Hours

Introduction; Optimising experimental procedure (Standard Test Procedures and Standard Operating Procedures); verifying the method- single-operator characteristics, blind analysis of standard samples, ruggedness testing, equivalency testing; validating the method as standard method: two-sample collaborative testing and analysis of variance.

UNIT V: Packaging and Regulatory Aspects **10 Hours**

Introduction; types of packing material and regulations acts in food and pharmaceutical industries; testing of material for packing; legal consideration in packing; regulatory aspects of food, drugs and cosmetics; Food safety and Standards Act, 2006; I.S.I., Agmark and other standard for foods and Cosmetic particularly with reference the testing of foods, drug and cosmetic and the raw material concerned; Government authorities concerned with the testing-their qualification, duties, powers and procedure to be followed; record to be maintain under the Acts; C.G.M.P. and C.G.L.P.S.; Department of 'WHO' certification.

TEXT BOOKS:

1. Fundamentals of Analytical Chemistry; D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, 8th Edition
2. Modern Analytical Chemistry; D. Harvey, McGraw-Hill Education

REFERENCE BOOKS:

1. Quality Assurance in Analytical Chemistry; W. Funk, V. Dammann, G. Donnevert, VCH Weinheim
2. Principles and Practice of Analytical Chemistry; F. W. Fifield and D. Kealy, Backwell Science Ltd. London
3. Vogel's Text Book of Quantitative Chemical Analysis; 6th Edition
4. Analytical Chemistry; G. D. Christian, 5th Edition, John Wiley and Sons, NY
5. Instrumental Methods of Chemical Analysis; H. Kaur, Pragati Prakashan
6. Pharmacopeias of India; Volume I and II
7. Quality in the Analytical Chemistry Laboratory; E. Prichard, John Wiley and Sons
8. Principals of Package Development; Gribbin etal
9. Modern Packaging Encyclopaedia and Planning Guide –Macqra Wreyco
10. Government of India Publications of Food Drug Cosmetic Acts and Rules

Course Code: CHAE- 502
Course Title: Bio analytical Chemistry
Credits: 2
Marks: 50
Course Objectives:

This course emphasises the techniques which are routinely been used in bio analytical laboratories.

Learning Outcome:

It will provide valuable training for students whose career goals include forensic, biotechnology.

UNIT I: Spectroscopic Methods for Matrix Characterization **06 Hours**

Introduction; Total protein- Lowry Method, Smith (BCA) Method, Bradford Method; Ninhydrin- based assay; other protein quantitation methods; total DNA: Diaminobenzoic acid method, diphenylamine method, other fluorometric methods; total RNA; total carbohydrate- ferricyanide method; Phenol– sulphuric acid method, 2-Aminothiophenol method, Purpald assay for bacterial polysaccharides; free fatty acids.

UNIT II: Antibodies **06 Hours**

Introduction, structural and functional properties of antibodies, polyclonal and monoclonal antibodies; antibody–antigen interactions; analytical applications of secondary antibody–antigen Interactions: agglutination reactions and precipitation reactions.

UNIT III: Biosensors **06 Hours**

Introduction, response of enzyme-based biosensors; examples of biosensor; configurations: ferrocene-mediated amperometric glucose sensor; potentiometric biosensor for phenyl acetate; potentiometric immune sensor for digoxin; evanescent-wave fluorescence biosensor for bungarotoxin; optical biosensor for glucose based on fluorescence energy transfer; piezoelectric sensor for nucleic acid detection, enzyme thermistors.

UNIT IV: Immunochemical techniques and biological tracers **03 Hours**

Antibodies- the keys to immunochemical measurements; analytical applications of biological tracers; principle and applications of radioimmunoassay (RIA); principle and applications of enzyme-linked immune sorbent assay (ELISA); immuno histochemistry: an important diagnostic tool.

UNIT V: Bio analytical approaches from diagnostic, research and pharmaceutical perspectives: **02 Hours**

Clinical genomics; proteomics and metabolomics; clinical diagnosis and screening; research and development; emerging pharmaceutical products, future perspectives.

UNIT VI: Transition metals in health and disease: **03 Hours**

Structure and characteristics of key transition metals, Importance of transition metals in physiological processes, Transition metals as mediators of disease processes, Therapeutic implications of transition metals, Determination of transition metals in nature

UNIT VII: Bio analysis by magnetic resonance technologies- NMR and MRI
04 Hours

NMR and MRI technologies: key tools for the life and health sciences; principles of NMR and the importance of bio molecular analytical technique; established and emerging applications of NMR; principles and applications of MRI; MRI as a principal diagnostic and research tool.

TEXT BOOKS:

1. Understanding Bioanalytical Chemistry; V. A. Gault, John-Wiley and Sons
2. Bioanalytical Chemistry; S. R. Mikkelsen, John-Wiley and Sons

REFERENCE BOOK:

1. Analytical Biochemistry, D. J. Holme, Pearson Education Ltd.
2. The Principals of ion-selective electrodes and membrane transport; W. E. Morf

Course Code: CHAE- 503
Course Title: Calibrations and Validation
Credits: 2
Marks: 50
Course Objectives:

To offer practical solution for understand the validation characteristics of some procedures used in laboratory.

Learning Outcome:

Student will understand the qualification of laboratory equipments as a precondition of reliable analytical testing.

UNIT I **10 Hours**

Regulatory requirements for analytical method validation, detailed discussion on accuracy and precision role in method validation; complete method validation package, analytical data, protocol, plan, revisions and change controls; International Conference on Harmonization (ICH) Guideline Q2A: Validation of analytical procedures.

UNIT II **10 Hours**

Overview of quantification of instruments, operation and performance qualification (IQ, OQ, PQ) of analytical equipments; validation and calibration of various instrument used for drug analysis such as UV-Visible Spectrophotometer, IR Spectrophotometer, Spectrofluorimeter, GC and HPLC; calibrations of pH meter and analytical balance; linearity and range criteria and their role in instrumental method validation.

UNIT III **10 Hours**

Role of quantification limit and specificity- S; Limit of Detection (LOD) and Limit of Quantification (LOQ); Robustness and method validation; Ruggedness of chromatographic method; Ruggedness of sample preparation procedure.

REFERENCES

1. Lachman " The Theory and Practice of Industrial Pharmacy Edition
2. Web Resources in Pharmacy, In Pharma Publication, Bangalore
3. Schedule M
4. WHO Guideline
5. Michael E. Swartz, Analytical Method Development and Validation.
6. Pharmaceutical Process Validation by Loftus and Nash
7. Vogel's Textbook of Quantitative Chemical Analyssis: 6^{th} edition, J. Mendham, RC Denny, JD Banes, Thomas, ELBS
8. Pharmaceutical Process Validation by Alfred H. Wachter, Informa Health Care.
9. Validation and Qualification in Analytical Laboratories, Second Edition, Ludwig Huber, Wiley Publisher.

Course Code: CHAE- 504
Course Title: Advanced Mass Spectrometry
Credits: 2
Marks: 50
Course Objectives:

The objective of the course is to teach the students the basics of Mass spectrometry, different ionisation methods, Mass analysers and its application to solve structural problems of proteins.

UNIT I: Ion Sources **10 Hours**

Mass Spectrometry- introduction, principle, diagram of MS; electron ionization; chemical ionization, proton transfer; adduct formation; charge-transfer chemical ionization; reagent gas; negative ion formation; desorption chemical ionization; field ionization; fast atom bombardment and liquid secondary ion mass spectrometry; field desorption; plasma desorption; laser desorption; matrix-assisted laser desorption ionization MALDI; thermo spray; atmospheric pressure ionization; electro spray; atmospheric pressure photo ionization, thermal ionization source; spark source; glow discharge source; inductively coupled plasma source.

UNIT II: Mass Analysers **10 Hours**

Quadrupole analysers; ion guide and collision cell;time-of-flight analysers; linear time-of-flight mass spectrometer; delayed pulsed extraction; reflectrons; tandem mass spectrometry with time-of-flight analyser; magnetic and electromagnetic analysers; tandem mass spectrometry in electromagnetic analysers.

UNIT III: Applications **10 Hours**

Fragmentation reactions; tandem mass analysis, proteomics.

TEXT BOOK:

1. Mass Spectrometry: Principles and application, Edmond D. Hoffmann, Vincent Stroobant J. Wiley

REFERENCE BOOKS:

1. Mass Spectrometry: A Textbook; Gross, Jurgen H. 2nd Edition, Springer
2. Electrospray and MALDI Mass Spectrometry: Fundamental, Instrumentations and Practicalities and Biological Applications; Richard B. Cole, John Wiley

SEMESTER IV

CORE COURSES

Course Code: CHAC- 503
Course Title: Fundamentals of Chemical Analysis
Credits: 4
Marks: 100
Course Objectives:

To understand fundamental concepts in acid base, precipitation, complex formation, redox system.

UNIT I: Acid-Base Titrations **12 Hours**

Theory of acid-base indicators for Acid-Base titrations; colour change; range of indicator; selection of proper indicator; indicator errors; neutralization curves for strong acid-strong base, weak acid-strong base and weak base-strong acid weak acid-weak base titrations; poly functional acids and bases; titration curves for poly functional acids and bases; titration curves for amphiprotic species; determining the equivalence point; feasibility of acid- base titrations; magnitude of the equilibrium constant; effect of concentration; typical applications of acid-base titrations.

UNIT II: Precipitation Titrations: **08 Hours**

Introduction; feasibility of precipitation titrations; titration curves; effect of titrant and analyte concentration on titration curves; effect of reaction completeness on titration curves; titration curves for mixture of anions; indicators for precipitation titrations; the Volhard, the Mohr and the Fajans methods; typical applications of standard silver nitrate solution.

UNIT III: Complexometric Titrations **20 Hours**

Introduction; the complex formation reactions; stability of complexes; stepwise formation constants; inorganic complexing agents (titrations involving unidentate ligands, titration of chloride with Hg^{2+} and cyanide with Ag^{+}); organic complexing agents; amino carboxylic acid titration; EDTA; acidic properties of EDTA; EDTA complexes with metal ions; equilibrium calculations involving EDTA in solution; condition of formation constants; EDTA titration curves; effect of other complexing agents on EDTA; factor affecting the titration curves; completeness of reaction; indicators for EDTA titrations; theory of common indicators; titration methods using EDTA- direct titration, back titration and displacement titration; indirect determinations; selectivity, masking and damasking agents; applications of EDTA titrations- hardness of water; magnesium and aluminium in antacids; magnesium and zinc in a mixture; analysis of ores and foods.

UNIT IV: Redox Titrations **12 Hours**

Introduction; equilibrium constants for redox reactions- electrode potentials in equilibrium systems; calculation of equilibrium constants; redox titration curves- formal redox potentials; derivation of titration curves; factors affecting the shape of titration curves-concentration; completeness of reaction; titration of mixtures- feasibility of redox titrations; detection of end point and redox indicators; structural aspect of redox indicators; specific and nonspecific indicators; choice of indicator; sample preparation- pre-reduction and pre-oxidation; applications.

UNIT V: Gravimetric Analysis **08 Hours**

Introduction; properties of precipitates and precipitating reagents; conditions for precipitation; completeness of precipitates; super saturation and precipitate formation; particle size and filterability of precipitates; colloidal precipitates; crystalline precipitates; purity of the precipitate; co- precipitation, post precipitation; fractional precipitation;

precipitation from homogenous solution; organic reagent as precipitants- dimethyl gloxime, washing of precipitates; drying and ignition of precipitates; result calculation from gravimetric data.

TEXT BOOKS:

1. Fundamentals of Analytical Chemistry; D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, 8th Edition

REFERENCE BOOKS:

1. Principles and Practice of Analytical Chemistry; F. W. Fifield and D. Kealy, Backwell Science Ltd. London
2. Vogel's Text Book of Quantitative Chemical Analysis; 6th Edition
3. Analytical Chemistry; G. D. Christian, 5th Edition, John Wiley and Sons, NY
4. Instrumental Methods of Chemical Analysis; H. Kaur, Pragati Prakashan
5. Quality in the Analytical Chemistry Laboratory; E. Prichard, John Wiley and Sons, NY

Course Code: CHAC- 504
Course Title: Techniques in Chemical Analysis
Credits: 4
Marks: 100
Course Objectives:

1. To illustrate the basic principles of modern instrumental methods at the advanced level.
2. To understand the basic theory underlying the construction of several common instruments and to become familiar with the operation of spectroscopic as well as non-spectroscopic techniques and the influence of instrumental settings

Learning outcomes:

1. To develop an understanding of the range and theories of instrumental methods available in analytical chemistry.
2. To provide theoretical knowledge in selected instrumental methods of analysis

UNIT I: Nephelometry and Turbidimetry 06 Hours

Introduction; principle and instrumentations of nephelometry and turbidimetry; effects of concentration, particle size and wavelength on scattering; choice between the nephelometry and turbidimetry; turbidimetry and colourimetry; nephelometry and fluorimetry; turbidimetric titrations; applications of nephelometry and turbidimetry.

UNIT II: Polarimetry 10 Hours

Introduction; plane polarized light; optical activity; theory of optical activity; applications of optical activity; polarimeter- principle; instrumentation; optical rotatory dispersion (ORD), plan curves; cotton effect curves; application of optical rotation method in rate constant determination; acid- inversion of cane sugar; relative strengths of acids; circular dichroism and its applications; selection rules; deduction of absolute configuration of molecules; octant rule for ketones and cotton effect

UNIT III: Refractometer 05 Hours

Introduction; theory; factors affecting refractive index; measurement of refractive index, instrumentation; types of refractometers; molecular refractivity and chemical constitution; applications of refractometry; qualitative and quantitative analysis.

UNIT IV: pH measurements and buffer solution 06 Hours

Introduction to pH measurement; colorimetric determination of pH, potentiometric determination of pH using hydrogen electrode, glass electrode and antimony electrode;

instrument for pH measurement; asymmetric potential; acid and alkali errors; factors affecting pH measurements; buffer solutions.

UNIT V: Spectrophotometric Analysis **10 Hours**
Introduction; law of absorption; absorbance and transmittance spectrum; technique for colour comparison; photodetectors; wavelength selection; radiation sources; standard cells; spectrophotometer instrumentation- single and double beam spectrophotometer; presentation of spectral data; spectrophotometric titrations; applications- determination of Mn (II) as $MnSO_4$, Fe (III) as thiocyanate, Cu (II) using salicyladoxime, simultaneous determination of Mn (II) and Cr (VI)

UNIT VI: Conductometric method **08 Hours**
Introduction; important laws, definitions and relations; conductance measurement; effect of dilution; basic aspects of conductometric titration; types of conductometric titration; advantages and disadvantages of conductometric titration; analytical applications.

UNIT VII: Thermal Analysis **15 Hours**
Thermo gravimetry analysis: Introduction; definition; instrumentation; information from TGA curve; factors affecting TGA curves based on instrumental and characteristics of sample factors; limitation and advantages of TGA; application of thermogravimetry; calculation of percent decomposition and composition of compounds.
Differential Thermal Analysis: Introduction, definition; theoretical basis of DTA; Instrumentation for DTA apparatus; factors affecting the DTA curve; advantages and disadvantages of DTA; applications of DTA.
Differential Scanning Calorimetry: Definition; comparison of DTA and DSC techniques; instrumentation of DSC, types of DSC; Factors affecting DSC curves; Applications.

REFERENCE BOOKS

1. Text Book of Quantitative Inorganic Analysis; A. I. Vogel, Longman
2. Instrumentation Methods of Chemical Analysis; G.W. Ewing, McGraw Hill
3. Basic Concepts of Analytical Chemistry; S. M. Khopkar
4. The Principals of ion-selective electrodes and membrane transport; W. E. Morf
5. Analytical Chemistry; G. D. Christian, Fifth Edition, John Wiley and Sons, NY
6. Instrumental Methods of Chemical Analysis; H. Kaur, Pragati Prakashan
7. Instrumental Methods of Chemical Analysis; B.K. Sharma, Goel Publishing House, Meerut

ELECTIVE COURSES

Course Code: CHAE- 505
Course Title: Applied Analytical Chemistry
Credits: 2
Marks: 50
Course Objectives:
This course deals with the various methods for identification of compounds using spectroscopy and also to determine the quantitative analysis of sample.
Learning outcome:
Upon completion of the Course students will be able to
1. Students will learn about the basic concepts used in clinical chemistry.
2. Students will be able to understand the chemistry of food and will be able to analyse different components in it.

UNIT I: Food Analysis-A **08 Hours**

Food legislation and public health; nutritional value of foods; General methods for determination of moisture, ash, crude protein, fat, crude fiber, carbohydrates, analysis of food like flour, starch, honey, jams, milk, tea, coffee and beverages (soft drinks, alcoholic drinks), calcium, potassium, sodium and phosphates.

UNIT II: Food Analysis- B **06 Hours**

Edible oils and fats- general composition of edible oils; detection of purity; rancidity of fats and oils; ratio of saturated and unsaturated fatty acids; estimation of rancidity; test for common edible oils like ground nut, castor, cottonseed and mustard; determination of- acid value; R.M. value; P.V. value; iodine value; ester value; acetyl value; titre value; total fatty acid; peroxide value.

UNIT III: Processing and Preservation **05 Hours**

Introduction; idea about food processing; fuel value of food; methods of food preservation- freezing, drying, pasteurization, sterilization, irradiation, canning, concentration; analysis of preservatives; types of packing materials and properties, industrial requirements; colouring matter, micronutrients; trace metals, pesticide residues.

UNIT IV: Clinical Chemistry **06 Hours**

Introduction; sample collection and preservation of physiological fluids; composition body fluid; detection of abnormal levels of certain constituents leading to diagnosis of diseases; analysis of physiological fluids- blood, urine and serum; estimation of blood glucose, cholesterol, urea, haemoglobin and billirubin; urine-urea, uric acid, calcium phosphate; physiological and nutritional significance of water soluble and fat soluble vitamins, minerals; analytical and microbiological techniques for vitamins.

UNIT V: Analysis of Cosmetics **05 Hours**

Introduction; analysis of lipsticks- determination of nonvolatile matter, lakes and fillers; analysis of deodorants and antiperspirants: Al, Zn, boric acid, chloride, sulphate, urea; analysis of face powder- fats, fatty acid, Ca, Mg, $BaSO_4$, Ti and Fe; oxides of Ti, Fe and Al (total); analysis of hair tonic: 2, 5-diaminotoluene, $KBrO_3$, resorcinol, salicylic acid.

REFERENCE BOOKS

1. Introduction to Food science and Technology Series; G. F. Stewart, M. A. America Academic Press
2. Analytical Chemistry of Foods; Ceiwyn S. James; Blackie Academic and Professional- Chapman and Hill Publisher, Madras, 1st Edition.
3. Chemical Analysis of Food; Pearson
4. Practical Biochemistry in Clinical Medicine; R. L. Nath, Academic Publishers, 2nd Edition
5. Analytical Biochemistry; D. J. Holme, H. Peck, Longman
6. Bio analytical Chemistry; S. R. Mikkelsen, E. Corton, John Wiley and Sons
7. Chemical Analysis of Food and Food Products; H. B. Jacob, Van Westrand Reinhold
8. Instrumental Methods of Chemical Analysis; H. Kaur, Pragati Prakashan

Course Code: CHAE- 506
Course Title: Advanced NMR Spectroscopy
Credits: 2
Marks: 50
Course Objectives:

The objective of the course is to teach the basic aspects of nuclear magnetic resonance (NMR) spectroscopy, which is an important analytical tool for characterization of molecules. The course covers topics in one-dimensional NMR, Chemical shifts, J-coupling, Interpretation of 1D NMR spectrum, Basics of 2D NMR, Different 2D NMR experiments and their application/interpretation, Application of 2D NMR for assignment of large molecules and proteins.

UNIT I: NMR **10 Hours**

Theory of nuclear magnetic resonance; quantum description of NMR; classical description of NMR; types of NMR spectra; applications of proton NMR in qualitative and quantitative analysis (in general).

UNIT II: ^{13}C and NMR Spectroscopy **10 Hours**

CW and PFT techniques- types of CMR spectra-undecoupled- proton decoupled-off-resonance decoupled (SFORD)-selectivity decoupled and gated ^{13}CJ) and hetero nuclear (^{13}C-H, ^{13} C-2HJ) couplings, nuclear over hauser effect, ATP (attached proton test), DEPT.

UNIT III: Introduction to 2D - NMR **10 Hours**

Classification of 2 D experiments- 2DJ resolved spectroscopy-HOMO and HETERO- 2D-J Resolved Spectra: correlation spectroscopy (COSY)- HOMO-COSY, 2D-INADEQUATE and NOESY.

TEXT BOOK:

1. Spectroscopic Identification of Organic Compounds; R. M. Silverstein, G.C. Bassler and T. M. Morril

REFERENCE BOOKS:

1. Spectroscopic Identification of Organic Compounds; R. M. Silverstein and Webster
2. NMR in Chemistry- A Multinuclear Introduction; William Kemp
3. ^{13}C NMR for Organic Chemists; G. C. Levy and G. L. Nelson
4. Understanding NMR Spectroscopy; 2nd Edition by James Keeler

Course Code: CHAE- 507
Course Title: Chemometrics
Credits: 2
Marks: 50
Course Objectives:

Computers and Computer application play a very important role in Chemistry. This course in aimed at providing a few basic tools in solving problems.

UNIT I: Introduction to Data and Statistics **10 Hours**

Introduction; univariate statistics review; probability; variance and sampling, linear regression and calibration data, digitization, and the Nyquist Theorem, detection limit, S/N ratio, and signal filtering; review of linear algebra: scalars, vectors, and matrices, matrix notation and matrix operations orthogonality, analysis of variance (ANOVA)- 1 variable, analysis of variance- 2 variables; introduction to Matlab^{TM}: programmed, basics and layout, matrix operations in Matlab^{TM} the diary command and examples, ANOVA in Matlab^{TM} experimental design: factorial design, simple versus complex models, factorial design in Matlab^{TM} ; half-factorial design.

UNIT II **20 Hours**

Multivariate Methods I: Introduction to various multivariate methods; the six habits of a chemometrician; principle component analysis (PCA); data pretreatment- mean centering and normalization; PCA in Matlab^{TM}.

Multivariate Methods II: Classical least squares (CLS), CLS in Matlab™; inverse least squares (ILS).

Multivariate Methods III: Multiple linear regression (MLR); principle component regression (PCR); partial least squares, examples in Matlab™; summary of multivariate methods; pattern recognition- supervised versus unsupervised pattern recognition, K nearest neighbours (KNN); soft independent modelling for chemical analysis (SIMCA), summary of pattern recognition.

TEXT BOOKS:

1. Chemo metrics, A Practical Guide; Kenneth R. Beebe, Randy J. Pell, and Mary Beth Seasholtz, John Wiley and Sons, Inc., New York

REFERENCE BOOKS:

1. The computer program MATLAB™ will be required for some portions of the course.

CHAD 508: DISSERTATION

The dissertation should comprise original research and may be conducted either at Institute or with approval, in an outside institution or company e.g. the student's employers. The guiding teacher may serve some laboratory hours for industry work.
The dissertation work is to be submitted for evaluation and for Viva Voice examination at the end of Semester IV.

CHAM -509 MODULES IN EXPERIMENTAL CHEMISTRY

This Module consists of Seven Units in experiments of various areas of Chemistry. Each Unit is equivalent to 30 hours duration.

INSTRUMENTAL
MODULE I: IR

1. Quantification of acetyl group from polymers using IR.
2. Plasticizer from PVC using IR
3. Determination of ethanol in gasoline.
4. Spectral analysis of different compounds (synthesised inorganic complexes and organic compounds)
5. Following micro scale reaction using FTIR.

MODULE II: POTENTIOMETRY

1. Potentiometric determination of reducing sugars.
2. Potentiometric titration using pencil and graphite sensor.
3. Kinetics of Reaction (bromination): A potentiometric study.
4. Non- aqueous titration of a mixture of aniline and ethanolamine

MODULE III: GC

1. Plasticizer from PVC using GC
2. Synthesis of high boiling organic compound by Derivatisation and analyses by GC
3. Separation of alcoholic mixtures.
4. Determination of alcoholic content in: i. Beer ii. Wine iii. Local drinks
5. Gas chromatographic analysis for: i. automobile exhaust ii. Cigarette smoke
6. Analysis of preservatives from solid and liquid samples (Extraction, sample preparation and analysis)

MODULE IV: HPLC
1. Determination of caffeine content in: i. Tea ii. Coffee iii. Soft drinks iv. Chocolates
2. Qualitative and quantitative analysis of pharmaceutical Drug (e.g. aspirin)
3. Purity of the solvents using HPLC.

MODULE V: TG/DTA/DSC
1. Determination of the purity of pharmaceuticals samples.
2. Thermal properties of peanut proteins
3. Glass transition temperature of polymers (polymer used in preparation of membrane sensor)
4. Determination of water of crystallization in inorganic salts.

MODULE VI: UV-VISIBLE
1. Method development and validation for a drug by UV/Visible spectrophotometer
2. Photometer (to build a photometer using LED) a guided-inquiry experiment to introduce analytical instrument.
3. To determine the composition of Cu and Fe (III) solution by spectrophotometric titration with EDTA

MODULE VII: AAS
1. Analysis of Fe, Zn, Cu in water samples.
2. Analysis of metal from soil /ore.
3. Analysis of metal from alloys Fe and Cr from steel / Cu and Zn from Brass / Sn and Pb solder.
4. Analysis of Lead and cadmium in toys.

NON INSTRUMENTAL
1. Preparation of nano composites.
2. Preparation of ZnO and mixed ferrites and its characterization
3. Analysis of Fats and oils- Saponification value, iodine value, peroxide value, acid value.
4. Detection of rancidity of oils from samples.
5. Determination of ascorbic acid in vinegar
6. Synthesis of:
   i. preparation of polystyrene using suspension polymerisation
   ii. Solvent free synthesis (Biginelli reaction)
   iii. Hydrogenation using Pd-C
   iv. Formylation of naphthalene
   v. Extraction of natural products using Soxhlet apparatus.
7. Electrolytic separation of metals Cu/Ni
8. Determination of copper in brass by titrimetry.

CHAI - 510 INTERNSHIP MODULES

MODULE I: Internship at Industry One Week per Semester (Semester III and IV) **90 Hours**

MODULEII: Write up of the Internship work per Semester (Semester III and IV) **20 Hours**

MODULE III: Students to design two modules based on their experience at industry **70 Hours**

*Assessment to be done at the end of Semester IV

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M. Sc. ANALYTICAL CHEMISTRY COURSE STRUCTURE

SEMESTER	COURSES	CREDITS	HOURS
I	**CORE COURSES**		
	CHIC-401: General Inorganic Chemistry	4	60
	CHIC-402: Laboratory Course in Inorganic Chemistry	4	60
	CHOC-401: Fundamentals of Organic Chemistry	2	90
	CHOC-402: Laboratory Course in Organic Chemistry	2	90
	ELECTIVE COURSES		
	CHAE-401: Analytical Techniques	2	30
	CHAE-402: Electro analytical Techniques – I	2	30
	CHIE-401: Topics in Inorganic Chemistry	2	30
	CHOE-401: Reaction Mechanisms in Organic Chemistry	2	30
	CHPE-401: Topics in Physical Chemistry	2	30
II	**CORE COURSES**		
	CHAC-401: Spectroscopy in Chemistry	4	60
	CHAC-402: Laboratory Course in Analytical Chemistry	2	90
	CHPC-401: General Physical Chemistry	4	60
	CHPC-402: Laboratory Course in Physical Chemistry	2	90
	ELECTIVE COURSES		
	CHAE-403: Electro analytical Techniques - II	2	30
	CHIE-402: Environmental Control and Chemical Analysis	2	30
	CHOE-402: Reagents in Organic Synthesis	2	30
	CHPE-402: Diffraction Methods	2	30
III	**CORE COURSES**		
	CHAC-501: Fundamentals of Chemical Analysis	4	60
	CHAC-502: Spectral Methods of Analysis	4	60
	CHAC-505: Experiments in Analytical Chemistry	4	60
	ELECTIVE COURSES		
	CHAE-501: QA and Q C in Analytical Chemistry	2	30
	CHAE-502: Bio analytical Chemistry	2	30
	CHAE-503: Calibrations and Validation	2	30
	CHAE-504: Advanced Mass Spectrometry	2	30
IV	**CORE COURSES**		
	CHAC-503: Separation Techniques	4	60
	CHAC-504: Techniques in Chemical Analysis	4	60
	ELECTIVE COURSES		
	CHAE-505: Applied Analytical Chemistry	2	30
	CHAE-506: Advanced NMR Spectroscopy	2	30
	CHAE-507: Chemometrics	2	30
	CHAD-508: Dissertation*	8	360
	CHAM-509: Modules in Experimental Chemistry	4	180
	CHAI-510: Internship Module	4	180

Parvatibai Chowgule College of Arts and Science

AUTONOMOUS
MARGAO - GOA

POST GRADUATE DEPARTMENT OF CHEMISTRY

M. Sc. ANALYTICAL CHEMISTRY

REVISED SYLLABUS

SEMESTER I

SEMESTER II

SEMESTER III

SEMESTER IV

EFFECTIVE FROM: 2020 - 2021

M. Sc. PART - I
CHEMISTRY

SEMESTER I

CORE COURSES

Course Code: CHIC-401
Course Title: General Inorganic Chemistry
Credits: 4
Maximum Marks: 100
Duration: 60 Hours

Course Objectives:
1. To enable students to know about the atomic structure and different properties of atom and elemental chemistry
2. To enable students to study the fundamentals of Inorganic Chemistry

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Identify different complexes and symmetry elements
CO2: Understand the importance of elements in biological systems
CO3: Understand molecular orbital theory for various molecules
CO4: Predict geometry of various molecules

UNIT I: Atomic Structure, Molecular structure and Bonding 15 Hours
Atomic Structure- Recapitulation; Atomic parameters: Atomic and ionic radii, ionisation energy, electron affinity, electro negativity (Pauling, Allred-Rochow definition, Mulliken definition); Molecular structure and bonding: Lewis structures and bond properties; the VSEPR Model- Walsh diagrams (tri and penta-atomic molecules); Valence bond theory- hydrogen molecule, homonuclear diatomic molecules, polyatomic molecules, hybridisation; Molecular orbital theory: approximations of the theory (LCAO-MO), bonding and anti bonding orbitals, homonuclear and heteronuclear diatomic molecules.

UNIT II: Molecular Symmetry and Solid State Chemistry 15 Hours
Symmetry elements and symmetry operations; equivalent symmetry elements and equivalent atoms; symmetry point groups with examples; point groups of very high symmetry; systematic procedure for symmetry classification of molecules and illustrative examples; dipole moment; optical activity and point groups.
Packing of spheres: Unit cell and description of crystal structure; close packing of spheres; holes in closed-packed structures; structure of metals: polytypism, structures other than closed packed; polymorphism of metals, atomic radii of metals, alloys; Ionic solids: characteristic structures of ionic solids, the rationalization of structures, the energetics of ionic bonding, consequences of lattice enthalpy; defects in crystals.

UNIT III: Boron and Coordination Chemistry 15 Hours
Boron - introduction, borane, carboranes, borazine and its derivatives; halides of boron.
Coordination Chemistry- Recapitulation; shapes of coordination compounds; bonding in coordination compounds- valence bond theory and crystal field theory; magnetism in coordination compounds; colour of coordination compounds; reaction mechanisms of transition metal complexes (in brief).

UNIT IV: Bioinorganic and Organometallic Chemistry 15 Hours
Bioinorganic Chemistry- metal ions in biological systems; deficiency of trace metal ions (Fe, Zn, Cu and Mn); proteins and their functions- Heme proteins, synthetic oxygen carriers,

electron transfer proteins-cytochromes, metalloproteins as enzymes-carboxypeptidase and Vitamin B12 coenzyme; chlorophyll and its use in photosynthesis.
Organometallic Chemistry- Definitions, classification of organo-transition metal complexes; the EAN, 18-electron and 16-electron rules; synthesis, structure, bonding and important reactions of metal carbonyls, metal nitrosyls, dinitrogen and dioxygen complexes.

TEXT BOOK:
1. Inorganic Chemistry; D. F. Shriver and P. W. Atkins, 5th Edition, Oxford University Press

REFERENCE BOOKS:

1. Principles of Solid State Chemistry, H. V. Keer, New Age International Ltd, New Delhi
2. Inorganic Chemistry: Principles of Structure and Reactivity, J. E. Huheey, E. A. Kiter; 4th Edition, Addison-Wesley Publishing House
3. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson, 6th Edition, Wiley Eastern, New Delhi
4. Theoretical Inorganic Chemistry, M. C. Day and J. Selbin, 2nd Edition; Van Nostrand-Reinhold, New York
5. Nature of Chemical Bond, L. Pauling, 3rd Edition, Cornell University Press
6. Solid State Chemistry, D. K. Chakrabarty; 2nd Edition, New Age Publishers
7. Coordination Chemistry, D. Banerjea, Tata McGraw-Hill, New Delhi
8. Concise Inorganic Chemistry, J. D. Lee, 5th Edition, Chapman and Hall
9. Solid State Chemistry and Its Applications, A. R. West; John Wiley and Sons, Singapore
10. Basic Inorganic Chemistry, F. A. Cotton and G. Wilkinson; 3rd Edition, John Wiley and Sons, Singapore

WEB REFERENCES:

1. https://en.wikiversity.org/wiki/Atomic_structure
2. https://byjus.com/jee/atomic-structure/
3. https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Supplemental_Modules_(Inorganic_Chemistry)/Coordination_Chemistry
4. http://www.chemistry.wustl.edu/~edudev/LabTutorials/naming_coord_comp.html
5. https://www.toppr.com/guides/chemistry/coordination-compounds/bonding-in-metal-carbonyls/

Course Code: CHIC-402
Course Title: Laboratory Course in Inorganic Chemistry
Credits: 2
Maximum Marks: 50
Duration: 90 Hours

Course Objectives:
1. To enable students to prepare different coordination compounds and determine its purity
2. To enable students to analyse various inorganic analytes by various methods

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Understand the chemistry of coordination compounds
CO2: To perform quantitative analysis for various coordination compounds
CO3: To quantitatively detect various metal ions from coordination compound
CO4: Interpret XRD spectra

Preparation and Characterisation of following Complexes

1. $K_3[Cr(SCN)_6].4H_2O$
2. $K_3[Cr(C_2O_4)_3]$ and estimate volumetrically the oxalate in the complex
3. Solid phase synthesis of trans-bisglycinato copper(II)
4. Potash alum from scrap aluminium (at micro scale level); to calculate the yield and percent purity

Quantitative Estimations

5. Estimation of Nitrite by volumetric method
6. Estimation of Calcium from Calcite ore
7. Estimation of Copper in Gun Metal alloy or Devarda's alloy iodometrically
8. Estimation of Nickel as Ni-DMG complex by solvent extraction
9. Titrate the Zn (II) by $K_4[Fe(CN_6)]$ and verify the composition of the complex $K_3Zn_3[Fe(CN)_6]_2$
10. Preparation and characterisation study of Metal Oxides
11. Estimation of Cu/ Fe/ Zn by AAS method
12. To determine the amount of copper from copper ammonia complex by spectrophotometric method
13. Determination of phosphate by heteropoly blue method
14. Spectrophotometric determination of total chromium using 1, 5- diphenyl carbazide
15. Spectrophotometric determination of chloride by methyl orange indicator

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REFERENCE BOOKS:

1. Vogel's Text Book of Quantitative Chemical Analysis; 3rd and 4th Edition
2. Handbook of preparative Inorganic Chemistry; G. Brauer, Volume: 1 and 2

Course Code: CHOC-401
Course Title: Fundamentals of Organic Chemistry
Maximum Marks: 100
Credits: 4
Duration: 60 Hours

Course Objectives:

1. To develop the knowledge of students on the molecular orbital theory
2. To develop the knowledge of students on the concepts of topicity, pro stereoisomerism and chemo-, regio- and stereoselectivity in organic reactions
3. To develop the knowledge of students on mechanisms of reactions in organic synthesis

Course Outcomes:

On successful completion of the course, the student will be able to:
CO1: Identify the presence or absence of aromaticity in organic compounds
CO2: Understand and apply various concepts in stereo chemistry
CO3: Propose plausible mechanism of organic reactions
CO4: State various addition and elimination reactions

UNIT I: Stereochemistry **15 Hours**

Configurational nomenclature: *R* and *S*; D- and L- ; *E* and *Z*; *cis* and *trans*; *syn* and *anti* nomenclature; chirality in molecules with two and more chiral centres; conformational analysis of open chain compounds; *erythro* and *threo* nomenclature; structure, conformation and stereochemistry of monocyclic cycloalkanes (cyclopropane, cyclobutane, cyclopentane, cyclohexane, cycloheptane and cyclooctane) with simple substituents; topicity and prostereoisomerism- topicity of ligands and faces; homotopic, enantiotopic and diastereotopic ligands and faces; chemoselective, regioselective and stereoselective reactions;

stereochemistry of *cis*- and *trans*-decalins; conformation and reactivity of cyclohexane, substituted cyclohexanes 'stereochemistry of cyclohexene and cyclohexanone' 2-alkyl and 3-alkyl ketone effect; introduction to stereochemistry of compounds containing N, S and P.

UNIT II: Molecular orbitals, Delocalised chemical bonding, Structure and Reactivity 15 Hours

Molecular orbitals of simple acyclic and monocyclic systems, qualitative description; frontier orbitals; importance of FMOs in organic reactions; conjugation, cross conjugation, resonance, hyper conjugation and tautomerism; alternant and non-alternant hydrocarbons; aromaticity in benzenoid and non-benzenoid compounds; Huckel's rule; annulenes, aromatic, non-aromatic and antiaromatic compounds; Acidity and basicity- different concepts, HSAB concept and factors affecting it; effect of structure and medium on acid and base strength; concept of super acids and super bases; electrophilicity and nucleophilicity, ambident nucleophiles and electrophiles, concepts and examples; tautomerism- concept, tautomeric equilibrium, relation with isomerism; types of tautomerism including ring, chain tautomerism and valence tautomerism; proto tropic shift in different systems.

UNIT III: Reaction Mechanism 15 Hours

Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes; types of- reactions, mechanisms; thermodynamic and kinetic-requirements, control; the Hammond postulate and principle of microscopic reversibility; methods for determining reaction mechanisms like identification of products; determination of the presence of intermediates (isolation, detection, trapping and addition of suspected intermediate); isotopic labeling; stereochemical evidence; kinetic evidence and isotope effect (sufficient reactions to exemplify each method be studied).

UNIT IV: Addition to carbon-carbon multiple bonds and elimination reactions15 Hours

Mechanism and stereochemistry of addition reactions involving electrophiles, nucleophiles and free radicals; addition of HCl, HBr, HI, HOH, R-OH, NH_3, H_2SO_4, and halogen Br_2 to carbon-carbon double and triple bonds in open chain and cyclic compounds; addition of H_2 to C-C multiple bonds; hydroboration-oxidation and oxy mercuration/ demercuration; elimination reaction- the E_2, E_1 and E_{1cb} mechanisms; orientation of the double bond, Saytzeff and Hofmann rule; effects of changes in the substrate, base, leaving group and medium on overall reactivity; comparison between E_1, E_2 and E_{1cb}; elimination verses substitution; mechanism and orientation in pyrolytic syn elimination; various examples involving cyclic and acyclic substrates.

TEXT BOOK:

1. Advanced Organic Chemistry Reaction, Mechanism and Structure, J. March, 4th Edition, John Wiley

REFERENCE BOOKS:

1. Stereochemistry and Chemistry of Natural Products, I. L. Finar; ELBS, Longmans
2. Stereochemistry, V. M. Potapov, MIR Publishers, Moscow
3. Organic Chemistry, F. A. Carey
4. Organic Chemistry, S.H. Pine; 5th Edition, McGraw-Hill International
5. Advanced Organic Chemistry, F. A. Carey, R. J. Sundberg; Vol I and II, Plenum Press
6. Fundamentals of Organic Reaction Mechanisms, M. Hamis, Carl C. Wamser, John Wiley and Sons
7. Organic Chemistry- A Concise Approach, F. M. Menger, D. J. Goldsmith and L. Mendell
8. Organic Laboratory Techniques; R. J. Fessenden, J. S. Fessenden, Brookes/Cole Publishing Company
9. Stereochemistry of Organic Compounds- Principles and Application, D. Nassipuri, 2nd Edition, Wiley Eastern Limited

10. Mechanism and Structure in Organic Chemistry, E. S. Gould et al.
11. Stereochemistry of Carbon Compounds, E. L. Eliel, Tata MacGraw Hill

WEB REFERENCES:

1. https://www.sciencedirect.com/topics/chemistry/stereochemistry
2. https://www.sciencedirect.com/topics/chemistry/detailed-reaction-mechanisms
3. http://web.chem.ucla.edu/~harding/notes/notes_14D_additionpibonds.pdf
4. http://www.chem.ucalgary.ca/courses/350/Carey5th/Ch05/ch5-4.html
5. http://home.iitk.ac.in/~madhavr/CHM102/Lec13.pdf

Course Code: CHOC-402
Course Title: Laboratory Course in Organic Chemistry
Maximum Marks: 50
Credits: 2
Duration: 90 Hours

Course Objectives:

1. To enable the students to apply certain theoretical concepts experimentally
2. To provide students with hands on experience on the basic laboratory techniques required for organic syntheses

Course Outcomes:

On successful completion of the course, the student will be able to:

CO1: Gain the understanding of stoichiometric requirements during organic syntheses
CO2: Understand safe and good laboratory practices, handling of laboratory glassware, chemical reagents and equipment
CO3: Learn common laboratory techniques including reflux, distillation, steam distillation, vacuum distillation and aqueous extraction
CO4: Synthesise the studied organic compounds and purify them

I. Laboratory Techniques

1. Introduction to safety techniques: First aid; Fire extinguishers; usage of hazardous chemicals
2. Simple distillation: Ethanol-water mixture using water condenser, Nitrobenzene and aniline using air condenser
3. Steam distillation: Clove oil from cloves or separation of *o*-and *p*- nitro phenols
4. Crystallisation: Concept of induction of crystallization
   i. Crystallisation of phthalic acid from hot water using fluted filter paper and stem less funnel
   ii. Acetanilide from boiling water
   iii. Decolourisation and crystallization of brown sugar (sucrose) with activated charcoal using gravity filtration
5. Sublimation: Simple sublimation of camphor and succinic acid

II. Organic Synthesis

6. Aliphatic electrophilic substitution: Preparation of iodoform from ethanol and acetone
7. Aromatic electrophilic substitution: Preparation of p-bromoacetanilide
8. Oxidation: i. Benzoic acid from toluene ii. Iso-borneol to camphor using Jones reagent iii. Cyclohexanone from cyclohexanol (any one)
9. Reduction: p-nitrophenyl methylcarbinol from p-nitro acetophenone by $NaBH_4$ and purification of the product through distillation under reduced pressure
10. Bromination of an alcohol using KBr/ $KBrO_3$ (at micro scale level)
11. Aldol condensation: Dibenzal acetone from Benzaldehyde

12. Cannizzaro reaction using 4-chlorobenzaldehyde as substrate
13. Preparation of benzylideneaniline from benzaldehyde
14. Preparation of chalcone from benzaldehyde and acetophenone
15. Esterification: Preparation of Butyl acetate from 1-Butanol

III. Extractions of:

16. Cinnamaldehyde from cinnamon sticks
17. Caffeine from tea bags

REFERENCE BOOKS:

1. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall
2. Organic Experiments, K. L. Williamson, D. C. Heath
3. Experimental Organic Chemistry, Vol I and II, P. R. Singh, D. S. Gupta, K. S. Bajpai, Tata McGraw Hill
4. Laboratory Manual in Organic Chemistry, R. K. Bansal, Wiley Eastern
5. Green Chemistry, Samuel Delvin, IVY Publishing House, Delhi
6. Organic Chemistry Laboratory, O. R. Rodig, C. E. Bell Jr. and A. K. Clark, Saunders College Publishing, New York
7. Organic Analytical Chemistry, Jag Mohan, Narosa Publishing House, New Delhi
8. Vogel's Textbook of Practical Organic Chemistry, A. R. Tatchell, John Wiley

ELECTIVE COURSES

Course Code: CHAE- 401
Course Title: Analytical Techniques
Credits: 2
Maximum Marks: 50
Duration: 30 Hours

Course Objectives:

1. To provide students with knowledge about fundamentals of chromatography and chromatographic techniques and to enable them to understand the principle of separation

Course Outcomes:

On successful completion of the course, the student will be able to:

CO1: Know the fundamentals of chromatographic separations
CO2: Address modern challenges across the chemical, biological, and physical sciences and to isolate and examine chemical and biological species as pure substances
CO3: Apply theoretical knowledge to design practical analysis
CO4: Identify suitable chromatographic technique for separation of various compounds

UNIT I: Introduction to Chromatographic Techniques 15 Hours

Introduction; definitions; theories; principle of chromatographic technique; terms and parameters used in chromatography; classification of chromatographic methods; development of chromatogram; qualitative and quantitative analysis by chromatography; Thin Layer Chromatography- definition; mechanism; efficiency of thin layer plates; methodology; criteria for selection of stationary and mobile phases; choice of adsorbents; preparation of plates; spotting; development; identification and detection; reproducibility of R_f values; comparison of TLC with paper chromatography and column chromatography; applications; High Performance Thin Layer Chromatography- introduction; instrumentation; methodology; quantitative and qualitative analysis; applications; Partition Chromatography- introduction to partition chromatography, technique of partition chromatography; movement of solute in chromatographic column; applications.

UNIT II: Paper, Column and Ion Exchange Chromatography 15 Hours

Paper chromatography- Introduction, principle, theory; types, techniques, choice of solvent; two dimensional paper chromatography; circular paper chromatography; applications; Column Chromatography- definition, types, principle, elution in column chromatography, experimental requirements, theory of development; migration rates of solutes; band broadening and column efficiency; variables that affect column efficiency; Van Deemter equation and its modern version; qualitative and quantitative analysis; applications; Ion exchange chromatography- introduction, definitions, principle, types of ion exchange resins; synthesis; requirements for ion exchange resin; basic features of ion exchange reactions; factors affecting ion exchange equilibrium; packing of column; analysis of elute; resin properties- ion exchange capacity; resin selectivity; factors affecting the selectivity; applications.

TEXT BOOK:

1. Fundamentals of Analytical Chemistry, D. A. Skoog, D. M. West and F. J. Holler, 7th Edition, Sounders College Publishing

REFERENCE BOOKS:

1. Analytical Chemistry, G. D. Christian, 5th Edition, John Wiley, New York
2. Principles of Instrumental Analysis, F. J. Holler, D. A. Skoog, S. R. Crouch, 6th Edition, Thomson Books/Cole
3. Analytical Chemistry: Principles, J. H. Kennedy, 2nd Edition, Saunders College Publishing
4. Vogel's Textbook of Quantitative Inorganic Analysis, J. Mendham, R. C. Denney, J. D. Barnes and M. Thomas; 6th Edition, Pearson Education Asia
5. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle; 7th Edition; CBS Publishing New Delhi,
6. Instrumental Methods of Chemical Analysis, G. W. Ewing; 5th Edition, McGraw-Hill
7. Analytical Chemistry: Principles and Techniques, L. G, Hargis; Prentice Hall, New Jersey
8. Basic Concepts of Analytical Chemistry, S. M. Khopkar; Wiley Eastern

WEB REFERENCES:

1. https://bitesizebio.com/29947/basics-chromatography-column/
2. https://www.studyread.com/column-chromatography/
3. Acikara, O. B. (2019). Ion-Exchange Chromatography and Its Applications. doi:10.5772/55744
4. https://byjus.com/chemistry/partition-chromatography/
5. https://www.news-medical.net/life-sciences/How-Does-Ion-Exchange-Chromatography-Work.aspx

Course Code: CHAE- 402
Course Title: Electro analytical Techniques- I
Credits: 2
Maximum Marks: 50
Duration: 30 Hours

Course Objectives:

1. To enable the students to understand the theory of electro analytical chemistry
2. To incorporate the electrochemical measurements using a combination of problem-based learning approach to develop critical thinking skills in students

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Comprehend the factors that must be controlled to obtain reliable and reproducible data from electro analytical experiments
CO2: Identify the most appropriate electro analytical technique for a specific analysis
CO3: Design simple electrodes and determine their redox potentials to characterize electrodes
CO4: Draw redox cell diagram, cell notation and determine the cell potential

UNIT I: Introduction to potentiometry and Ion-selective potentiometry 15 Hours
Electrochemical cell; reversible and irreversible cells; EMF series; standard electrode potential; Nernst equation; calculation of cell potential; introduction to potentiometer; metallic electrodes- electrodes of first and second kind; reference electrodes- hydrogen gas electrode, calomel, and silver/silver chloride; different types of potentiometric titrations; different method for determination of equivalent point; applications.
Membrane electrodes- classifications and properties; principle, design; theory of ion selective electrodes; membrane potential; selectivity; crystalline liquid membrane and enzyme electrodes; crystalline liquid membrane, enzyme membrane and glass membrane electrodes; solid-state sensors; membrane gas-sensor.

UNIT II: Polarography and Chrono methods 15 Hours
Introduction; basic principle; deposition potential; dissolution potential, polarization of electrode; polarography instrumentation, electrodes in polarography; advantages and limitations of dropping mercury electrode; polarographic wave, half wave equation (derivation expected), Illkovic equation; supporting electrolytes; interference of oxygen; half wave maxima; applications of polarography; numericals; Chrono methods- introduction, principle, methodology; applications of- chrono potentiometry, chrono amperometry, chrono coulometry.

TEXT BOOK:
1. Fundamentals of Analytical Chemistry, D. A. Skoog, D. M. West, F. J. Holler; 7th Edition, Sounders College Publishing

REFERENCES BOOKS:
1. Analytical Chemistry, G. D. Christian; 5th Edition, John Wiley, New York
2. Principles of Instrumental Analysis, F. J. Holler, D. A. Skoog, S. R. Crouch; 6th Edition, Thomson Books/Cole
3. Analytical Chemistry: Principles, J. H. Kennedy; 2nd Edition, Saunders College Publishing
4. Vogel's Textbook of Quantitative Inorganic Analysis, J. Mendham, R. C. Denney, J. D. Barnes and M. Thomas; 6th Edition, Pearson Education Asia
5. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle; 7th Edition, CBS Publishing New Delhi,
6. Instrumental Methods of Chemical Analysis, G. W. Ewing; 5th Edition, McGraw-Hill
7. Polarographic Methods in Analytical Chemistry, A. M. Bond
8. Instrumental Methods of Chemical Analysis, B. K. Sharma; Goel Publishing House

WEB REFERENCES:
1. https://derangedphysiology.com/main/core-topics-intensive-care/arterial-blood-gas-interpretation/Chapter%205.0.2/ion-selective-electrode-membranes
2. http://www.federica.unina.it/agraria/analytical-chemistry/potentiometry/
3. https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Supplemental_Modules_(Analytical_Chemistry)/Analytical_Sciences_Digital_Library/JASDL/Courseware/Analytical_Electrochemistry%3A_Potentiometry
4. https://www.ias.ac.in/article/fulltext/reso/009/09/0051-0061
5. https://nvlpubs.nist.gov/nistpubs/jres/34/jresv34n2p97_A1b.pdf

Course Code: CHIE- 401
Course Title: Topics in Inorganic Chemistry
Credits: 2
Maximum Marks: 50
Duration: 30 Hours

Course Objectives:
1. To provide students with an overview of important topics in Inorganic Chemistry
2. To provide students with in-depth knowledge of various inorganic elements

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Understand the basics of acid and bases
CO2: Understand the chemistry of: p-block elements, d-block elements, lanthanide and actinides
CO3: Have an idea about the magnetic properties of elements from transition elements
CO4: Understand the importance of f- block elements

UNIT I: Main group elements and their selected compound 15 Hours
A. Carbon group: allotropes of carbon, C60 and compounds (fullerenes), intercalation compounds of graphite, carbon nano tubes, carbides; compounds of silicon: silanes, silicates and silicones, Zeolites; Nitrogen group: nitrogen activation, oxidation states of nitrogen and their inter conversion; PN and SN compounds; Oxygen group: metal selenides and tellurides, oxy acids and oxoanions of S and N; ring, cage and cluster compounds of P- block elements, halogen group: inter halogens, pseudo halogen, synthesis, structures, properties and applications.
B. oxy acids and oxoanions of halogens; compounds of noble gases; oxide; hydroxide; alkoxide ions; poly nuclear oxo anions; halogen containing anions; sulphide and hydro sulfide anions.

UNIT II: Chemistry of transition and inner transition elements 15 Hours
A. Transition elements: metallic character, oxidation states, atomic and ionic size, colour, melting and boiling points, ionisation energy, density, magnetic properties, catalytic properties, important compounds and complexes, biological importance, difference between first row and subsequent row elements.
B. Inner-transition elements: lanthanides and actinides: occurrence, properties, oxidation states, electronic structure, colour and spectra, magnetic properties, lanthanide contraction, compounds of lanthanides and actinides, separation techniques.
C. Bronsted acidity, its periodic trends; Lewis acidity, classification of Lewis acids and bases; heterogeneous acid-base reactions.

TEXT BOOK:
1. Inorganic Chemistry, D. F. Shriver and P. W. Atkins; 5th Edition, Oxford University Press

REFERENCE BOOKS:
1. Inorganic Chemistry: Principles of Structure and Reactivity, J. E. Huheey, E. A. Kiter; 4th Edition, Addison-Wesley Publishing House
2. Chemistry of the Elements, N. N. Greenwood and A. Earn shaw; Pergamon Press, Exetr, Great Britain
3. Advanced Inorganic Chemistry, F. A. Cotton, G. Wilkinson, Hurillo and Bochmann, 6th Edition, Wiley Inter science
4. Concise Inorganic Chemistry, J. D. Lee, 5th Edition, Chapman and Hall
5. Basic Inorganic Chemistry, F. A. Cotton and G. Wilkinson, Paul L. Gaus, 3rd Edition, John Wiley and Sons

WEB REFERENCES:

1. https://chemed.chem.purdue.edu/genchem/topicreview/bp/ch11/acidbase.php
2. https://www.visionlearning.com/en/library/Chemistry/1/Acids-and-Bases/58
3. https://byjus.com/jee/lanthanides/
4. https://people.wou.edu/~courtna/ch462/tmcolors.htm
5. https://byjus.com/jee/f-block-elements/

Course Code: CHOE- 401
Course Title: Reaction Mechanisms in Organic Chemistry
Maximum Marks: 50
Credits: 2
Duration: 30 Hours

Course Objectives:

1. To enable students to understand electrophilic substitution reactions and mechanisms
2. To enable students to apply mechanistic concepts of nucleophilic addition to carbonyl group

Course Outcomes:

On successful completion of the course, the student will be able to:
CO1: Understand organic reactions and be able to propose plausible mechanisms
CO2: Choose appropriate reagents to carry out substitution reactions
CO3: Understand the aromatic electrophilic and nucleophilic substitution reactions
CO4: Understand the aliphatic electrophilic and nucleophilic substitution reactions

UNIT I: Aliphatic Nucleophilic and Electrophilic Substitution 15 Hours

The S_N2, S_N1, mixed S_N1 and S_N2 and SET mechanisms; neighbouring group mechanism, neighbouring participation by π and σ bonds, anchimeric assistance; classical and non classical carbocations, phenonium ions, norbornyl system, common carbocation rearrangements; the S_Ni mechanism; nucleophilic substitution at an allylic, aliphatic and vinylic carbon; reactivity effects of substrate structure, attacking nucleophiles, leaving group and reaction medium; bimolecular mechanisms- S_E2 and S_Ei; S_E1 mechanism; electrophilic substitution accompanied by double bond shifts; effects of substrates; leaving group and the solvent polarity on the reactivity.

UNIT II: Aromatic electrophilic, nucleophilic substitution and addition to Carbon-Oxygen multiple bonds 15 Hours

Introduction to general mechanisms involved, reactivity of arenes, product distribution; ipso attack and orientation in benzene with more than one substituent; Friedel-Crafts and related reactions- alkylation, acylation, formylation; Vilsmeier reaction, Gattermann-Koch reaction; Fries rearrangement and Prins reaction; diazotization, nitrosation, nitration, sulphonation, mercuration; introduction to addition-elimination mechanisms and elimination-addition mechanism in aromatic nucleophilic substitution; Ullmann reaction; Schiemann reaction; Von Richter reaction; Sommelet-Hauser rearrangement; Smiles rearrangement; Mechanism of condensation reactions involving enolates- Aldol, Knoevenegel, Claisen, Darzen, Stobbe, Perkin and Benzoin reactions; hydrolysis of esters and amides; aminolysis of esters.

TEXT BOOK:

1. Advanced Organic Chemistry Reaction, Mechanism and Structure, J. March, 4^{th} Edition; Wiley

REFERENCE BOOKS:

1. Organic Chemistry, F. A. Carey

2. A Guidebook to Mechanisms in Organic Chemistry, P. Sykes; 6th Edition, Pearson Education
3. Organic Chemistry, Clayden, Greeves and Warren; Oxford University Press
4. Mechanism and Structure in Organic Chemistry, E.S. Gould et al
5. Organic Chemistry, S. H. Pine; 5th Edition, McGraw-Hill International
6. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Vol. I and II, Plenum Press

WEB REFERENCES:

1. https://www.organic-chemistry.org/namedreactions/nucleophilic-substitution-sn1-sn2.shtm
2. https://www.sciencedirect.com/topics/chemistry/nucleophilic-aliphatic-substitution
3. http://www.chem.ucla.edu/~harding/notes/notes_14D_EAS01.pdf
4. https://www.sciencedirect.com/topics/chemistry/electrophilic-aromatic-substitution
5. https://www.masterorganicchemistry.com/2018/08/20/nucleophilic-aromatic-substitution-nas/

Course Code: CHPE- 401
Course Title: Topics in Physical Chemistry
Credits: 2
Maximum Marks: 50
Duration: 30 Hours

Course Objectives:

1. To enable students to study the physical behaviour and some chemical reactions under the influence of visible and ultraviolet light
2. To enable students to understand the concepts of magnetism
3. To enable students to understand the mechanism of the polymerization and its applications

Course Outcomes:

On successful completion of the course, the student will be able to:
CO1: Understand the magnetic behaviour of materials
CO2: Understand the chemistry of polymers and its applications
CO3: Use photochemistry principle in various areas like lasers, flash photolysis
CO4: Understand the various reaction like photo reduction and photo oxidation

UNIT I: Magneto chemistry **15 Hours**

Introduction; types of magnetism- diamagnetism, paramagnetism, ferromagnetism, anti ferromagnetism and ferrimagnetism; electron spin and magnetic moment; theory of diamagnetism; Langevins theory; magnetic susceptibility and its measurements- Guoy's and Quinke's method; Ranking's transition metal complexes; ferromagnetism; domain theory; hysteresis in magnetism; ferrimagnetisms; magnetic anisotropy, magnetic exchange interactions; magnetic transition- Curie and Neel temperature; ceramic magnetic materials; applications of magnetic materials.

UNIT II: Photochemistry and Polymers **15 Hours**

Absorption and emission radiation of photochemical interest (Einstein's derivation equation, not expected); Frank-Condon principle; laws of photochemistry; Jablonski diagram illustrating fluorescence and phosphorescence; long range and short range energy transfer; flash photolysis and lasers; photo reduction; photo oxidation; photosensitised reactions and photosynthesis; mechanism of chemiluminescence; Polymers- introduction, types; molecular weight distributions; mechanism of free radical; determination of chain length; condensation polymerization; degree of polymerization from kinetic data (derivation not expected); polymers- conformers, thermodynamics; conducting polymers and applications.

TEXT BOOKS:

1. Polymer Science, V. R. Gowarikar, V. N. Viswanathan, Jayadev Sreedhar, New Age International Publishers
2. Fundamentals of Photochemistry, K. K. Rohatgi-Mukherjee; Wiley Eastern, New Delhi

REFERENCE BOOKS:

1. Magnetic susceptibility, L. N. Muley, Inter science Publishers, New York
2. Instrumental Methods of Chemical Analysis, B. K. Sharma; Goel Publishing House
3. Polymer Science and Technology, Joel R. Fried, Prentice- Hall of India Private Limited

WEB REFERENCES:

1. http://www.irm.umn.edu/hg2m/hg2m_b/hg2m_b.html
2. https://www.google.com/url?sa=t&source=web&rct=j&url=https://www.britannica.com/science/polymer&ved=2ahUKEwitpqAx5HnAhVExTgGHQv8C24QFjAmegQIBxAB&usg=AOvVaw0-_N41elqjLur5vCql3p8z&cshid=1579501965101
3. http://www.ccl.net/cca/documents/dyoung/topics-orig/magnet.html
4. https://plastics.americanchemistry.com/plastics/The-Basics/
5. https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/photchem.htm

SEMESTER II

CORE COURSES

Course Code: CHAC- 401
Course Title: Spectroscopy in Chemistry
Credits: 4
Maximum Marks: 100
Duration: 60 Hours

Course Objectives:
1. To enable students to identify and characterize the samples
2. To enable students to identify the organic compounds using spectroscopic methods

Course outcomes:
On successful completion of the course, the student will be able to:
CO1: Understand the basic concepts in spectroscopy
CO2: Have an understanding on the different spectroscopic methods in chemistry
CO3: Explain the theory of electronic spectroscopy
CO4: Identify and characterize organic compounds using spectroscopic methods

UNIT I: General Introduction and Infrared Spectroscopy 15 Hours
Interaction of electromagnetic radiation with matter and characterization; quantization of energy; regions of spectrum; atomic and molecular spectra; representation of spectra; electronic spectra, molecular structure; radiation sources; monochromators; signal-to-noise; resolving power; width and intensity of spectral transitions; Infrared spectroscopy- introduction, infrared absorption and molecular structure; near- Infrared spectrometry; molecular vibrations, factors influencing vibrational frequencies; instrumentation of FT-IR and sampling techniques; characteristic vibrational frequencies of various functional groups and frequency shifts associated with structural changes.

UNIT II: Atomic Absorption, Emission and Electronic Spectroscopy 15 Hours
Atomic Absorption Spectroscopy- introduction, theory, instrumentation; Internal Standard and Standard Addition Calibration; applications; Flame Emission Spectrometry- introduction, theory, instrumentation; distribution between ground and excited states- atoms in the ground state; flame and electro thermal atomizers; ICP-AES theory, plasma sources, atomization and ionization, interferences in plasma and flame; Electronic spectroscopy- introduction, theory, chromophore and auxochrome; instrumentation; deviation from Beer-Lambert Law; Electronic spectroscopy- introduction; Woodward-Fischer rule; conjugated dienes, trienes, polyenes; α, ß- unsaturated carbonyl compounds; aromatic hydrocarbons; stereochemical factors.

UNIT III: NMR Spectroscopy 15 Hours
Introduction, theory, instrumentation; chemical shift, factors influencing chemical shift; solvents used in NMR; theory of spin-spin splitting and simple spin systems, AB, A_2B_3, A_2B_2; factors influencing coupling constant; introduction and principle to ^{13}C; off resonance decoupled spectra.

UNIT IV: Mass Spectrometry, various techniques for structure determination 15 Hours
Basic principles; instrumentation; isotope abundances; molecular ion; metastable ions; fragmentation processes; fragmentation associated with simple components like alcohols, amines, alkenes, simple aromatic and aliphatic hydrocarbons, aldehydes, ketones, halogen compounds; structure elucidation using UV-VIS, IR, NMR, mass spectra.

TEXT BOOK:
1. Analytical Chemistry, G. D. Christian; 5th Edition, John Wiley

REFERENCE BOOKS:

1. Instrumental Methods of Chemical Analysis; G. W. Ewing, 5th Edition McGraw-Hill
2. Instrumental Methods of Chemical Analysis, H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle; 7th Edition CBS Publishing New Delhi
3. Analytical Chemistry: Principles, J. H. Kennedy, 2nd Edition; Saunders College Publishing
4. Spectroscopy of Organic Compounds, P. S. Kalsi; 2nd Edition; New Age International
5. Organic Chemistry, R. T. Morrison, R. N. Boyd; 4th Edition; Prentice Hall India
6. Organic Spectroscopy, William Kemp, Palgrave; 3rd Edition
7. Fundamentals of Molecular Spectroscopy, C. N. Banwell, E. M. McCash; 4th Edition Tata McGraw-Hill, New Delhi
8. Vogel's Textbook of Quantitative Inorganic Analysis, J. Mendham, R. C. Denney, J. D. Barnes and M. Thomas; 6th Edition, Pearson Education Asia
9. Spectrometric Identification of Organic Compounds, R. M. Silverstein, and F. X. Webster; 6th Edition, Wiley India
10. Introduction to Spectroscopy, D. L. Pavia, G. M. Lampman; 4th Edition; Brooks/Cole

WEB REFERENCES:

1. http://www.chem.ucalgary.ca/courses/350/Carey5th/Ch13/ch13-ir-1.html
2. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/infrared-spectroscopy
3. https://www.sciencedirect.com/topics/materials-science/atomic-absorption-spectrometry
4. https://www.cis.rit.edu/htbooks/nmr/inside.htm

Course Code: CHAC-402
Course Title: Laboratory Course in Analytical Chemistry
Credits: 2
Maximum Marks: 50
Duration: 90 Hours

Course Objectives:

1. To provide students with an overview of the different analytical techniques for analysis

Course Outcomes:

On successful completion of the course, the student will be able to:
CO1: Handle and use various analytical instruments
CO2: Understand the quantitative approach towards various instruments
CO3: Perform qualitative and quantitative analysis
CO4: Develop good laboratory practices, both conceptually and practically

I. UV-visible Spectrophotometer:

1. Estimation of Iron from Pharmaceutical sample by thiocyanate method
2. Estimation of Iron from Pharmaceutical sample by 1,10 phenanthroline method
3. To estimate the amount of D-glucose in given solution using Anthrone reagent
4. Estimation of phosphorous in cola drinks by molybdenum blue method
5. Estimation of nitrite in water sample

II. Flame Spectrophotometer:

6. Estimation of Na from milk sample
7. Estimation of K from fertilizer

III. Thermal Studies:

8. TG-DTA studies of $CaC_2O_4.H_2O$

9. TG-DTA studies of $CuSO_4.5H_2O$
10. DSC study on Pharmaceutical product

IV. Volumetric Method:
11. Estimation of Ca in pharmaceutical sample
12. Estimation of Al and Mg in antacid sample

V. Ion Exchange Chromatography:
13. Separation and estimation of Ni and Co from the mixture
14. Separation and estimation of chloride and bromide from the mixture

VI. Solvent Extraction:
15. Extraction of copper as copper dithiocarbamate (DTC) using solvent extraction and estimation by spectrophotometric method

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REFERENCE BOOKS:

1. Analytical Chemistry, G. D. Christian; 5th Edition, John Willey and Sons
2. Vogel's Textbook of Quantitative Inorganic Analysis, 6th Edition, Pearson Education, Asia
3. Collection of Interesting Chemistry Experiments, A. J. Elias, University Press
5. Quantitative Analysis, Day and Underwood, 6th Edition, Prentice Hall
6. Analytical Chemistry for Technicians, Kenkel, 3rd Edition, Lewis Publishers

Course Code: CHPC- 401
Course Title: General Physical Chemistry
Credits: 4
Maximum Marks: 100
Duration: 60 Hours

Course Objectives:
1. To enable students to understand the mechanism of reactions in nature
2. To enable students to understand the concept of micro objects and its solutions with the help of quantum chemistry
3. To provide students with detail knowledge about thermodynamics and equilibrium systems

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Apply the knowledge of thermodynamics
CO2: Propose the mechanism of different reactions taking place in the environment
CO3: Apply the knowledge of quantum chemistry to conjugated molecules
CO4: Apply the basic principle of miscibility of liquids

UNIT I: Quantum Chemistry **15 Hours**
Historical development of quantum theory, principle of quantum mechanics, wave particle duality, uncertainty principles; operators, functions, Eigen value equations; Schrodinger equation, application to simple system viz. free particle, particle in one dimensional, two dimensional and three dimensional box (quantization, separation of variables, degenerate wave functions); Hydrogen like atoms, Schrodinger equation and its solutions; atomic orbital wave function and interpretation; Hückel MO theory, secular equations, secular determinant, delocalization energy, charge density, pi-bond order, free valence, applications to C_2H_4, C_3H_5(radical), C_4H_6, C_4H_4, C_6H_6, C_6H_8.

UNIT II: Thermodynamics **15 Hours**
Thermodynamic properties- state and path properties; intrinsic and extrinsic properties, exact and inexact differentials, internal energy, enthalpy, entropy, free energy and their relations and significances; Gas laws, Real gases, Boyle temperature; Maxwell's relation;

thermodynamic equations of state; Joule-Thomson effect; Joule-Thomson coefficient for van der Waals' gas, Joule-Thomson effect and production of low temperature; adiabatic demagnetization, inversion temperature; third law of thermodynamics; need for the third law; Nernst heat theorem, apparent exceptions to third law, application of third law, use of thermodynamic functions E, H, S and G in predicting direction of chemical change; entropy probability and its relation to partition function; numerical on calculation of entropy.

UNIT III: Chemical Kinetics **15 Hours**

General introduction to various types of order of reaction including fractional order; comparative study of transition state and collision state theory (derivation not required); Eyring equation; free radical reactions, complex reactions like decomposition of acetaldehyde and ozone; reaction between H_2 and Br_2; homogeneous, heterogeneous and acid-base catalysis; elementary enzyme reactions; autocatalysis and oscillatory reaction.

UNIT IV: Electrochemistry and Phase equilibria **15 Hours**

EMF series, decomposition potential and overvoltage, electrogravimetry, basic principles, completeness in deposition; separation with controlled potentials; constant current electrolysis; composition of electrolyte; potential buffers; physical characteristics of metal deposits; electroplating and electro less plating; electro synthesis; potentiostatic and dynamic related numerical problems; Phase rule- discussion of two component systems forming solid solutions with and without maximum or minimum in freezing point curve; systems with partially miscible solid phases; three component systems- graphical representation; three component liquid systems with one pair of partially miscible liquids, influence of temperature; systems with two pairs and three pairs of partially miscible liquids; the role of added salts.

NOTE: Numerical to be solved in possible units

TEXT BOOKS:

1. Physical Chemistry, P. W. Atkins and Julio De Paula, 8th Edition, Oxford University Press
2. Quantum Chemistry, Ira N. Levine

REFERENCE BOOKS:

1. Physical Chemistry, J. M. Castellan.
2. Chemical Kinetics, K. J. Laidler, Tata McGraw Hill
3. Quantum Chemistry, R. K. Prasad, 3rd Edition, New Age International
4. Electrochemical Methods, A. J. Bond
5. Text Book of Physical Chemistry, Volume 1- 4; K. L. Kapoor; Macmillan India Limited

WEB REFERENCES:

1. https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Kinetics/Modeling_Reaction_Kinetics/Transition_State_Theory/Eyring_equation
2. https://www.lenntech.com/library/ozone/decomposition/ozone-decomposition.htm
3. https://www.britannica.com/science/phase-rule
4. https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Supplemental_Modules_(Analytical_Chemistry)/Electrochemistry/Basics_of_Electrochemistry
5. https://www.google.com/url?sa=t&source=web&rct=j&url=http://vazecollege.net/wp-content/uploads/2016/08/TYBSc_electrochemistry_march14.pdf&ved=2ahUKEwjCxNmQxpHnAhWCbn0KHei6C0gQFjACegQIAxAB&usg=AOvVaw1YBK9pXzEdc_l850t48i_w

Course Code: CHPC- 402
Course Title: Laboratory Course in Physical Chemistry
Credits: 2
Maximum Marks: 50
Duration: 90 Hours

Course Objectives:

1. To give students an overview of the different techniques and instruments used in physical chemistry laboratory

Course Outcomes:

On successful completion of the course, the student will be able to:

CO1: Handle instruments like conductometer, potentiometer and pH meter

CO2: Understand stoichiometric calculations

Experiments:

1. To study the kinetics of hydrolysis of ethyl acetate and to determine: Energy of activation; Entropy of activation and Free energy change
2. To study the kinetics of the reaction between $K_2S_2O_8$ and KI and to determine: Energy of activation; Entropy of activation and Free energy change
3. To determine the order of reaction between potassium $K_2S_2O_8$ and KI by graphical, fractional change and differential methods
4. To determine the degree of hydrolysis of salt obtained from weak base and strong acid using conductometer
5. To determine the composition of a mixture of acetic acid, monochloroacetic acid and hydrochloric acid by conductometric titration
6. To determine the equivalence point from derivative plot and determine the dissociation constants of a dibasic acid, malonic acid
7. To determine the equivalence point from derivative plot and the dissociation constants of a tribasic acid, phosphoric acid
8. To determine the equivalence point from derivative plot and hence the formal redox potential of Fe^{2+} /Fe^{3+} and Ce^{3+}/Ce^{4+} system
9. To study three component system of $C_6H_5CH_3$; C_2H_5OH and H_2O and obtain tie line.
10. To study three component system of CH_3COOH; $CHCl_3$ and H_2O and obtain tie line.
11. To determine the molecular weight of high molecular weight polymer (Polystyrene) by viscosity measurement
12. To determine CMC of soap by Conductometric measurements
13. To determine the surface tension of liquid at different temperatures and hence the critical temperature of the liquid
14. To determine: i. the phase of naphthalene and diphenyl system ii. Freezing point diagram of *o*- nitro phenol and *p* – toluidine
15. To determine the composition of copper and iron (III) by photometric titration using disodium salt of EDTA

REFERENCE BOOKS:

1. Practical Physical Chemistry, A. Finlay and J. A Kitchener, Longman
2. Experimental Physical Chemistry, F. Daniels, J. H. Mathews, Longman
3. Practical Physical Chemistry, A. M. James, J. A. Churchil
4. Experimental Physical Chemistry, D. P. Shoemaker and C. W. Garland, McGraw-Hill
5. Advanced Physical Chemistry, J. B. Yadav; Goel Publishing House, Meerut
6. Systematic Experimental Physical Chemistry, S. W. Rajbhoj, T. K. Chondhekar; Anjali Publication, Aurangabad

ELECTIVE COURSES

Course Code: CHAE-403
Course Title: Electro analytical Techniques -II
Credits: 2
Maximum Marks: 50
Duration: 30 Hours

Course Objectives:

1. To provide students with the basic understanding about the fundamental principles of voltammetry with rotating disk-ring electrodes, stripping voltammetry and amperometry
2. To demonstrate the experiments to students
3. To improve the basic understanding power of students for the techniques

Course Outcomes:

On successful completion of the course, the student will be able to:
CO1: Understand the basic concepts of potentiometry and electrodes
CO2: Understand physical and chemical properties of a material which can be studied by commonly used electroanalytical techniques
CO3: Differentiate and compare different voltamograms
CO4: Apply theoretical concepts to analyse various metal ions quantitatively

UNIT I: Voltammetry and Amperometry **15 Hours**

Voltammetry- introduction, fundamental, excitation signals, instrumentation of voltammetry; working electrodes and modified electrodes; voltammagram; hydrodynamic voltammetry, applications- oxygen sensor and enzyme-based sensor; cyclic voltammetry, pulse voltammetry; differential pulse voltammetry and square wave voltammetry, stripping voltammetry- anodic and cathodic stripping method, voltammetry with microelectrodes; applications of voltammetry; amperometry- introduction to amperometric titrations, instrumentation, electrical circuit, indicator electrodes, reference electrodes, titration procedure; advantages and disadvantages of amperometric titrations, applications.

UNIT II: Coulometry and Karl Fischer Titration **15 Hours**

Coulometry - introduction, theory, current measuring devices- hydrogen-oxygen coulometer, silver coulometer, iodine coulometer; coulometry at controlled potential; coulometry at constant current; variation in coulometric techniques, coulometric titration of chloride in biological fluids, applications; Karl Fischer Titrations - introduction; theory; types; criterion in selection; methodology for determination of water content in samples and general sample requirement.

TEXT BOOK:

1. Fundamentals of Analytical Chemistry, D. A. Skoog, D. M. West and F. J. Holler; 7th Edition, Sounders College Publishing

REFERENCES BOOKS:

1. Principles of Instrumental Analysis; F. J. Holler, D. A. Skoog, S. R. Crouch, 6th Edition, Thomson Books/Cole
2. Analytical Chemistry: Principles; J. H. Kennedy, 2nd Edition, Saunders College Publishing
3. Instrumental Methods of Chemical Analysis, B. K. Sharma; Goel Publishing House
4. Instrumental Methods of Chemical Analysis, H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle;7th Edition, CBS Publishing New Delhi
5. Instrumental Methods of Chemical Analysis, G. W. Ewing, 5th Edition, McGraw-Hill
6. Analytical Chemistry, G. D. Christian; 5th Edition, John Wiley, New York.
7. Vogel's Textbook of Quantitative Inorganic Analysis, J. Mendham, R. C. Denney, J. D. Barnes and M. Thomas; 6th Edition, Pearson Education Asia

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1. https://www.azom.com/article.aspx?ArticleID=16017
2. https://mcckf.com/english/kf-basic/what.html
3. https://chem.uiowa.edu/sites/chem.uiowa.edu/files/people/shaw/LUCIO%20GM% 20KF-Titration%20March-2013.pdf
4. https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Supplemental_Modules_(Analytical_Chemistry)/Analytical_Sciences_Digital_Library/Active_Learning/In_Class_Activities/Electrochemical_Methods_of_Analysis/02_Text/7%3A_Electrochemical_Analytical_Me
5. http://rxpharmaworld.blogspot.com/2016/12/coulometry.html

Course Code: CHIE-402
Course Title: Environmental Control and Chemical Analysis
Credits: 2
Maximum Marks: 50
Duration: 30 Hours

Course Objectives:

1. To enable students to explain the sources, effects and mitigation of various types of pollution
2. To enable students to gain knowledge of the procedure for the analysis of greenhouse gases, pesticides, explosives, cosmetics and paints

Course Outcomes:

On successful completion of the course, the student will be able to:
CO1: Identify the sources and effects of various types of pollution
CO2: Describe the analysis of greenhouse gases
CO3: State the control measures of various types of pollution
CO4: Describe the analysis of pesticides, explosives, cosmetics and paints

UNIT I: Air and Water Pollution **15 Hours**

A. Air Pollution: Sources and sinks of gaseous pollutants; classification; effects of air pollutants on living and nonliving objects; sampling methods for gaseous, liquid and solid pollutants; greenhouse effect; acid rain; ozone depletion and their consequences on environment; major air pollution disasters; electrostatic precipitation; wet and dry scrubbers, filters, gravity and cyclonic separation, adsorption, absorption, condensation of gaseous effluent; problems in industrial area; method to control air pollution; air pollution problems in India; global air pollution problems; analysis of CO, CO_2, NO_2, SO_2 and H_2S.

B. Water Pollution: Introduction; types; sources and classification of water pollutants; toxic elements in water; mercury pollution and estimation of organo-mercurials; pesticides in water; potable and sanitary water; industrial water pollution; constituents of aquatic environment; oxygen content of water and aquatic life; oxygen electrode and its use; effects of water pollutants on life and environment; method to control water pollution; analytical procedures for analyses of industrial waste water and treatment; aerobic and anaerobic aeration of water; principle of coagulation; flocculation; softening; disinfection; demineralization and fluoridation; measurements of dissolved oxygen (DO); Chemical oxygen demand (COD); Biochemical oxygen demand (BOD); Total organic carbon (TOC).

UNIT II: Soil pollution and Analysis of paints, pigments, pesticides, explosives 15 Hours

A. Soil Pollution: Classification of pollutants and their characteristics, sources, prevention and control; soil composition; organic and inorganic components in soil; degradation by natural sources; sources of pesticide residue in the soil, its effect on life; biochemical effect of pesticides; analytical techniques for pesticide residue analysis; Nitrogen and NPK in soil and water; instrumental techniques in environmental pollutant analysis.

B. Analysis of:

i. Paints and Pigments- introduction to paints; pigment separation; identification of binder; identification and analysis of thinner, primers, pigments; binder and thinner of- latex paints, solvent type coatings; tests on total coating.

ii. Explosives- introduction; general methods; heat of explosion; hygroscopicity; qualitative tests of explosives; quantitative analysis of explosive mixtures; dynamites, blasting caps and electric detonators; solid and liquid propellants.

iii. Insecticides and pesticides- analysis of BHC, DDT, Malathion, Parathion, 2, 4-dichloro phenoxy acetic acid.

iv. Herbicides and fungicides - dalapon, paraquat, Butacarb, Benomyl, Bordeaux mixture.

TEXT BOOKS:

1. Environmental Chemistry; A. K. De, New Age International Publishers

REFERENCE BOOKS:

1. Standard Methods of Waste and Waste Water Analysis, A. K. De
2. Environmental Chemistry, B. K. Sharma
3. Introduction to Air Pollution, P. K. Trivedi
4. Environmental Pollution Analysis, S. M. Khopkar
5. Standard Methods of Chemical Analysis, F. J. Welcher, Volume 3, Part-B
6. Cosmetics, W. D. Poucher, Volume I, II, III
7. Environmental Chemistry, Garry. W. Vanloon, 3rd Edition, Oxford University Press

WEB REFERENCES:

1. https://www.sciencedirect.com/topics/chemistry/water-pollution
2. http://www.ncids.com/forensic/labs/Trace/Technical/3_PAINT.pdf
3. https://www.sepa.org.uk/media/120465/mtc_chem_of_air_pollution.pdf
4. https://www.sciencedirect.com/topics/engineering/soil-pollution
5. https://www.sciencedirect.com/book/9780080238463/the-analysis-of-explosives

Course Code: CHOE-402
Course Title: Reagents in Organic Synthesis
Credits: 2
Maximum Marks: 50
Duration: 30 Hours

Course Objectives:

1. To provide students with knowledge of oxidation processes used in organic syntheses
2. To provide students with knowledge of reduction processes used in organic syntheses

Course Outcomes:

On successful completion of the course, the student will be able to:

CO1: Choose appropriate oxidizing agent for oxidation of a particular functional group
CO2: Choose appropriate reducing agent for reduction of a particular functional group
CO3: Propose the mechanism of reduction reactions
CO4: Propose the mechanism of oxidation reactions

UNIT I: Oxidation reactions **15 Hours**

Oppenauer oxidation, aromatization and dehydrogenation, oxidation of hydroxyl group with Triphenylbismuth carbonate, O_2/Pt catalyst, silver carbonate/celite, sodium bromate/CAN and NaOCl/CH_3COOH; chromium and manganese compounds: oxidation of alcohols, aldehydes, C-C double bonds and C-H bonds in hydrocarbons; peracids and other peroxides;

types of peracids and preparation; oxidation of C-C double bonds in acyclic and cyclic systems, carbonyl compounds, amines and sulfides, allylic C-H bonds and oxidation with molecular oxygen; other methods of oxidation involving periodic acid, Na/K metaperiodate, lead tetra acetate, mercuric acetate, selenium dioxide, ruthenium tetroxide, osmium tetroxide, DMSO, thallium nitrate, DDQ, Prevost's reagent and Woodward conditions; ozonolysis, catalytic oxidation over Pt; photosensitised and palladium-catalysed oxidation of alkenes.

UNIT II: Reduction reactions **15 Hours**

Catalytic hydrogenation- different catalysts, solvents and equipment; functional group reductions and homogeneous catalytic hydrogenation; reductions by hydride-transfer reagents and related reactions- MPV reduction, $NaBH_4$, $NaB(CN)H_3$, Trialkyl borohydrides, LAH and lithium hydrido alkoxyaluminates, mixed LAH-$AlCl_3$ reagents, DIBALH and Reductions with borane and dialkylboranes; enzymatic reduction involving liver alcohol dehydrogenase/ NADH and Baker's yeast; other methods of reduction- Wolff-Kishner, Raney Ni desulphurisation, di-imide, low-valent titanium species, trialkyl tin hydrides and trialkyl silanes; Green chemistry- principles; phase transfer catalysis; microwave synthesis; green reagents for oxidation, reduction processes; ultrasound synthesis; Electro-organic synthesis.

TEXT BOOK:

1. Some Modern Methods of Organic Synthesis, W. Carruthers; Cambridge University Press, Cambridge

REFERENCE BOOKS:

1. Modern Synthetic Reactions, Herbert O. House, W. A. Benjamin, 2nd Edition
2. Green Chemistry- Environment Friendly Alternatives, Rashmi Sanghi, M. M. Srivastava, Narosa Publishing House, New Delhi
3. Green Chemistry- Frontiers in Benign Chemical Synthesis and Processes, Paul T. Anastas and Tracy C. Williamson, Oxford University Press, Oxford
4. Advanced Organic Chemistry Reaction, Mechanism and Structure, Jerry March, Mc Graw Hill International Books Company
5. Advanced Organic Chemistry, F. A. Carey, R. J. Sundberg; Vol I and II, Plenum Press

WEB REFERENCES:

1. https://www.organic-chemistry.org/namedreactions/meerwein-ponndorf-verley-reduction.shtm
2. https://www.organic-chemistry.org/namedreactions/wolff-kishner-reduction.shtm
3. https://www.organic-chemistry.org/namedreactions/prevost-reaction.shtm
4. https://chem.pg.edu.pl/documents/614792/2c6c0579-c52b-400e-a396-07a03363f4e0
5. https://www.organic-chemistry.org/namedreactions/oppenauer-oxidation.shtm

Course Code: CHPE-402
Course Title: Diffraction Methods
Credits: 2
Maximum Marks: 50
Duration: 30 Hours

Course Objectives:

1. To give students an overview of diffraction methods in solid state chemistry for solving structural problem
2. To enable students learn the use of excel in solving problems on X-ray diffraction

Course Outcomes:

On successful completion of the course, the student will be able to:
CO1: Interpret the XRD spectra

CO2: Understand the working of XRD
CO3: Handle the software like origin used in determination of crystal structure determination
CO4: Use Microsoft Excel to get X-ray analysis

UNIT I: X-ray diffraction and Information from X-ray analysis 15 Hours

Introduction, cubic and hexagonal close packing, radius ratio rule, inter dependence of ionic radii and coordination, crystal geometry, lattice energy, Bravias lattice, types of unit cells and their characteristics; principle, instrumentation, scope and limitations of the method; X-ray scattering factors, Bragg's Law, powder method, single-crystal X-ray diffraction; calculations of unit cell dimensions from powder diffraction patterns for cubic, tetragonal and orthorhombic systems; reciprocal lattice concept; X-ray intensity calculations to decide the ionic configurations

UNIT II: Problem solving through diffraction methods 15 Hours

Introduction to spreadsheet based software; Microsoft Excel; development of spreadsheets for- some simple test cases like Gaussian curve (study of effect of standard deviation and centre of Gaussian), plotting of trigonometric functions like sin, cos and their linear combinations (Fourier synthesis for crystal structure determination); precise lattice parameter measurements; crystal structure determination- cubic; FCC, BCC and Hexagonal.

TEXT BOOK:

1. Solid State Chemistry and its Applications; A. R. West, John-Wiley and Sons, Chinchester

REFERENCE BOOKS:

1. X-ray diffraction: A practical Approach, C. Suryanarayana and M. Grant, Norton Plenum Press, New York
2. Elements of X- ray Diffraction, B. D. Cullity; Addison Wesley

WEB REFERENCES:

1. https://www.originlab.com/Origin
2. https://books.google.co.in/books?id=vk9fnLH56DYC&printsec=frontcover&dq=powder+diffraction+theory+and+practice&hl=en&sa=X&ved=0ahUKEwisvu--mpHnAhXPyDgGHW3XDMoQ6AEIZzAJ#v=onepage&q&f=false
3. https://link.springer.com/chapter/10.1007/978-1-4614-3954-7_12
4. https://epdf.pub/queue/powder-diffraction-theory-and-practice.html

M. Sc. PART - II
ANALYTICAL CHEMISTRY
SEMESTER III

CORE COURSES

Course Code: CHAC-501
Course Title: Fundamentals of Chemical Analysis
Credits: 4
Maximum Marks: 100
Duration: 60 Hours

Course Objectives:
1. To enable students to understand the concept of titrimetry
2. To enable students to understand fundamental concepts in acid-base, precipitation, complex formation, redox system

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Determine equivalence point of various titrations theoretically
CO2: Make basic quantitative calculations regarding a number of chemical concepts
CO3: Write and understand chemical reactions and stoichiometry
CO4: Master the concepts like chemical equilibria, complexation, solubility, acidity and basicity

UNIT I: Acid-Base Titrations **15 Hours**
Acid-Base titrations- introduction, theory of acid-base indicators; range of indicator; selection of proper indicator; indicator errors; colour change; neutralization curves for strong acid-strong base, weak acid-strong base and weak base-strong acid weak acid-weak base titrations; poly functional acids and bases; titration curves for poly functional acids and bases; titration curves for amphiprotic species; determining the equivalence point; feasibility of acid- base titrations; magnitude of the equilibrium constant; effect of concentration; typical applications of acid-base titrations.

UNIT II: Precipitation and Redox Titrations **15 Hours**
Precipitation titrations -introduction; feasibility; titration curves- effect of reaction completeness; effect of titrant and analyte concentration, for mixture of anions; indicators for precipitation titrations; the Volhard, the Mohr and the Fajans methods; typical applications of standard silver nitrate solution; Redox titration- introduction, equilibrium constants; electrode potentials in equilibrium systems; calculation of equilibrium constants; redox titration curves-formal redox potentials; derivatives of titration curves; factors affecting the shape of titration curves- concentration; completeness of reaction; titration of mixtures- feasibility of redox titrations; detection of end point and redox indicators; choice of indicator; structural aspect of redox indicators; specific and nonspecific indicators; sample preparation- pre-reduction and pre-oxidation; applications.

UNIT III: Complexometric Titrations **15 Hours**
Introduction; complex formation reactions; stability of complexes; stepwise formation constants; inorganic complexing agents; titrations involving unidentate ligands, titration of chloride with Hg^{2+} and cyanide with Ag^{+} ; organic complexing agents; amino carboxylic acid titration; EDTA; acidic properties of EDTA; EDTA complexes with metal ions; equilibrium calculations involving EDTA in solution; conditional formation constants; EDTA titration curves; effect of other complexing agents on EDTA; factors affecting the titration curves; completeness of reaction; indicators for EDTA titrations; theory of common indicators;

titration methods using EDTA- direct titration, back titration and displacement titration; indirect determinations; selectivity, masking and demasking agents; applications of EDTA titrations- hardness of water; magnesium and aluminium in antacids; magnesium and zinc in a mixture; analysis of ores and foods.

UNIT IV: Gravimetric Analysis **15 Hours**

Introduction; properties of precipitates and precipitating reagents; conditions for precipitation; completeness of precipitates; super saturation and precipitate formation; particle size and filterability of precipitates; colloidal precipitates; crystalline precipitates; purity of the precipitate; co-precipitation, post precipitation; fractional precipitation; precipitation from homogenous solution; organic reagent as precipitant- dimethyl glyoxime; washing of precipitates; drying and ignition of precipitates; result calculation from gravimetric data.

TEXT BOOKS:

1. Fundamentals of Analytical Chemistry, D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch; 8th Edition

REFERENCE BOOKS:

1. Principles and Practice of Analytical Chemistry, F. W. Fifield and D. Kealy, Backwell Science Ltd., London
2. Vogel's Text Book of Quantitative Chemical Analysis, 6th Edition
3. Analytical Chemistry, G. D. Christian; 5th Edition, John Wiley, NY
4. Instrumental Methods of Chemical Analysis, H. Kaur, Pragati Prakashan
5. Quality in the Analytical Chemistry Laboratory, E. Prichard, John Wiley and Sons, NY

WEB REFERENCES:

1. https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Book%3A_Analytical_Chemistry_2.1_(Harvey)/08%3A_Gravimetric_Methods/8.02%3A_Precipitation_Gravimetry
2. http://www.wiredchemist.com/chemistry/instructional/laboratory-tutorials/gravimetric-analysis/
3. https://chem.libretexts.org/Bookshelves/Ancillary_Materials/Demos%2C_Techniques%2C_and_Experiments/General_Lab_Techniques/Titration/Acid-Base_Titrations
4. https://opentextbc.ca/chemistry/chapter/14-7-acid-base-titrations/
5. https://chem.libretexts.org/Courses/Northeastern_University/09%3A_Titrimetric_Methods/9.5%3A_Precipitation_Titrations

Course Code: CHAC-502
Course Title: Spectral Methods of Analysis
Credits: 4
Maximum Marks: 100
Duration: 60 Hours

Course Objectives:

1. To provide students with basics about the characterization of materials using XRD
2. To enable students to understand the concept of emission measurement for quantification of related compounds
3. To provide students with basic knowledge about spectroscopy for identification of inorganic compounds

Course Outcomes:

On successful completion of the course, the student will be able to:

CO1: Understand the basics of emission, diffraction concepts

CO2: Understand the different phenomenon of emission occurring in an organism

CO3: Understand the use of EDAX

CO4: Apply the knowledge of Mossbauer and electron spin spectroscopy in identification of compounds

UNIT I: X-ray Absorption, Diffraction; Neutron Diffraction, Fluorescence Spectroscopy 15 Hours

X-ray absorption- introduction, theory, origin and interaction of X-ray with matter; X-ray spectrometer; Bragg's law; X-ray diffraction- introduction, theory; comparison of X-ray absorption and X-ray diffraction; X-ray diffraction by crystal; determination of crystal structure (single crystal and powder); interpretation of X-ray diffraction pattern; calculation of lattice parameters; neutron diffraction- introduction; theory; instrumentation and applications; X-ray fluorescence- introduction, applications; X-ray photoelectron spectroscopy.

UNIT II: Molecular Fluorescence, Phosphorescence and Chemiluminescence 15 Hours

Fluorescence and phosphorescence- introduction, definition; principles of fluorescence, chemical structure and fluorescence; theory of molecular fluorescence; instrumentation- single and double beam filter fluorimeters; relationship between intensity of fluorescence and concentration; factors influencing fluorescence and phosphorescence; basic differences in measurement of fluorescence and phosphorescence; advantages; limitations and precautions; spectrofluorometer; phosphorimeter; selection of excitation wavelength for analysis; reporting fluorescence spectra; applications of fluorimetric analysis- inorganic, pharmaceutical, agricultural, biochemical and biomedical materials; Chemiluminescence- introduction, principle, types; meaning of luminescence, chemiluminescence; instrumentation; chemiluminescence titrations, chemiluminescence measurement; quantitative chemiluminescence; gas phase chemiluminescence analysis; electro-chemiluminescence.

UNIT III: Mossbauer Spectroscopy and Raman Spectroscopy 15 Hours

Mossbauer Spectroscopy- introduction; principle; theory; instrumentation; line width; isomer shift; quadrupole interaction; magnetic interaction; information on spin and oxidation states; structure and bonding; spin transition from spectra of different Mossbauer active nuclei in various environments; Mossbauer effect; application of Mossbauer effect to the investigations of compounds of iron and tin; Raman spectroscopy- introduction, light scattering by molecules, Raman effect- in solids, liquids, gases; mechanism; molecular structure; nature of Raman spectra; Raman activity of molecular vibrations; dynamic light scattering and determination of colloidal particle size.

UNIT IV: Microscopy and Electron Spin Resonance Spectroscopy 15 Hours

Chemical microscopy- microscope; parts and optical path; numerical aperture and significance; Kofler's hot stage microscope; fluorescence, polarizing; interference and phase microscopy; applications, qualitative and quantitative study; Electron microscopy- principle, operation, sample preparation, replicas, shadowing, application to analysis; electron probe analyzer, ion microscope; metallography- metallurgy, microscopic examination; specimen preparation and examination; interpretation of micrographs by SEM, EDAX, TEM, AFM; Electron Spin Resonance Spectroscopy- introduction; instrumentation, difference between ESR and NMR, Hyperfine interactions and qualitative analysis, study of free radicals, study of inorganic compounds, transition elements, structural determination.

TEXT BOOK:

1. Fundamentals of Molecular Spectroscopy, C. N. Banwell, E. M. McCash; 4th Edition Tata McGraw-Hill, New Delhi

REFERENCE BOOKS:

1. Elements of X- ray Diffraction; B. D. Cullity, Addison Wisley
2. Diffraction Method, Wormald, Oxford University Press

3. Neutron Scattering in Chemistry, E. Butleworth Baun, G, London
4. Mossbauer Spectroscopy, N. N. Greenwood, T. C. Gibbs, Chapmann Hall
5. Chemical Application of Mossbauer Spectroscopy, V. I. Goldanski and R. H. Harber, Academic Press
6. Spectroscopy in Inorganic Compounds, CNR Rao, G. R. Ferraro; Academic Press
7. Basic Principles of Spectroscopy, Cheney R. MacGrows Hill
8. Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler; 5th Edition
9. Instrumental Methods of Analysis, B.K. Sharma, Goel Publishing House

WEB REFERENCES:

1. https://serc.carleton.edu/research_education/geochemsheets/techniques/XRD.html
2. https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Map%3A_Principles_of_Instrumental_Analysis_(Skoog_et_al.)/15%3A_Molecular_Luminescence_Spectrometry
3. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/mossbauer-spectroscopy
4. https://serc.carleton.edu/research_education/geochemsheets/techniques/mossbauer.html
5. https://www.google.com/url?sa=t&source=web&rct=j&url=https://www.nanoscience.com/techniques/atomic-force-microscopy/&ved=2ahUKEwjS-enSyJHnAhWXTX0KHWw1BqoQFjAaegQIAhAB&usg=AOvVaw2ou89f5fahKqUBqZgmLuIc&cshid=1579502355346

Course Code: CHAC-505
Course Title: Experiments in Analytical Chemistry
Credits: 4
Maximum Marks: 100
Duration: 180 Hours
Course Objectives:
1. To enable students in understanding the knowledge of separation and characterisation
2. To enable students to carry out, record and analyse the result of analytical experiments

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Understand the quantitative approach towards various instruments
CO2: Identify appropriate method to carry out quantitative analysis for desired samples
CO3: Perform titrimetric and spectrophotometric analysis
CO4: Develop good laboratory practices, both conceptually and practically

This course consists of Seven Units of experiments in various areas of Analytical Chemistry Each Unit is equivalent to thirty hours duration

UNIT I
Analysis of Pharmaceutical Tablets/Samples:
1. Estimation of calcium from dietary supplements using Murexide indicator
2. Estimation of Ibuprofen / Paracetamol
3. Estimation of sulphadiazine / sulphonamide
4. Determination of neutralising power of tablets of different brands and compare effectiveness
5. Determination of iron using Zimmermann-Reinhardt reagent by titrating against potassium permanganate
6. Estimation of iron from given pharmaceutical drug sample using thioglycolic acid

UNIT II
Simple Chromatography:

1. Separation of alpha amino acids by paper chromatography
2. Determination of various impurities by thin layer chromatography
3. Separation of leaf pigments: chlorophyll ‘a’ chlorophyll ‘b’, carotene and xanthophylls
4. Determination of R_f value of glycine by ascending paper chromatography
5. Separation of sugars, amino acids by paper and thin layer chromatography
6. Separation of a mixture of o- and p- nitro anilines on an alumina/silica column
7. To study the presence of lactose in milk by descending paper chromatography

UNIT III
Ion Exchange Chromatography and Solvent Extraction Method:

1. To determine the capacity of a cation exchange resin
2. To determine the capacity of an anion exchange resin
3. To estimate the amount of potassium ion from fertilizer sample using cation exchange resin
4. To separate and estimate the cobalt and nickel ions using an anion exchange resin
5. To determine the Ni ion as Ni-DMG complex using Butyl acetate/$CHCl_3$ as extracting solvent
6. To determine the Fe ion as Fe-oxine complex using Butyl acetate/ $CHCl_3$ as extracting solvent
7. Separation of acidic, basic and neutral compounds from a mixture by solvent extraction

UNIT IV
Gas Chromatographic Analysis:

1. Optimum flow rate for the determination of chloroform using Van Deemter equation
2. Quantitative analysis of a mixture of chloroform and carbon tetrachloride
3. Gas chromatographic analysis for a mixture of gases like O_2, N_2 and CO_2

HPLC Analysis:

1. HPLC analysis of mixture of alcohols
2. HPLC quantitative assay of ampicillin in a powder for injection
3. To analyze a mixture of two hydrocarbons by HPLC
4. HPLC analysis of Ibuprofen or Paracetamol (analgesics) in a commercial sample/tablet
5. To develop and validate the analytical method of any one drug using HPLC
6. Determination of number of theoretical plates by HPLC using Acetophenone as reference material

UNIT V
Spectrophotometric Method:

1. To determine pka value of methyl red indicator at room temperature
2. To determine the indicator constant and isobestic point of an indicator
3. To determine the stoichiometry and stability constant of ferric salicylic acid complex by Job`s method and mole ratio method
4. To determine the amount of each p-nitrophenol and m-nitrophenol from the mixture by spectrophotometric titration using standard NaOH solution at λ_{max}= 280 nm
5. To record UV absorption spectrum of acetone in n-hexane and identify the various transitions
6. Estimation of aspirin and caffeine from APC tablet by UV-Visible spectrophotometry
7. Iodination of acetone by spectrophotometry
8. Estimation of Pb/Hg by AAS method
9. Determination of critical micelle concentration by spectrophotometry

UNIT VI
Electrochemical Method:

1. pH-metric determination of hydrolysis constant of aniline hydrochloride
2. pH-metric determination of the acid-base dissociation constant and isoelectric point of amino acid
3. Potentiometric estimation of bicarbonate and carbonate
4. Potentiometric determination of dissociation constant of Cu-ammonia complex
5. To determine the dissociation constant of given dibasic acid (oxalic acid) by pH metry
6. Determination of Pb/Cu by differential pulse voltammetry
7. Determination of Pb/Cu/Zn by Anodic/Cathodic Stripping Voltammetry

UNIT VII
Interpretation Exercise:

1. X-ray powder diffraction analysis of cubic compound:
    a. Determination of Lattice constants and crystallite Size
    b. Density
2. Interpretation of Mossbauer spectrum with reference to determination of: isomer shift; quadruple splitting; internal magnetic field; general comment
3. Interpretation of IR spectrum with reference to stretching vibration of: C=N; C=O; N-O; M-O
4. Interpretation of NMR spectrum with reference to calculation of chemical shifts and general comments
5. Interpretation of absorption spectra for:
    a. Verification of the position of ligands in spectrochemical series
    b. Calculation of spectral splitting parameters
    c. Determination of geometry of a given compound (octahedral, tetrahedral, square planar)
6. Statistical revaluation of spectrophotometric data

REFERENCE BOOKS:

1. Vogel's Text Book of Quantitative Chemical Analysis, 6th Edition
2. Comprehensive Experimental Chemistry, V. K. Ahluwalia, New Age Publications
3. Experimental Physical Chemistry, F. Daniels and J. Williams
4. Experimental Physical Chemistry, R. C. Das and B. Behera
5. Practical Physical Chemistry, B. Viswanathan, P. S. Raghavan
6. An Introduction to Practical Biochemistry, D. T. Plummer; 3rd Edition, Tata Mc Graw Hill, New Delhi
7. Advanced Physical Chemistry, J. B. Yadav, 14th Edition Goel Publishing House
8. Systematic Experimental Physical Chemistry; S. W. Rajbhoj, T. K. Chondhekar, Anjali Publication, Aurangabad

ELECTIVE COURSES

Course Code: CHAE-501
Course Title: Q A and Q C in Analytical Chemistry
Credits: 2
Maximum Marks: 50
Duration: 30 Hours

Course Objectives:

1. To enable students to understand the basics of quality control and quality assurance
2. To enable students to describe the types of packaging and regulatory aspects in food and pharmaceutical industries

Course Outcomes:

On successful completion of the course, the student will be able to:

CO1: Explain the basics of quality control and quality assurance

CO2: Know the types of packaging and regulatory aspects in food and pharmaceutical industries

CO3: Handle reagents and chemicals appropriately

CO4: Evaluate the quality assurance data

UNIT I: Introduction to Quality Control and Quality Assurance 15 Hours

Introduction to basic concepts, quality assurance; aspect of specification and tolerance; quality acceptance; sampling reality; cost aspect of quality decisions; quality control in raw materials; finished product; laws related to quality control; case studies of quality control in various industries like agrochemicals, petrochemicals, pharmaceuticals, dyes, plastics, polymers; selecting and handling reagents and chemicals; cleaning and marking laboratory ware; measuring volume; calibrating volumetric flask; importance of laboratory note book; safety in laboratory; methods of quality assessment- internal, external; evaluating quality assurance data- prescriptive approach and performance-based approach.

UNIT II: Standard Method, Analysis, Packaging and Regulatory Aspects 15 hours

A. Development of a standard method and analysis- introduction; optimising experimental procedure (Standard Test Procedures and Standard Operating Procedures); verifying the method- single-operator characteristics; blind analysis of standard samples; ruggedness testing; equivalency testing; validating standard method; two-sample collaborative testing and analysis of variance.

B. Packaging and Regulatory Aspects- introduction; types of packing material and regulations; acts in food and pharmaceutical industries; testing of material for packing; legal consideration in packing; regulatory aspects of foods, drugs and cosmetics; food safety and Standards Act, 2006; I.S.I., AGMARK, other standards for foods and cosmetics with reference to testing of foods, drugs and cosmetics; raw material; Government authorities concerned with testing- their qualification, duties, powers, procedure to follow; records to be maintained under the Acts; C.G.M.P. and C.G.L.P.S.; Department of 'WHO' certification.

TEXT BOOK:

1. Fundamentals of Analytical Chemistry, D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch; 8th Edition

REFERENCE BOOKS:

1. Quality Assurance in Analytical Chemistry; W. Funk, V. Dammann, G. Donnevert, VCH Weinheim
2. Principles and Practice of Analytical Chemistry; F. W. Fifield and D. Kealy, Backwell Science Ltd. London
3. Vogel's Text Book of Quantitative Chemical Analysis; 6th Edition

4. Modern Analytical Chemistry, D. Harvey, McGraw-Hill Education
5. Analytical Chemistry, G. D. Christian; 5th Edition, John Wiley and Sons, NY
6. Instrumental Methods of Chemical Analysis, H. Kaur, Pragati Prakashan
7. Pharmacopeia of India, Volume I and II
8. Quality in the Analytical Chemistry Laboratory, E. Prichard, John Wiley
9. Principals of Package Development, Gribbinetal
10. Modern Packaging Encyclopaedia and Planning Guide- MacqraWreyco
11. Government of India Publications of Food Drug Cosmetic Acts and Rules

WEB REFERENCES:

1. https://asq.org/quality-resources/quality-assurance-vs-control
2. https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nbsir85-3105.pdf
3. https://www.who.int/water_sanitation_health/resourcesquality/wqmchap9.pdf
4. https://www.who.int/medicines/areas/quality_safety/quality_assurance/control/en/
5. https://www.who.int/tdr/publications/documents/glp-handbook.pdf

Course Code: CHAE- 502
Course Title: Bio analytical Chemistry
Credits: 2
Maximum Marks: 50
Duration: 30 Hours

Course Objectives:

1. To enable students to understand the techniques which are routinely used in bio analytical laboratories
2. To enable students to study various bio analytical techniques used for diagnosis of diseases

Course Outcome:

On successful completion of the course, the student will be able to:
CO1: Have valuable training in forensic science and biotechnology
CO2: Understand antibody-antigen interactions
CO3: Understand various bio analytical techniques used for medical diagnosis and research
CO4: Understand the working of various biosensors used to detect biological compounds

UNIT I: Antibodies, immunoassay, spectroscopic methods for matrix characterization **15 Hours**

A. Introduction, structural, functional properties of antibodies, polyclonal and monoclonal antibodies; antibody- antigen interactions; analytical applications of secondary antibody-antigen interactions: agglutination reactions and precipitation reactions.
B. Introduction; method for total protein- Lowry, Smith (BCA), Bradford; Ninhydrin- based assay; other protein quantification methods; methods for total DNA- fluorometric, diamino benzoic acid, diphenylamine; total RNA; method for determination of total carbohydrate-ferricyanide, phenol sulphuric acid, 2-aminothiophenol; Purpald assay for bacterial polysaccharides; free fatty acids.
C. Antibodies- keys to immunochemical measurements; analytical applications of biological tracers; principle and applications of radioimmunoassay (RIA); enzyme-linked immune sorbent assay (ELISA); immuno histochemistry- important diagnostic tool.

UNIT II: Biosensors and Bio analytical approaches **15 Hours**

A. Introduction to biosensensor, examples of biosensor; configurations; response of enzyme-based biosensors; ferrocene-mediated amperometric glucose sensor; potentiometric biosensor for phenyl acetate, potentiometric immune sensor for digoxin; evanescent-wave fluorescence biosensor for bungaro toxin; optical biosensor for glucose based on fluorescence energy transfer; piezoelectric sensor for nucleic acid detection, enzyme thermistors; clinical genomics; proteomics and metabolomics; clinical diagnosis and screening; research and development; emerging pharmaceutical products, future perspectives.

B. Structure and characteristics of key transition metals, importance of transition metals in physiological processes, transition metals as mediators of disease processes, therapeutic implications of transition metals, determination of transition metals in nature.

C. NMR and MRI technologies- key tools for life and health sciences; importance of bio molecular analytical technique; established and emerging NMR applications; MRI- principles and applications.

TEXT BOOK:

1. Understanding Bio analytical Chemistry, V. A. Gault, John-Wiley and Sons

REFERENCE BOOK:

1. Analytical Biochemistry, D. J. Holme, Pearson Education Ltd.
2. The Principals of ion-selective electrodes and membrane transport, W. E. Morf
3. Bio analytical Chemistry, S. R. Mikkelsen, John-Wiley and Sons

WEB REFERENCES:

1. https://www.elprocus.com/what-is-a-biosensor-types-of-biosensors-and-applications/
2. Mehrotra, P. (2016, January 6). Biosensors and their applications – A review. Journal of Oral Biology and Craniofacial Research. doi:10.1016/j.jobcr.2015.12.002
3. https://www.radiologyinfo.org/en/info.cfm?pg=bodymr
4. https://www.iaea.org/topics/radiotracers
5. https://www.antibodies-online.com/resources/17/1215/radioimmunoassay-ria/

Course Code: CHAE-503
Course Title: Calibration and Validation
Credits: 2
Maximum Marks: 50
Duration: 30 Hours

Course Objectives:

1. To enable students to understand the validation characteristics of some procedures used in laboratory
2. To enable students to have an idea about ICH guidelines used in pharmaceutical industry

Course Outcomes:

On successful completion of the course, the student will be able to:

CO1: Understand the qualification of laboratory equipment as a precondition of reliable analytical testing

CO2: Understand the basic rules of documentation in QA

CO3: Calibrate the instruments of industrial importance

CO4: Have knowledge of ICH guidelines in method development

UNIT I: Regulations and qualifications 15 Hours

Regulations: Regulatory requirements for analytical method validation; validation of analytical methods; complete method validation package, analytical data, protocol, plan, revisions and change controls; International Conference on Harmonization (ICH) Guideline Q2A: Validation of analytical procedures; linearity and range criteria and their role in instrumental method validation; GMP (US), GAMP, working regulations; Qualification: Overview of qualification of instruments; installation, operation and performance qualification (IQ, OQ, PQ) of analytical equipments; method validation and calibration for various instruments used for drug analysis such as UV-Visible Spectrophotometer, IR Spectrophotometer, Spectrofluorimeter, HPTLC, GC, HPLC; qualitative and quantitative method validation; parameters of validation; statistics in validation; detailed discussion on accuracy and precision role in method validation; protocols and interpretation.

UNIT II: Calibration 15 Hours

Calibration of pH meter and analytical balance; linearity and range criteria and their role in instrumental method validation; role of quantification limit and specificity; Limit of Detection (LOD) and Limit of Quantification (LOQ); Robustness and method validation; Ruggedness of chromatographic method; Ruggedness of sample preparation procedure; Calibration verses Qualification verses Validation; Case study for HPLC, UV.

REFERENCE BOOKS:

1. The Theory and Practice of Industrial Pharmacy Lachman Edition
2. Web Resources in Pharmacy, In Pharma Publication, Bangalore
3. Schedule M
4. WHO Guideline
5. Analytical Method Development and Validation, Michael E. Swartz
6. Pharmaceutical Process Validation, Loftus and Nash
7. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, RC Denny, J. D. Banes, Thomas, 6^{th} Edition, ELBS
8. Pharmaceutical Process Validation, Alfred H. Wachter
9. Validation and Qualification in Analytical Laboratories, Ludwig Huber, 2^{nd} Edition, Wiley Publisher

WEB REFERENCE:

1. https://uc.xyz/1mhmZR?pub=link
2. https://www.researchgate.net/publication/8508200_Qualification_of_analytical_instruments_for_use_in_the_pharmaceutical_industry_A_scientific_approach/link/02bfe50f872c59f953000000/download
3. https://www.slideshare.net/mobile/dhavalrock24/concept-of-ursdqiqoqpq
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4670047/
5. https://www.pharmaguideline.com/2010/05/calibration-of-uv-visible.html?m=1
6. https://nvlpubs.nist.gov

Course Code: CHAE- 504
Course Title: Advanced Mass Spectrometry
Credits: 2
Maximum Marks: 50
Duration: 30 Hours

Course Objectives:

1. To enable students to understand the basics of Mass spectrometry, different ionisation methods, Mass analysers and its application to solve structural problems of proteins

Course Outcome:

On successful completion of the course, the student will be able to:
CO1: Choose a proper technique for the analysis of the desired compound
CO2: Interpret and recognise various mass spectra
CO3: Solve and elucidate structures of various organic compounds
CO4: Explain and understand various ionisation processes and recognise different spectra based on ionisation modes

UNIT I: Ionisation Sources 15 Hours

Mass Spectrometry- introduction, principle, diagram of MS; electron ionization; chemical ionization, proton transfer; adduct formation; charge-transfer chemical ionization; reagent gas; negative ion formation; desorption chemical ionization; field ionization; fast atom bombardment and liquid secondary ion mass spectrometry; field desorption; plasma desorption; laser desorption; matrix-assisted laser desorption ionization MALDI; thermo spray; atmospheric pressure- ionization, photo ionization; electro spray; thermal ionization source; spark source; glow discharge source; inductively coupled plasma source.

UNIT II: Mass Analysers and Applications of MS **15 Hours**

Quadrupole analysers; ion guide and collision cell; MS^n, time-of-flight analysers; linear time-of-flight mass spectrometer; delayed pulsed extraction; reflectrons; tandem mass spectrometry with time-of-flight analyser; magnetic and electromagnetic analysers; tandem mass spectrometry in electromagnetic analysers; fragmentation reactions; tandem mass analysis, proteomics.

TEXT BOOK:

1. Mass Spectrometry: Principles and application, Edmond D. Hoffmann; Vincent Stroobant John Wiley

REFERENCE BOOKS:

1. Mass Spectrometry: A Textbook, Jurgen H. Gross, 2nd Edition, Springer
2. Electrospray and MALDI Mass Spectrometry: Fundamental, Instrumentations and Practicalities and Biological Applications; Richard B. Cole, John Wiley

WEB REFERENCES:

1. http://chemistry.emory.edu/msc/tutorial/mass-spectrometry-ionization.html
2. http://chemguide.co.uk/analysis/masspec/fragment.html
3. https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Map%3A_Organic_Chemistry_(Wade)/11%3A_Infrared_Spectroscopy_and_Mass_Spectrometry/11.08%3A_Fragmentation_Patterns_in_Mass_Spectrometry
4. https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Supplemental_Modules_(Analytical_Chemistry)/Instrumental_Analysis/Mass_Spectrometry/Mass_Spectrometers_(Instrumentation)/Mass_Analyzers_(Mass_Spectrometry)
5. Schwartz J C, Senko M W, Syka J E P. A two-dimensional quadrupole ion trap mass spectrometer. Journal of the American Society for Mass Spectrometry, 2002, 13(6): 659-669

SEMESTER IV

CORE COURSE

Course Code: CHAC- 503
Course Title: Separation Techniques
Credits: 4
Maximum Marks: 100
Duration: 60 Hours

Course Objectives:

1. To give students a theoretical and practical introduction to the techniques of separation
2. To address modern challenges across the chemical, biological, and physical sciences as it is often necessary to isolate and examine chemical and biological species as pure substances

Course Outcomes:

On successful completion of the course, the student will be able to:

CO1: Describe the methods of separation and their applications

CO2: Acquire technical knowledge, practical experience with respect to chromatography and capillary electrophoresis

CO3: Understand various chromatographic techniques employed

CO4: Learn applications of various processes for separation and purification of compounds

UNIT I: Basic Separation Techniques **15 Hours**

General aspects of separation techniques- role of separation techniques in analysis; classification; choice of separation method; distribution processes; continuous, discrete and equilibrium; distribution behaviour; chemical structure; errors resulting from separation process; distillation and sublimation; operation variables and their effect; relative volatility, reflux ratio, theoretical plates and HETP; batch and continuous process; columns- types and choice; applications; molecular distillation- theory; setup and applications; sublimation-apparatus, applications; field-flow fractionation.

UNIT II: Solvent Extraction and Electrophoresis **15 Hours**

Basic principles of solvent extraction; extraction efficiency, extraction equilibrium; classification- liquid-liquid extraction; solid-liquid extraction: solid-phase and micro extraction; accelerated and microwave assisted extraction; solvent extraction applications.

Electrophoresis- introduction, types, technique of paper electrophoresis; instrumentation theory; continuous, moving boundary, thin layer, density gradient, zone electrophoresis; factors influencing the mobility of ions; macromolecular size and charge; interaction with supporting electrolyte; pH and concentration discontinuities; temperature and supporting media; capillary electrophoresis; electrolysis; osmosis and reverse osmosis; electro osmosis; applications.

UNIT III: Chromatographic Techniques **15 Hours**

Definition, theories and principle of chromatographic technique; terms and parameters used in chromatography; classification of chromatographic methods; plate and rate theory, Van Deemter equation, development of chromatograms; qualitative and quantitative analysis by chromatography; Gas Chromatography- introduction, principle, theory, instrumentation; study of detectors- ionization, flame ionization, thermal conductivity, electron capture; evaluation of gas chromatogram; identification of chromatogram; applications; comparison of GSC and GLC; applications; Pyrolysis Gas Chromatography - introduction, instrumentation and applications; Vapour phase chromatography- introduction, instrumentation and applications; High Performance Liquid Chromatography- introduction; principle; instrumentation; pumps, column and column packing; column efficiency and selectivity;

applications; comparison of HPLC and GLC; characteristics of liquid chromatography; types of detectors- UV, RI, and fluorescence detectors; advantages, applications; Supercritical Fluid Chromatography-introduction; theory, principle; properties of supercritical-fluids; instrumentation; theory; principle; types, applications.

UNIT IV: Miscellaneous Chromatography and Hyphenated Techniques 15 Hours
Gel chromatography- introduction, theory of size exclusion; principle of gel permeation chromatography (GPC)- instrumentation and applications; theory and mechanism of ion exclusion; applications of ion exclusion technique; inorganic molecular sieves; principle; types of sieves; applications.
Hyphenated Techniques - introduction; principle, instrumentation, and applications of GC-FTIR; GC-MS; LC-MS; MS-MS (tandem) spectrometry (use of stable isotopes); ICP-MS, TG-MS.

TEXT BOOK:

1. Fundamentals of Analytical Chemistry; D. A. Skoog; D. M. West, F. J. Holler, 9th Edition

REFERENCE BOOKS:

1. Chemical Instrumentation: A Systematic approach, H. A. Strobel
2. Analytical Chemistry, G. D. Christian, 5th Edition, John Wiley and Sons, NY
3. Instrumental Methods of Chemical Analysis, H. Kaur, Pragati Prakashan
4. Vogel's Text Book of Quantitative Chemical Analysis, 6th Edition
5. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt, J. A. Dean
6. Instrumental Methods of Chemical Analysis, B. K. Sharma, Goel Publishing House

WEB REFERENCES:

1. Jones, C. E. (2000). Pyrolysis Gas Chromatography. (pp. 544550) In C. E. Jones. Surrey, UK: Academia Press.
2. http://cdn.intechopen.com/pdfs/32828/InTechPyrolysis_gas_chromatography_mass_spectrometry_of_polymeric_materials.pdf
3. https://www.ijarnd.com/manuscripts/v2i4/V2I4-1168.pdf
4. https://www.pharmatutor.org/pharma-analysis/explain-electrophoresis-its-principle-and-factors-governing-it
5. https://www.iitk.ac.in/dordold/index.php?option=com_content&view=category&layout=blog&id=220&Itemid=239

Course Code: CHAC-504
Course Title: Techniques in Chemical Analysis
Credits: 4
Maximum Marks: 100
Duration: 60 Hours

Course Objectives:

1. To illustrate to students the basic principles of modern instrumental methods
2. To enable students in understanding the basic theory underlying the construction of several common instruments and to become familiar with the operation of spectroscopic as well as non-spectroscopic techniques

Course Outcomes:

On successful completion of the course, the student will be able to:

CO1: Develop an understanding of the range and theories of instrumental methods available in analytical chemistry
CO2: Have theoretical knowledge on selected instrumental methods of analysis
CO3: Have the knowledge on analytical study by spectroscopy

CO4: Understand and compare a range of analytical techniques and explain underlying principles

UNIT I: Refractometry and Polarimetry 15 Hours

Introduction; theory; factors affecting refractive index; measurement of refractive index, instrumentation; types of refractometers; molecular refractivity and chemical constitution; applications of refractometry; qualitative and quantitative analysis; plain curves; cotton effect curves; Polarimetry- introduction, theory, principle; plane polarized light; optical activity; theory of optical activity; applications of optical activity; instrumentation; application of optical rotation method in rate constant determination; acid- inversion of cane sugar; relative strengths of acids; optical rotatory dispersion (ORD) and its applications; selection rules; deduction of absolute configuration of molecules; octant rule for ketones and cotton effect.

UNIT II: Conductometric method, pH measurements 15 Hours

Conductometric method- introduction; important laws, definitions and relations; conductance measurement; effect of dilution; basic aspects of conductometric titration; types of conductometric titration; advantages and disadvantages of conductometric titration; analytical applications; pH measurement- introduction, instrument for pH measurement; factors affecting pH measurements; buffer solutions; potentiometric determination of pH using hydrogen gas electrode, glass electrode; use of glass electrode in non aqueous media, asymmetric potential; acid and alkali errors.

UNIT III: Spectrophotometric, Nephelometry and Turbidimetry Analysis 15 Hours

Introduction; law of absorption; absorbance and transmittance spectrum; technique for colour comparison; photo detectors; wavelength selection; radiation sources; standard cells; spectrophotometer instrumentation- single and double beam spectrophotometer; presentation of spectral data; spectrophotometric titrations; applications- determination of Mn(II) as $MnSO_4$, Fe(III) as thiocyanate, Cu (II) using salicyladoxime, simultaneous determination of Mn(II) and Cr(VI); Nephelometry and turbidimetry- introduction; principle; instrumentations; effects of concentration; particle size and wavelength on scattering; choice between the nephelometry and turbidimetry, turbidimetry and colorimetry, nephelometry and fluorimetry; turbidimetric titrations; applications of nephelometry and turbidimetry.

UNIT IV: Thermal Analysis 15 Hours

Thermo gravimetric analysis- introduction; definition; instrumentation; information from TGA curve; factors affecting TGA curves- instrumental, characteristics of sample; limitation and advantages of TGA; applications of thermogravimetry; calculation of compound composition, percent decomposition; Differential Thermal Analysis- introduction, definition; theoretical basis of DTA; DTA instrumentation; factors affecting the DTA curve; advantages and disadvantages of DTA; applications of DTA; Differential Scanning Calorimetry- definition; instrumentation of DSC, types, factors affecting DSC curves; comparison of DTA and DSC techniques; applications.

REFERENCE BOOKS:

1. Text Book of Quantitative Inorganic Analysis, A. I. Vogel, Longman
2. Instrumentation Methods of Chemical Analysis, G.W. Ewing, McGraw Hill
3. Basic Concepts of Analytical Chemistry, S. M. Khopkar
4. The Principals of ion-selective electrodes and membrane transport, W. E. Morf
5. Analytical Chemistry, G. D. Christian, 5th Edition, John Wiley and Sons, NY
6. Instrumental Methods of Chemical Analysis, H. Kaur, Pragati Prakashan
7. Instrumental Methods of Chemical Analysis, B. K. Sharma; Goel Publishing House

WEB REFERENCES:

1. http://rxpharmaworld.blogspot.com/2016/12/nephelometry-and-turbidimetry.html

2. http://www.environmentalpollution.in/pollution/regulation-andmonitoring/nephelometry-and-turbidimetry-principle-theory-and-techniques/1880
3. https://www.slideshare.net/ChaitraliJadhav/optical-rotatory-dispersion-andcircular-dichroism-presentation
4. https://www.microscopyu.com/techniques/polarizedlight/introduction-to-polarized-light
5. https://www.slideshare.net/sujitpatel11/optical-rotatory-dispersion

ELECTIVE COURSES

Course Code: CHAE-505
Course Title: Applied Analytical Chemistry
Credits: 2
Maximum Marks: 50
Duration: 30 Hours

Course Objectives:
1. To enable students with knowledge on various methods for identification of compounds using spectroscopy and to determine the quantitative analysis of sample
2. To students enable to analyse various constituents in various fields like clinical chemistry and cosmetics analysis

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Learn about the basic concepts used in clinical chemistry
CO2: Understand the chemistry of food and will be able to analyse different components in it
CO3: Apply knowledge of analytical chemistry in analysis of cosmetics
CO4: Get an idea about the nutritional values of food stuff

UNIT I: Food Analysis **15 Hours**
Food legislation and public health; nutritional value of foods; general methods for determination of moisture, ash, crude protein, fat, crude fiber, carbohydrates; analysis of food like flour, starch, honey, jams, milk, tea, coffee and beverages (soft drinks, alcoholic drinks), calcium, potassium, sodium and phosphates; edible oils and fats- general composition of edible oils; detection of purity; rancidity of fats and oils; estimation of rancidity; ratio of saturated and unsaturated fatty acids; test for common edible oils like ground nut, castor, cottonseed and mustard; determination of- total fatty acid, acid value, R. M. value, P. V. value, iodine value, ester value, acetyl value, titre value, peroxide value.

UNIT II: Food Processing, Preservation; Clinical Chemistry and Cosmetics Analysis **15 Hours**
A. Food processing and preservation- introduction; food processing; food preservation methods- freezing, drying, pasteurization, sterilization, irradiation, canning, concentration; analysis of preservatives; types of packing materials and properties; industrial requirements; colouring matter; micronutrients; trace metals; pesticide residues.
B. Clinical Chemistry- introduction; sample collection and preservation of physiological fluids; composition of body fluid; detection of abnormal levels of certain constituents leading to diagnosis of diseases; analysis of physiological fluids like- blood, urine, serum; estimation of blood glucose, cholesterol, urea, haemoglobin, billirubin, uric acid, urine in urea, calcium, phosphate; physiological and nutritional significance of water soluble and fat soluble vitamins, minerals.
C. Cosmetics analysis- introduction, analysis of lipsticks- determination of non-volatile matter, lakes and fillers; analysis of deodorants and antiperspirants for- Al, Zn, boric acid,

chloride, sulphate, urea; analysis of face powder- fats, fatty acid, Ca, Mg, $BaSO_4$, Ti and Fe; oxides of Ti, Fe and Al (total); analysis of hair tonic: 2, 5- diamino toluene, $KBrO_3$, resorcinol, salicylic acid.

TEXT BOOK:

1. Food Composition and Analysis, H. O. Triebold, L. W. Aurand

REFERENCE BOOKS:

1. Introduction to Food science and Technology Series; G. F. Stewart, M. A. America Academic Press
2. Food Chemistry, H. K. Chopra, P. S. Panesar; Narosa Publication
3. Food Chemistry; Alex V. Ramani; M. J. P. Publishers
4. Analytical Chemistry of Foods, Ceiwyn S. James; 1st Edition, Blackie Academic and Professional Chapman and Hill Publisher
5. Chemical Analysis of Food, Pearson
6. Practical Biochemistry in Clinical Medicine; R. L. Nath, 2nd Edition, Academic Publishers
7. Analytical Biochemistry, D. J. Holme, H. Peck, Longman
8. Bio analytical Chemistry, S. R. Mikkelsen, E. Corton, John Wiley and Sons
9. Chemical Analysis of Food and Food Products, H. B. Jacob, Van Westrand Reinhold
10. Instrumental Methods of Chemical Analysis, H. Kaur, Pragati Prakashan

WEB REFERENCES:

1. https://www.news-medical.net/life-sciences/Clinical-Chemistry-Tests.aspx
2. https://www.sciencedirect.com/science/article/pii/0379073881901730
3. https://www.slideshare.net/mobile/parth241989/analysis-of-cosmetics-112070804018
4. https://www.sciencedirect.com/science/article/pii/S2214750015000165
5. https://sciencemonk.com/forensic-chemistry/

Course Code: CHAE-506
Course Title: Advanced NMR Spectroscopy
Maximum Marks: 50
Credits: 2
Duration: 30 Hours

Course Objectives:

1. To enable students to understand basic aspects of nuclear magnetic resonance spectroscopy
2. To enable students to understand one-dimensional NMR, Chemical shifts, J-coupling, Interpretation of 1D NMR spectrum, basics of 2D NMR, different 2D NMR experiments and their application/interpretation

Course Outcomes:

On successful completion of the course, the student will be able to:
CO1: Explain the concept of nuclear magnetic resonance spectroscopy
CO2: Apply nuclear magnetic resonance spectroscopy for identifying organic compounds
CO3: Explain the concept of 2D NMR spectroscopy
CO4: Apply 2D NMR to identify organic compounds

UNIT I: NMR Spectroscopy **15 Hours**

Nuclear magnetic resonance- theory, quantum description; classical description of NMR; types of NMR spectra; applications of proton NMR in qualitative and quantitative analysis (in general); CW and PFT techniques

UNIT II: ^{13}C-NMR Spectroscopy and Introduction to 2D – NMR **15 Hours**

Types of CMR spectra-undecoupled- proton decoupled-off-resonance decoupled (SFORD)-selectivity decoupled and gated ^{13}CJ) and heteronuclear (^{13}C-^{1}H, ^{13}C-^{2}HJ) couplings, nuclear overhauser effect, ATP (attached proton test), DEPT; Classification of 2D experiments- 2DJ resolved spectroscopy- HOMO and HETERO- 2DJ Resolved Spectra: correlation spectroscopy (COSY) - HOMO-COSY, 2D-INADEQUATE and NOESY.

TEXT BOOK:

1. Spectroscopic Identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. M. Morril

REFERENCE BOOKS:

1. Spectroscopic Identification of Organic Compounds, R. M. Silverstein and Webster
2. NMR in Chemistry- A Multinuclear Introduction, William Kemp
3. ^{13}C NMR for Organic Chemists, G. C. Levy, G. L. Nelson
4. Understanding NMR Spectroscopy, James Keeler; 2nd Edition

WEB REFERENCES:

1. http://chem.ch.huji.ac.il/nmr/techniques/2d/2d.html
2. http://www.cryst.bbk.ac.uk/PPS2/projects/schirra/html/2dnmr.htm
3. http://chem.ch.huji.ac.il/nmr/techniques/2d/cosy/cosy.html
4. http://www-keeler.ch.cam.ac.uk/lectures/2d_a4.pdf
5. http://chem.ch.huji.ac.il/nmr/techniques/2d/noesy/noesy.html

Course Code: CHAE-507
Course Title: Chemometrics
Credits: 2
Maximum Marks: 50
Duration: 30 Hours

Course Objectives:

To provide students with a basic tools in solving problems

Course Outcomes:

On successful completion of the course, the student will be able to:
CO1: Handle computers and data sheet
CO2: Handle statistical arrangements of data

UNIT I: Introduction to Data and Statistics **15 Hours**

Introduction; univariate statistics review; probability; variance and sampling, linear regression and calibration data, digitization, and the Nyquist Theorem, detection limit, S/N ratio, and signal filtering; review of linear algebra: scalars, vectors, and matrices, matrix notation and matrix operations orthogonality, analysis of variance (ANOVA)- 1 variable, analysis of variance- 2 variables; introduction to Matlab^{TM}: programmed, basics and layout, matrix operations in Matlab^{TM}the diary command and examples, ANOVA in Matlab^{TM} experimental design: factorial design, simple versus complex models, factorial design in Matlab^{TM}; half-factorial design.

UNIT II: Multivariate Methods **15 Hours**

A. Introduction to various multivariate methods; the six habits of a chemometrician; principle component analysis (PCA); data pretreatment- mean centering and normalization; PCA in Matlab^{TM}.

B. Classical least squares (CLS), CLS in Matlab^{TM}; inverse least squares (ILS).

C. Multiple linear regression (MLR); principle component regression (PCR); partial least squares, examples in Matlab^{TM}; summary of multivariate methods; pattern recognition-supervised versus unsupervised pattern recognition, K nearest neighbours (KNN); soft independent modelling for chemical analysis (SIMCA), summary of pattern recognition.

TEXT BOOK:

1. Chemometrics, A Practical Guide; Kenneth R. Beebe, Randy J. Pell, and Mary Beth Seasholtz, John Wiley and Sons, Inc., New York

REFERENCE BOOK:

1. The computer program MATLAB^{TM} will be required for some portions of the course

NOTE: Students can opt either for CHAD 508: Dissertation; or CHAM 509: Modules in Experimental Chemistry and CHAI 510: Internship Modules

CHAD-508: DISSERTATION

The dissertation should comprise of original research and may be conducted either at the Institute or with approval, in an outside institution or company e.g. the student's employers. The guiding teacher may serve some laboratory hours for industry work.

The dissertation work is to be submitted for evaluation and for Viva Voice examination at the end of Semester IV.

Written test should be conducted regarding basic principles of techniques or instrument used with respect to the area of dissertation topic.

Students may be assessed based on designing question bank by students on dissertation topic.

CHAM-509: MODULES IN EXPERIMENTAL CHEMISTRY

This Module consists of Seven Units in experiments of various areas of Chemistry. Each Unit is equivalent to 30 hours duration.

INSTRUMENTATION

MODULE I: IR

1. Quantification of acetyl group from polymers using IR
2. Plasticizer from PVC using IR
3. Determination of ethanol in gasoline
4. Spectral analysis of different compounds (synthesised inorganic complexes and organic compounds)
5. Following micro scale reaction using FTIR

MODULE II: POTENTIOMETRY

1. Potentiometric determination of reducing sugars
2. Potentiometric titration using graphite sensor
3. Kinetics of bromination reaction: A potentiometric study
4. Non- aqueous titration containing mixture of aniline and ethanolamine

MODULE III: GC

1. Plasticizer from PVC using GC
2. Synthesis of high boiling organic compound by derivatisation and analyses by GC
3. Separation of alcoholic mixtures
4. Determination of alcoholic content in: i. Beer ii. Wine iii. Local drinks
5. Gas chromatographic analysis for: i. automobile exhaust ii. Cigarette smoke
6. Analysis of preservatives from solid and liquid samples (extraction, sample preparation and analysis)

MODULE IV: HPLC

1. Determination of caffeine content in: i. Tea ii. Coffee iii. Soft drinks iv. Chocolates
2. Qualitative and quantitative analysis of pharmaceutical Drug (e.g. aspirin)
3. Purity of the solvents using HPLC

MODULE V: TG/DTA/DSC

1. Determination of the purity of pharmaceuticals samples
2. Thermal properties of peanut proteins
3. Glass transition temperature of polymers (polymer to be used in preparation of membrane sensor)
4. Determination of water of crystallization in inorganic salts/ coordination compounds
5. Studies on thermal decomposition of Zinc EDTA salt
6. Studies on thermal decomposition of Zinc NTA salt
7. DSC study on pharmaceutical product

MODULE VI: UV-VISIBLE

1. Method development and validation for a drug by UV/Visible spectrophotometer
2. Photometer (to build a photometer using LED) a guided-inquiry experiment to introduce analytical instrument
3. To determine the composition of Ni and Fe (III) solution by spectrophotometric titration using Disodium salt of EDTA

MODULE VII: AAS

1. Analysis of Na, K and Ca in water samples
2. Analysis of metal from soil /ore
3. Analysis of metal from alloys: Fe and Cr from steel /Cu and Zn from Brass / Sn and Pb from solder
4. Analysis of Lead and cadmium in toys

NON INSTRUMENTATION

1. Synthesis of nano composites
2. Synthesis of mixed metal ferrites and its characterization
3. Analysis of Fats and oils- saponification value, iodine value, peroxide value, acid value
4. Determination of rancidity of oil samples
5. Determination of acetic acid in vinegar
6. Synthesis of:
   i. Polystyrene using suspension polymerisation
   ii. Biginelli reaction (Solvent free synthesis)
   iii. Hydrogenation using Pd-C
   iv. Extraction of natural products using Soxhlet apparatus
7. Electrolytic separation of metals Cu/Ni
8. Determination of copper in brass by titrimetry

CHAI-510 INTERNSHIP MODULES

MODULE A: Internship at Industry; One week per Semester (Semester III and IV) **90Hours**

MODULE B: Write up of the Internship work per Semester (Semester III and IV) **30 Hours**

MODULE C: Students to design two modules based on their experience at industry **60 Hours**

*Assessment to be done at the end of Semester IV

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	**CORE COURSES**			
	CHIC-401: General Inorganic Chemistry	Unit III	Halide of boron is added; compounds of phosphorus phosphazenes; metal-metal clusters, deleted	Deleted part is not relevant to boron chemistry
	CHIC-402: Laboratory Course in Inorganic Chemistry	Experiment Number 1, 9 and 12	Experiment Number 1, 9 and 12 are omitted. Replaced by new experiments	They are repeated in other laboratory courses
	CHOC-401: Fundamentals of Organic Chemistry	Unit I	Included 'Stereochemistry of cyclohexene and cyclohexanone', '2-alkyl and 3-alkyl ketone effect'	More detailed study
	CHOC-402: Laboratory Course in Organic Chemistry	Experiment Number 1. D. iii; 1. E.; 2. vi; viii; x; xi; xii; xiii; xiv	Experiments are excluded and replaced with new experiments. Experiment Number 1. D. iii. Crystallization of naphthalene; 1. E. Vacuum sublimation; 2.vi. Grignard reaction; viii. acetoacetic ester condensation; x. Friedel Craft reaction; xi. Solvent- free preparation of coumarin; xii. Natural product extraction; xiii preparation of dyes; xiv. Preparation of benzyl acetate from benzyl alcohol; are to be excluded.	Naphthalene is possibly carcinogenic. Experiments are replaced with new experiments.
	ELECTIVE COURSES			
	CHAE-401: Analytical Techniques		Remains same	
	CHAE-402: Electro analytical Techniques - I		Remains same	
	CHIE-401: Topics in Inorganic Chemistry	Unit I, Unit II	Unit I title changed to 'Main group elements and their selected compound'	

			and Unit II title changed to 'Chemistry of transition and inner transition elements'. Sub units in both units made	More appropriate title
	CHOE-401: Reaction Mechanisms in Organic Chemistry		Remains same	
	CHPE-401: Topics in Physical Chemistry	Unit II	To include 'degree of polymerization' without derivation in unit II.	Derivation being lengthy
II	**CORE COURSES**			
	CHAC-401: Spectroscopy in Chemistry	Unit IV	Title changed to 'Mass Spectrometry and various techniques for structure determination.	More appropriate title
	CHAC-402: Laboratory Course in Analytical Chemistry	Experiment Number 3 and 4	Experiment Number 3 and 4 are deleted	Experiment Number 3 is replaced by new experiment as the experiment is included in UG syllabus
	CHPC-401: General Physical Chemistry		Remains same	
	CHPC-402: Laboratory Course in Physical Chemistry	Experiment Number 11	Experiment Number11 is replaced new experiment. In addition two experiments are added.	Experiment Number 11 is replaced by new experiment as the experiment is included in UG syllabus
	ELECTIVE COURSES			
	CHAE-403:Electro analytical Techniques - II		Remains same	
	CHIE-402:Environmental Control and Chemical Analysis	Unit II	Title changed to 'Soil pollution and Analysis of paints, pigments, pesticides, explosives' and sub units are made 'Analysis of Soaps and detergents' is deleted	More appropriate title Content not relevant
	CHOE-402: Reagents in Organic Synthesis	Unit II	Unit II title changed to 'Reduction reactions.' 'Electro organic synthesis' is added.	Replaced with more relevant title. Relevant concept.
	CHPE-402: Diffraction Methods	Unit II	Unit II title changed to 'Problem solving through diffraction methods,' and 'Fourier synthesis for crystal structure determination' is added	Replaced with more relevant title and topic
III	**CORE COURSES**			
	CHAC-501: Fundamentals of Chemical Analysis		Content remains same	Shifted from Semester IV to Semester III

	CHAC-502: Spectral Methods of Analysis	Unit II	To include 'dynamic light scattering and determination of colloidal particle size'	New concept
	CHAC-505: Experiments in Analytical Chemistry 	 Unit IV Unit VI	Experiments were removed Experiment added on 'Determination of number of theoretical plates by HPLC using Acetophenone as reference material' Experiments added on 'Determination of Pb/Cu by differential pulse voltammetry' and 'Determination of Pb/Cu/Zn by Anodic/Cathodic Stripping Voltammetry'.	Experiments repeated in other semesters More relevant to the theory content More relevant to the theory content
	ELECTIVE COURSES			
	CHAE-501: QA and Q C in Analytical Chemistry	Unit II	Title changed to 'Standard method, Analysis, Packaging and Regulatory Aspects' and sub units were made.	Title was too long
	CHAE-502: Bio analytical Chemistry	Unit II	Title changed to 'Biosensors and Bio analytical approaches' and sub units are made. Sub topics 'principles of NMR' and 'MRI as principle diagnostic and research tool' is omitted.	Title was too long
	CHAE-503: Calibrations and Validation		Remain same	
	CHAE-504: Advanced Mass Spectrometry		Remain same	
IV	**CORE COURSES**			
	CHAC-503: Separation Techniques	Unit I Unit III Unit IV	Subtopics 'basic principles of distillation; theory of fractional distillation; fractionation by evaporation' omitted To include 'Supercritical Fluid Chromatography' from unit IV. To include subtopics 'plate and rate theory, Van Deemter equation, HETP'. Replace 'mechanism of gel permeation	Already taught at UG level. More relevant to the title More relevant to the title

			chromatography' with 'principle of gel permeation chromatography'	
	CHAC-504: Techniques in Chemical Analysis	Unit II	Title changed to 'Conductometric method and pH measurements.' To include 'use of glass electrode in non aqueous media' 'Antimony electrode' omitted	More appropriate title
	ELECTIVE COURSES			
	CHAE-505: Applied Analytical Chemistry		Remain same Sub units were made	
	CHAE-506: Advanced NMR Spectroscopy		Remain same	
	CHAE-507: Chemometrics		Remain same	
	CHAD-508: Dissertation*		Remain same	
	CHAM-509: Modules in Experimental Chemistry		Remain same	
	CHAI-510: Internship Module		Remain same	

MSc. IT

Annexure II

Parvatibai Chowgule College of Arts and Science
(Autonomous)
Margao, Goa

Course Structure of M.Sc IT

Semester I(24 Credits)

Paper Code	Paper Type	Paper Name	Credits	Student (hrs/week)		
				L	T	P
MIT 11	Core – I	Data Structures and Algorithms	4	4	0	0
MIT 12	Core – II	Applied Probability and Statistics	4	4	0	0
MIT 13	Core – III	Operating Systems and Networks	4	4	0	0
MIT 14	Elective – I	Elective Paper	4	4	0	0
MIT 15	Soft Skills – I	Communication Skills Course	4	4	0	0
MIT 16	Lab – I	Data Structures and Algorithms Lab	2	0	0	6
MIT 17	Lab – II	Operating Systems and Networks Lab	2	0	0	6

Semester II (22 credits)

Paper Code	Paper Type	Paper Name	Credits	Student (hrs/week)		
				L	T	P
MIT 21	Core – IV	Software Architecture, Design Patterns and Frameworks	4	4	0	0
MIT 22	Core – V	Design and Analysis of Algorithms	4	4	0	0
MIT 23	Core – VI	Advanced Database Management Systems	4	4	0	0
MIT 24	Elective – II	Elective Paper	4	4	0	0
MIT 25	Lab – III	Software Architecture, Design Patterns and Frameworks Lab	2	0	0	6
MIT 26	Lab – IV	Design and Analysis of Algorithms Lab	2	0	0	6
MIT27	Lab-V	Advanced Database Management Systems Lab	2	0	0	6

Semester III (22 credits)

Paper Code	Paper Type	Paper Name	Credits	Student (hrs/week)		
				L	**T**	**P**
MIT 31	Core – VII	Emerging Technologies	4	4	0	0
MIT 32	Core – VIII	Information Retrieval	4	4	0	0
MIT 33	Elective – III	Elective Paper	4	4	0	0
MIT 34	Elective – IV	Elective Paper	4	4	0	0
MIT 35	Elective – V	Elective Paper	4	4	0	0
MIT 36	Lab VI	Emerging Technologies & Information Retrieval Lab	2	0	0	6

Semester IV(12 credits)

Paper Code	Paper Type	Paper Name	Credits	Student (hrs/week)		
				L	**T**	**P**
MIT 41		Dissertation	12	0	0	0

Legend:

L – Lectures
T – Tutorials
P – Practicals

Parvatibai Chowgule College of Arts and Science
(Autonomous)
Margao, Goa

Semester I & II Syllabi for

MSc IT

(2016-2017)

Paper Title: Data Structures and Algorithms

Paper Code: MIT 11

Max Marks: 100

Max Credits: 4

Course Pre-Requisites:

An introductory course on Data Structures

Course Objectives:

- The objective of the course is to understand the real-life applications of data structures.
- Be familiar with writing recursive and iterative methods using Data Structure.

Learning Outcome:

- Have an idea of applications of algorithms in a variety of areas such as game theory etc.
- To make foundation of writing programs using algorithms on trees,graphs etc.

Syllabus:

1: Algorithm Analysis: **[5L]**

Mathematical Background, Big-O notation, RunningTime computation, Introduction to different strategies of algorithm design – Divide and Conquer, Greedy, DynamicProgramming etc.

2:Review of Basics Data Structure: **[4L]**

List, Doubly linked list, Circular list, Stack, Queue, Recursion.

3:Trees: **[17L]**

The Huffman algorithm, Representing list and binary trees, Height balanced tree, Dictionaries, Optimal Binary Search T\rees,AVL Tree, Red Black Tree, B tree, B+ tree, suffix trees,Splay trees,Binary Tries, Compressed Binary Tries. Tries and Packet Forwarding,Quad Trees,R-Trees.

4:Sorting and searching: **[10L]**

Radix Sort,Heap sort, Quick Sort, Merge Sort ,Interpolation search,Tree Searching,General Search Trees,Hashing,External Sorting Algorithm.

5:Graphs and their applications: [12L]

Revision of basic graph traversal and search technique,spanning trees,Cut-sets and Cut-Vertices: Cut-Sets, Properties of Cut-sets, All Cut-sets in a Graph ,Eulerian Graphs , Hamiltonian Graphs

6:Storage management: [6L]

General list, Automatic list management, Dynamic memory management.

7:Problem classification: [3L]

Nondeterministic algorithm, The class of P, NP, NP-hard and NP- Complete problems

8: Introduction to Approximation and Randomized Algorithms [3L]

Absolute Approximation,€ approximations and randomization

List of Books:

1. Aaron M. Tenenbaum & Augenstein "Data structures using C and C++" PHI
2. Sartaj Sahani "Data structures, Algorithms and Applications in C++"
3. Alfred V. Aho, John E. &: Hoproft, Jeffrey D. Ullman, "Data structures and algorithms"
4. Advanced Data Structures by Peter Brass
5. Graph Theory with Applications to Engineering and Computer Science, Narasingh Deo, PHI.

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Paper Title: Applied Probability and Statistics

Paper Code: MIT 12

Marks: 100

Credits: 4

Course Pre-Requisites:

- None

Course Objectives:

- To provide the foundation of Probability theory and Statistical inference in order to apply statistical methods to various fields such as Statistical Quality Control.

Learning Outcomes:

- Gain knowledge about the probability theory and statistical inference.
- Provide an outline of statistical quality control.

Syllabus:

1. **Introduction:** **[6L]**
   Probability models, sample space events, algebra of events, graphical methods of representing events, probability axioms, combinational problems, conditional probability, independence of events, Baye's rule, Bernoulli trials

2. **Discrete Random Variables:** **[10L]**
   Introduction, random variables and their spaces, the probability mass function, distribution functions, special discrete distributions, analysis of program, the probability generating function, Discrete Random Vectors, independent random variables

3. **Continuous Random Variables:** **[10L]**
   Introductions, the exponential distribution, some important distribution, functions of a random variable, jointly distributed random variables, distributions of sums, functions of normal random variables

4. **Expectation:** **[10L]**
   Introduction moments, expectation of functions of more than one random variable, moments and transforms of some important distributions, computations of mean time to failure, inequalities and limits theorems

5. **Conditional Distribution and Conditional Expectation:** **[2L]**
   Conditional Expectation

6. **Statistical Inference:** **[14L]**
   Introduction, Parameter Estimation, Hypothesis testing: z, t, chi square, F test, Regression, correlation and 'analysis of variance: Introduction, least squares curve fitting, the coefficient of Determination, confidence Intervals in linear Regression, correlation analysis, simple nonlinear regression, Higher dimensional least-squares fit, Analysis of variance; Non parametric tests: sign test, u test, Rank test, Median test

7. **Statistical Quality Control:** **[8L]**
   Control charts, Mean chart, R chart, sigma chart, C chart

List of Books:

1. Gupta S.G.,and V.K.Kapoor, Introduction to Probability and Statistics
2. Sheldon M. Ross, Probability
3. P. S. Mann, Introduction to Statistics, Willey Student Edition

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Paper Title: Operating Systems and Networks

Paper Code: MIT 13

Marks: 100

Credits: 4

Course Pre-Requisites:

- Basics of Operating Systems and Networks

Course Objectives:

- To understand Real time operating systems
- To gain understanding in specific areas of networking such as the design and maintenance of individual networks.

Learning Outcomes:

- Understand real time operating systems.
- Understand and building the skills of subnetting and routing mechanisms. Familiarity with the basic protocols of computer networks, and how they can be used to assist in network design and implementation.

Syllabus:

1. Overview of Operating Systems [5L]

Processes and Threads - Process Scheduling -Synchronization Mechanisms –Deadlocks: Detection, Prevention and Recovery – Models of Resources – MemoryManagement Techniques.

2. Real time Operating systems [10L]

Basic model of real time systems, Characteristics, Applications of real time systems, Real time task scheduling, handling resource sharing, Mobile operating systems, Micro kernel design, Processes and Threads, Memory Management, File system.Failure Recovery and Fault Tolerance:Types of faults, Issues, Failed system behavior, Failure detection, Approaches of fault tolerance

3. Overview of Network Service Design [4L]

Introduction, Strategy for Network Service Implementation, Issues in Network design

4. **TCP/IP [8L]**

Introduction to TCP/IP, Benefits of using TCP/IP,IP addressing, IP Network and Host addressing,Classfull and classless IP addresses, IPV6, Subnet mask, Subnet ting and super netting

5. Switch Technology [5L]

Switch fundamentals (Bridges vs. Switches) – Spanning Tree Protocol: Overview, Spanning tree protocol, Rapid Spanning tree protocol.

6. VLANs and VLAN Trunking [8L]

VLAN- concepts, broadcast domains with VLANs and routers, benefits, types, configuration (geographic, static, verifying, saving, deleting, troubleshooting), preventing broadcast storms. VLANTrunking Protocol, VTP modes of operation, Routing between VLANs, Inter-VLAN routing-issues, solutions, interfaces (physical, logical), subinterfaces.

7. Routing [8L]

Static V/s Dynamic routes, Adding and deleting static routes

Demand on dial routing, Routing protocol, RIP, OSPF, IGP, Secure IP routing.

8. **Network administration [8L]**

SNMP & RMON - Overview and features, MIB Management Information base

Installing SNMP Servers, SNMP communities, Authentication and securing

Monitoring and analysis and troubleshooting, Overview and installation configuration: fire wall, NAT, E-mail (Send mail), Radius, Remote access servers, proxy servers.

9. **Wireless Networking** **[**4L]

Overview, Infrastructure mode, Ad Hoc Mode, ESSID, wireless channels, wireless security, Authentication.

List of books:

1. MukeshSinghal and N.G Shivaratri, “Advanced concepts in operating systems”, McGraw-Hill 2000.
2. Jeffrey S. Beasley and PiyasatNilkaew, A practical guide to advanced networking,Pearson.
3. William Stallings, "Wireless Communications and networks" Pearson / Prentice Hallof India, 2nd Ed., 2007.

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Paper Title: Communication Skills Course

Paper Code: MIT 15

Marks: 100

Credits: 4

Course Pre-Requisites:

- None

Course Objectives:

- To understand the essential elements of Written Communication, and the process of writing.
- To learn various subgenres of workplace communication, including business & technical writing
- To learn the dynamics involved in oral communication, including non-verbal interaction
- To use language effectively in public oral communication

Learning Outcomes:

- To apply creative thinking abilities necessary for effective communication in the modern workplace situation

- To demonstrate clarity, precision, conciseness and coherence in use of language
- To learn how to make one's writing better, faster and more successful
- To produce successful documents in any given situation in different formats, while considering the writer’s objectives, the reader’s needs, the reader-writer relationship and the context.
- To increase personal confidence in delivering speeches to small & large audiences
- To understand and gain non-verbal skills essential to effective speaking.
- Make proper presentations that disseminate information, conduct negotiation and use persuasion

1. Introduction & theory of Written Communication [6L]
Process of Communication, Language as a Tool of Communication, Levels of Communication, Flow of Communication, Communication Networks, Barriers to Communication

2. The Writing process [5L]
Features of academic communication, Prewriting (Invention), Stasis Theory, Creating a Thesis Statement, Developing an Outline, Proofreading, Avoiding Plagiarism

3. Constituents of Effective Writing [8L]
Words & phrases, Sentence Construction, Paragraph Development, Précis Writing, Reading Comprehension

4. Business Writing [9L]
Letters, Memos, Emails, Proposals, Reports, Analysis and Presentation of Data, Documentation and Document Design

5.Technical Writing [4L]
Defining Technical Writing, Technical Description, Process Description, Instruction Manuals, User Manuals, Audience Awareness

6. Introduction to Oral Communication [6L]
Theory of Verbal Communication, Features of Verbal Communication, Listening Skills

7. Non-verbal communication [6L]
Kinesics, Proxemics, Paralinguistics, Chronemics

8. Public Speaking [8L]
Preparation for Public Speaking, Speech Writing, Delivery of Speech, Anxiety Management

9. Meetings / group activity [8L]
Interviews, Group Communication and Discussion, Team work, Leadership Skills

List of book:

Meenakshi Raman, Technical Communication : Principles and Practice, Oxford University press India, 3rd Edition.

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Paper Title: Data Structures and Algorithms Lab

Paper Code:MIT 16

Marks:50

Credits:2

Course Pre-Requisites:

- Theoretical Knowledge of Data Structures

Course Objective:

- Introduce students to a number of highly efficient algorithms and data structures for fundamental computational problems across a variety of areas.

Learning Outcome:

- Knowledge of key issues in advanced data structures, such as appropriateness of data structures and efficiency of their related algorithms.
- Proficiency in applying knowledge from the theory of advanced data structures to various application areas.

List of suggested assignments:

1.Implementation of Basic Data Structure such as stack,Queue,Linked List etc. [3P]
2. Write a program to implement self organised linked list. [2P]
3. Write a program to implement different sorting techniques. [2P]
4. Write a program to implement Optimal Binary Search Tree. [2P]
5. Write a program to generate a Huffman code for the text file. [2P]
7. Write a program to implement insertion and deletion in AVL Tree. [2P]
8. Write a program to implement Red Black tree. [2P]
9.Write a program to implement B-Tree. [2P]
10. Write a program to implement B+ Tree. [2P]
11. Implementation of R-Tree and Quad Tree. [3P]
12. Implementation of Tries. [2P]
11.Implementation of Compressed Binary Tries. [2P]

11. Implementation of Dictionaries. [2P]
13. Implementation of Graph Traversal Techniques. [1P]
14. Write a program to implement linear probing, quadratic hashing and Double hashing. [1P]

Mini Project on the application of Data Structures.

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Paper Title: Operating Systems and Networks Lab

Paper Code: MIT 17

Marks: 50

Credits: 2

Course Pre-Requisites:

- Theoretical Knowledge of operating systems and networks.

Course Objectives:

- To provide practical base in operating system and networks.

Learning Outcomes:

- Understand the basic structure and functioning of operating system.
- Implement various networking concepts**.**

Course contents:

1. Write a program to implement File I/O and efficiency, file system calls, dup functions, fcntl, stat functions, set uids, permissions, sticky bit, links, file times and utime function, directory creation and reading, mkdir, chdiretc, special files. [3P]

2. Implement Streams and file objects, positioning, reading and writing to streams, binary I/O, formatted I/O. [3P]

3. Implement Identifiers, fork, exec, wait functions, race conditions, changing user and group ids, process accounting and times, controlling terminals. [3P]

4. Implement an iterative TCP client and server application (eg. transfer file). [2P]

5. Implement a concurrent TCP client and server application to transfer file. [2P]

6. Implement UDP client and server application to reverse the given input sentence. [2P]

7. Using port scanning to identify open ports and vulnerability detection. Using nmap command. [2P]

8. Installing and configuring a Firewall. [2P]

9. Installing and configuring Intrusion detection system. [2P]

10. Using Network protocol analyzer tool like ethereal or tcpdump to analyze network traffic. [3P]

11. Creating subnets and supernets using simulation tools. [2P]

12. Configuring static route and dynamic route using routing tools.[2P]

13. Configuring VLANs. [2P]

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Paper Title: Software Architecture, Design Patterns and Frameworks

Paper Code: MIT 21

Marks: 100

Credits: 4

Course Pre-Requisites:

- Introductory course on Software Engineering

Course Objectives:

- Learning Software Development using good OO Design and Architecture

- Understanding of Design and Architectural patterns and Frameworks.

Learning Outcomes:

- Understand various design patterns and their application in Software Development
- Understand software architecture and frameworks
- Understand antipatterns and steps that should not be taken while developing software

Syllabus:

1. **Principles of good OO design** **[6L]**
   Inheritance versus delegation, program to an interface.

2. **Design patterns** **[8L]**
   Motivation, reusability, extendibility, cataloging patterns, "GoF" patterns

3. **Software architecture** **[8L]**
   Definition, advantages, components and connectors, views, documenting, evaluating, mining.

4. **Architectural patterns:** **[8L]**
   Layered, pipe & filter, MVC, broker, microkernel, broker, peer to peer, plug-in, event bases software, SOA, middleware architectures

5. **Frameworks:** **[10L]**
   Enterprise frameworks, EJBs

6. **Software product lines:** **[6L]**
   Economies of scope, product line development, product development

7. **Model driven architecture:** **[6L]**
   PIM, PSM, transformation, software factories:

8. **Anti-patterns** **[8L]**
   Case studies

LIST OF BOOKS:

1. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, Design Patterns: Elements of Reusable Object-Oriented Software, Pearson Education

2. Len Bass, Paul Clements, Rick Kazman, Software Architecture in Practice, Pearson

Education

3. Frank Buchmann, Regine Munier, Hans Rohnert, Peter Sommerland, Michael Stahl, Pattern Oriented Software Architecture-I, Pearson Education

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Paper Title: Design and Analysis of Algorithms

Paper Code: MIT 22

Marks: 100

Credits: 4

Course Pre-Requisites:

- None

Course Objectives:

- Understand the basic concepts related to the design and analysis of algorithms
- Understand classical algorithms and their complexity
- Apply the algorithms to real-world problems

Learning Outcomes:

- To explain basic concepts related to the design and analysis of algorithms
- To describe classical algorithms and their complexity.
- To design and analyse their own algorithms.

Syllabus:

1: Introduction **[9L]**

The Role of Algorithm in computing, Framework for design and analysis of algorithms, Growth of functions: asymptotic notation; Recurrences: substitution method, recursion-tree method, master method; Probabilistic analysis and randomized algorithms, indicator random variables.
Advanced Design and Analysis Techniques

2:Dynamic programming: **[9L]**

Assembly line scheduling, matrix-chain multiplication, elements of DP, longest common subsequence,Optimal BST.

3: Greedy algorithms: **[7L]**

elements of greedy strategy, Huffman codes,.Optimal storage on tapes,Minimum cost spanning tree- Kruskal and Prim’s algorithms, performance analysis.

4: Backtracking **[8L]**
The general method,8 Queens problem , sum of subsets,Graph coloring,

5: Amortized analysis: **[3L]**
Aggregate analysis, accounting method, potential method, dynamic tables

6: Graph Algorithms : **[8L]**
Elementary graph algorithms- Minimum spanning tree: growing a spanning tree, Single-source shortest paths: Bellman-ford algorithm, Dijkstra's algorithm. All pairs shortest paths: shortest paths and matrix multiplication, floyd-warshall algorithm.

7: Internet Algorithms **[7L]**
Strings and patterns matching algorithm. Tries.
Text compression.Text similarity testing.

8: NP-Completeness: **[4L]**
Polynomial time, polynomial time verification, NP-completeness and reducibility

9: Approximation algorithms: **[5L]**
The vertex cover problem, Traveling salesman problem, the set-covering problem

LIST OF BOOKS:

1. Cormen Thomas, L. Charles, R. Ronald, S. Clifford, "Introduction to Algorithms", Second Edition, EEE, PHI
2. Knuth Donald, "The Art of Computer Programming Vol I, II, III", Addison Wesley
3. Ellis Horowitz, Sartaj Sahni & Sanguthevar Rajasekaran, Computer Algorithms, Galgotia, 2nd Edition
4. A. Aho, J. Hopcroft, & J. Ullman, The Design and Analysis of Computer Algorithms, Addison Wesley
5. Richard Gilberg & Behrouz Forouzan, Data Structure: a Pseudo code Approach

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Paper Title: Advanced Database Management Systems

Paper Code: MIT 23

Marks: 100

Credits: 4

Course Pre-Requisites:

- Introductory course on Database Management Systems

Course Objectives:

- Understand the concept of a database transaction and related database facilities, including concurrency control, journaling, backup and recovery, and data object locking and protocols.

Learning Outcomes:

- Critically evaluate alternative designs and architectures for databases and data warehouses
- Discuss and evaluate methods of storing, managing and interrogating complex data
- Analyze the background processes involved in queries and transactions, and explain how these impact on database operation and design

Syllabus:

1: Design Theory for Relational Database: [7L]

Functional Dependencies, Decomposition of relational schemes, Normal forms for Relations, schemas, Multivalued and other forms of Dependencies.

2: Query Processing and Optimization: [9L]

Basic algorithms for executing query operations, Basicoptimization strategies, Algebraicmanipulations, optimization of selections in system, Exact optimization for a subset of relational queries, Optimization under weak equivalence.

3: Concurrent operation on the database: [9L]

Basic concepts, a simple transaction model, serializability, lock based protocols, Timestamp based protocol, concurrency for hierarchically structured items, Deadlock handling (Wait-die, wound-wait, nowaiting, cautious waiting), optimistic concurrency control.

4: Database Recovery Techniques: [8L]

NO-UNDO/REDO Recovery Based on differedupdate, Recovery technique based on immediate update, shadow paging,ARIES,Recovery in multidatabase system, Database backup and recovery from catastrophic Failures.

5: Distributed Database: [10L]

Principles of Distributed Databases, Framework for distribution, translation of global queries into fragment queries, query optimization and management of distributed transaction, concurrency control and reliability in distributed databases, Administration of distributed databases. Future Trends in data models: Semantic data models, DM for loosely structured data items, Multimedia database.

6: Emerging Technologies: [10L]

XML Databases: XML-Related Technologies-XML Schema- XML Query Languages- Storing XML in Databases-XML and SQL- Native XML Databases- Web Databases- Geographic Information Systems- Biological Data Management- Cloud Based Databases: Data Storage Systems on the Cloud- Cloud Storage Architectures-Cloud Data Models- Query Languages-Introduction to Big Data-Storage-Analysis.

7: NoSQL Database: [7L]

Introduction of NoSQLdatabases: Document Database,Graph Stores,Key value stores,Column stores, case study of Mongo DB(Document Based) and Neo 4J(Graph Based) databases

LIST OF BOOKS:

1. Fundamentals of Database Systems – By Elmasri & Navathe,Addison Wesl
2. Database System Concepts, Abraham Silberschatz, Henry F. Korth, Mc Graw Hill
3. J.D.Ullman Principles of Database Systems,Galgotia,New Delhi
4. S.Ceri and G.Relagatti Distributed Databases,McGraw Hills
5. C. Papadimitrious The Theory of Database Concurrency Control,Computer Science Press
6. T.Oszu& P.valduriez,Principles of Distributed Database Systems Pentice Hall.

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Paper Title: Software Architecture, Design Patterns and Frameworks Lab

Paper Code: MIT 25

Marks: 50

Credits: 2

Course Pre-Requisites:

- Introductory course on Software Engineering

Course Objectives:

- Implement the various concepts of Object Orientation
- Implement the various Design Patterns
- Usage of various Architectural patterns and Frameworks.

Learning Outcomes:

- Understand various design patterns and their application in Software Development
- Understand software architecture and frameworks
- Understand antipatterns and steps that should not be taken while developing software

Syllabus:

This course will have programming assignments for the various types of patterns and frameworks discussed in the corresponding theory paper.

1. Implementation of various concepts of Object Orientation [4P]
2. Implementation of the 21 Design patterns (Creational, Structural and Behavioural) [8P]
3. Experiments on Architectural Patterns [9P]
4. Experiments on Enterprise Frameworks [9P]

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Paper Title: Design and Analysis of Algorithms Lab

Paper Code: MIT 26

Marks: 50

Credits: 2

Course Pre-Requisites:

- Introductory course on Design and Analysis of Algorithms

Course Objectives:

- Understand the various algorithm design approach

Learning Outcomes:

- Implementation of various algorithmic approach.
- Implementation of algorithms for real life problem.

List of suggested Assignments:

1. Implementation of algorithms using divide and conquer approach. [5P]
   a. Binary Search
   b. Quick Sort
   c. Merge Sort
2. Implementaion of algorithms using dynamic programming approach. [5P]
   a. Assembly Line Scheduling
   b. Longest Common Subsequence
   c. Matrix Chain Multiplication
   d. Optimal Binary Search Tree
3. Implementaion of algorithms using Greedy programming approach. [5P]
   a. Huffman Codes
   b. Optimal Storage on Tapes
   c. Minimum Cost Spanning Tree(Prim's and Kruskal Algorithm)
4. Implementaion of Backtracking programming approach for various problems. [5P]
   a. 8-Queen's Problem
   b. Sum of Subsets
   c. Graph Coloring
5. Implementaion of various Graph algorithms. [5P]
   a. Dijikstra's Algorithm
   b. Bellman Ford Algorithm
   c. Floyd Warshall Algorithm

6. Implementation of various internet algorithms. [5P]
    a. Tries
    b. Text Compression
    c. Text Similarity Testing

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Paper Title: Advanced Database Management Systems Lab

Paper Code: MIT 27

Marks: 50

Credits: 2

Course Pre-Requisites:

- Introductory course on Database Management Systems

Course Objectives:

- Understand the concept of a database transaction and related database facilities, including concurrency control, backup and recovery, and data object locking and protocols.

Learning Outcomes:

- Implementation of different database architectures.
- Proficiency in storing, managing and interrogating complex data
- Representation the database using XML and work on it

List of suggested Assignments:

1: Revision and Normalization	[3P]
2: Advance SQL- Dynamic SQL, Triggers, Assertions	[3P]
3: Advance SQL- Stored Procedures	[2P]
4: Indexing	[1P]
5: Views,Roles,Grants	[3P]

6: Data recovery techniques in databases. [2P]

7: Design XML Schema and perform queries using Xquery and Xpath[3P]

8: Introduction to IndexedDB [2P]

9: Introduction to NO SQL database [1P]

10: Creating Documents,Collection,inserting records,embedding documents [2P]

11: Querying the documents [2P]

13: Aggregation Framework [2P]

14: Sharding [2P]

15: Application development on No SQL Database using Java/PHP or equivalent. [2P]

LIST OF ELECTIVES

1) Software Metrics & Project Management
2) Object Oriented Analysis and Design using UML
3) Mobile Computing
4) Introduction to Data Compression
5) Embedded Systems Design
6) Compiler Design
7) Computer Graphics
8) Natural Language Processing
9) Image Processing
10) Distributed Systems
11) Theory of Computation
12) Data Mining and Data Warehousing
13) Middleware Technology
14) Software Testing
15) Operating Systems, Kernel and Network Programming
16) Cloud Computing
17) Network Security

Paper Title: Software Metrics & Project Management

Marks: 100

Credits: 4

Course Pre-Requisites:

- Introductory course on Software Engineering

Course Objectives:

- Provide a deeper understanding of various software metrics and project management concepts

Learning Outcomes:

- Understand the various types of management namely scope, time, cost, quality, human resource, communication, risk, procurement and integration management.
- Understand software metrics and quality standards.

Syllabus:

1. Introduction **[3L]**
Introduction to Project and Project management, Project phases and project life cycle, organizational structure, Qualities of Project Manager.

2. Project Management Components. **[6L]**

Project Integration Management-Project plan development and execution, change controls, configuration management.

3. Scope & Time Management **[6L]**

Strategic planning ,scope planning, definition ,verification and control, Activity planning, schedule development and control.

4. Cost & Quality Management **[6L]**

Cost estimation and Control, Quality planning and assurance.

5. Human Resource & Communication Management **[9L]**

Organizational planning, staff acquisition, Information distribution, reporting.

6. Risk Management **[6L]**

Risk identification, Quantification and control.

7. Procurement Management **[4L]**

Solicitation, contract administration.

8. Software Metrics **[6L]**

The scope of software metrics, software metrics data collection, analyzing software data, measuring size, structure, external attributes.

9. Software Reliability **[4L]**

Measurement and prediction, resource measurement, productivity, teams and tools.

10. Planning a measurement program. **[6L]**

Metrics plan: Developing goals, questions and metrics.
Where and When: Mapping measures to activities.
How: Measurement tools.
Who: Measurers , analyst, tools revision plans.

11. Quality Standards – CMM, PSP/TSP **[4L]**

List of Books:

1. Information Technology Project Management By -Kathy Schwalbe.
2. Software Metrics A rigorous and practical approach By – Norman Fenton, Shari Lawrence Pfleeger.
3: Software Engineering By- Roger Pressman.

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Paper Title: Object Oriented Analysis and Design using UML

Marks: 100

Credits: 4

Course Pre-Requisites:

- None

Course Objectives:

- Provide a deeper understanding of various software metrics and project management concepts

Learning Outcomes:

- To understand OOAD concepts in depth and be able to model a software system using the various modeling techniques

Syllabus:

1. Introduction **[6L]**

Role of analysis and design in software development, purpose of analysis models, design models, introduction to OO analysis and design approach, comparison of OOAD and SSAD approaches, over view of OO analysis and design activities, overview of popular OOAD methodologies - common features and differences. Introduction to UML, Overview of various UML models.

2. Use case Modelling **[6L]**

Concepts of use case model, actors, association of actors to use cases, use case description, structuring use cases with «include» and «extend» relationships, purpose of use case modelling, guidelines for use case modelling, finding actors, finding use cases, use case realization

3. Structural Modelling **[6L]**

UML class diagram concepts - object, classes, class properties - attributes, operations, relationships between classes - association, aggregation, composition, inheritance, dependency, basic association adornments-multiplicity, role names; concept of package, grouping of classes into packages.

4. Behavioural Modelling **[8L]**

Modelling object interaction using UML interaction diagrams - Sequence diagrams, collaboration diagrams; modelling the behaviour of reactive objects using UML state chart diagrams; modelling systems workflows or operations using UML activity diagram .

5. Introduction to the Unified Software Development Process **[4L]**

Key features of the Unified Software Development Process - iterative model, use-case driven, architecture-centric, phases, iterations and workflows.

6. Software Architectural Design **[8L]**

Architecture modelling in UML, Software architectural design issues, organization into subsystems, handling concurrency, allocation of subsystems to processors, choosing strategy for implementing persistent data stores, choosing strategy to control access to global resources, choosing strategy for software control implementation, overview of common architectural styles. Architecture modelling in UML -modelling active objects, deployment diagram.

7. Class design **[8L]**

Class design activities, guidelines for - designing algorithms, design optimization, implementing state chart of class, adjustment of class hierarchies to increase reuse; design options for implementing associations, refinement of classes with attributes details and operations details, determining visibility between objects, physical packaging of classes into software modules, UML implementation diagram - Component diagram.

8. OO Design Patterns **[10L]**

Introduction to OO design patterns, a template for describing designs patterns, a classification scheme for OO design patterns, uses of design patterns, patterns v/s frameworks, and illustration of some OO design patterns.

9.Implementation Guidelines **[4L]**

Mapping a design class diagram for implementation in OO languages such C++ or Java. Overview of code generation and reverse engineering features of an OO case tool.

List of Books:

1. Craig Larman, Applying UML and Patterns: An Introduction to Object Oriented Analysis and Design; Pearson Low price edition
2. Martin Folwer and Kendall Scott; UML Distilled; Addison- Wesley
3. Object Oriented Analysis and Design using UML by Mahesh P. Matha, PHI Learning Pvt Ltd.
4. James Rumbaugh, Michael Blaha, William Premerlani, Frederick Edduy and William Lorensen; Object-Oriented Modelling and Design; Prentice-Hall
5. Grady Booch; Object-Oriented Analysis and Design with Applications,2nd Edition; Addison- Wesley
6. Jacobson, Booch and Rumbaugh; Unified Software Development Process; Addison- Wesley
7. Hans-Erik Eriksson and Magnus Penker; UML Toolkit; Wiley publishing
8. Rebecca Wirfs-Brock, Brian Wilkerson and Lauren Wiener; Designing Object-Oriented Software; Prentice Hall India

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Paper Title: Mobile Computing

Marks: 100

Credits: 4

Course Pre-Requisites:

- None

Course Objectives:

- To understand the basic concepts of Mobile Computing

Learning Outcomes:

- Apply data communicating methods and networking protocols for wireless and mobile environments.
- Understand positioning techniques and location based services and applications.
- Utilize and employ application frameworks for developing mobile applications.

Syllabus:

1. Introduction to Mobile Computing **[4L]**

i. Introduction and need for Mobile computing
ii. Mobility and portability
iii.Mobile and Wireless devices
iv.Applications
v. Brief History of wireless communication

2. Wireless Transmission **[4L]**

i. General Concepts of multiplexing and modulation
ii. Spread Spectrum
iii. Cellular Systems
iv. Cellular Phone Array
v. Mobile Phone Technologies (1G, 2G, 2.5G, 3G, 4G)

3. Medium Access Control Layer **[4L]**

i. Why specialized MAC? - hidden and exposed terminals- near and far terminals
ii.General Concepts and comparison of SDMA, FDMA, TDMA ,CDMA

4. Global System for Mobile Communication **[10L]**

i. Mobile Services (Bearer, Tele-and-supplementary services)
ii. System Architecture- Radio subsystem - Network and switching subsystem - Operation subsystem
iii. Protocols - Localization and calling - Handover
iv. Value Added Services- SMS Architecture, Mobile Originated and Mobile Terminated ,procedures - Cell Broadcast Service Architecture, Message Transfer Procedure – MMS Architecture, Protocol framework, Message Transfer
Procedure - Location Services, Logical Reference Model, Control Procedures, Network Architecture, determination of Location Information, Location based services
v. GPRS

5. Mobile IP **[6L]**

i. Goals, assumptions and requirements
ii. Entities and terminologies
iii. Agent Discovery
iv. Registration
v. Tunnelling and encapsulation
vi. Reverse Tunnelling
vii. IPv6
viii. IP micro-mobility support – Cellular IP, Hawaii, Hierarchical mobile IPv6
ix. Mobile Routing : Destination sequence distance Vector, Dynamic Source Routing, Alternative Matrix, Ad hoc Routing Protocols -Flat, Hierarchical, Geographic-position-assisted

6. Mobile TCP **[6L]**

i. Traditional TCP - Congestion Control, Slow start, Fast retransmit / Fast recovery
- Implications on mobility
ii. Classical TCP improvements Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit / Fast recovery, Transmission / Timeout freezing, Selective Retransmission, Transaction oriented TCP
iii. TCP over 2.5/3G wireless networks

7. Wireless Application Protocol **[6L]**

i. Architecture
ii. Wireless datagram protocol
iii. Wireless transport layer security
iv. Wireless transaction protocol
v. Wireless session protocol
vi. Wireless application environment
vii. WML
viii. WML Scripts
ix. Push Architecture
x. Push – Pull Services

8. Platform/Operating Systems **[4L]**

i. Palm OS
ii. Windows CE
iii. Embedded Linux
iv. J2ME (Introduction)
v. Symbian (Introduction)
vi. File Systems (Book1)

9. Java for Wireless Devices **[2L]**

i. Setting up the development environment
ii. Basic Data types, Libraries (CLDC, MIDP)

10. UI Controls **[4L]**

i. Displayable and Display
- Image

- Events and Event Handling
- List and choice
- Text box
- Alerts

11. Persistent Storage **[2L]**
i. Record Stores
ii. Records
iii. Record Enumeration

12. Network MIDlets **[4L]**
i. The Connection Framework
ii. Connection Interface
iii. Making a connection using HTTP
iv. Using datagram connection

13. Wireless Messaging **[4L]**

i. Architecture for Messaging application
ii. Messaging API
iii. Types of applications
iv. Pros and cons of messaging

List of web reference:

1. http://java.sun.com/products/wma
2. http://forum.nokia.com

List of Books:

1. Mobile Communications Jochen Schiller, Pearson Education, 2nd Edition
2. Pervasive Computing Technology and Architecture of Mobile Internet Applications
JochenBurkhardt, Dr. Horst Henn, Steffen Hepper, Klaus Rintdorff, Thomas Schack , Pearson Education
3. Wireless Java Programming with J2ME Yu Feng and Dr, Jun Zhu ,Techmedia Publications, 1st edition .
4. Mobile Networks GSM and HSCSD NishitNarang, SumitKasera, TataMcGrawHill
5. Mobile Computing Asoke K Talukdar, Roopa R. Yavagal, TataMcGrawHill

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Paper Title: Introduction to Data Compression

Max Marks:100

Credits: 4

Course Pre-Requisites:

- None

Course Objectives:

- Provide a deeper understanding of Data Compression

Learning Outcome:

- Implementation of Data Compression techniques in real life applications.

Course Contents:

1. Introduction **[5L]**

Compression techniques, Modelling and Coding

2. Huffman Coding **[6L]**

Huffman Coding algorithm, Adaptive Huffman Coding, Golomb Codes, Rice Codes, Tunstall Codes, Applications of Huffman Coding

3. Arithmetic Coding **[7L]**

Coding a sequence, Generating a binary code, Comparison of Huffman and Arithmetic Coding, Adaptive Arithmetic Coding, Applications

4. Dictionary Techniques **[6L]**

Static Dictionary, Adaptive Dictionary, Applications

5. Context based Compression **[8L]**

Prediction with partial match, the Burrows- Wheeler Transform, Associative code of Buyanovsky, Dynamic Markov Compression

6. Lossless Image Compression **[10L]**

The old JPEG standard, CALIC, JPEG – LS, Multi resolution approaches, FACSIMILE Encoding, MRC – T.44

7. Scalar Quantization **[9L]**

The Quantization problem, Uniform Quantizer, Adaptive Quantization, Non Uniform Quantization, Entropy coded Quantization

8. Vector Quantization **[9L]**

Advantages of Vector quantization over Scalar quantization, The Linde-Buzo-Grey Algorithm, Tree Structured Vector Quantizers, Structured Vector Quantizers, Variations on the Theme.

List of Books:

1. Khalid Sayood, Introduction to Data Compression, Morgan Kauffmann

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Paper Title: Embedded Systems Design

Marks: 100

Credits: 4

Course Pre-Requisites:

- Introductory course on Operating Systems

Course Objectives:

- Understand the Embedded Systems architecture, process and development
- Learn the basic concept of RTOS

Learning Outcomes:

- Design, test and critically evaluate embedded solutions to real world situations.
- Recognize the key features of embedded systems in terms of computer hardware and be able to discuss their functions.

Syllabus:

1. Introduction to embedded system [4L]

A First Look at Embedded systems- Examples of Embedded systems- applications area-categories of embedded system – recent trends in embedded system

2. Design challenge [4L]

Optimizing design metrics Common design metrics- Processor technology- General-purpose processors – software - Single-purpose processors – hardware- Application-specific processor- IC technology

3. Architecture of embedded system [4L]

Hardware architecture –software architecture - Programming for embedded system.

4. The process of embedded system development [5L]

Interrupts-Microprocessor-Architecture-Interrupt Basics-The Shared-Data Problem-Interrupt Latency shared data problems- survey of software architecture -Round-Robin-Round-Robin with Interrupts- Interrupt Latency – RTOS.

5. RTOS [6L]

Architecture of kernel –task and task scheduler-interrupt service routines-semaphores-message queues- mail boxes-pipes –events-timer – memory management –interrupt routines in RTOS Environment overview of embedded /real time operating system

6. Embedded Software Development Tools [4L]

Host and Target Machines-Linker/Locators for Embedded Software-Getting Embedded Software into the Target System.

7. Debugging Techniques [4L]

Testing on Your Host Machine-Instruction Set Simulators-The assert Macro-Using Laboratory Tools

8. An Example System [3L]

What the Program Does-Environment in which the Program Operates

9. Task Image creation [5L]

Operating system software –target image creation for windows XP embedded-porting RTOS on a microcontroller based development board.

10. Representative embedded systems [5L]

Programming in Linux-programming in RTLinux-Development of Navigation System –Development of protocol converter-mobile Java applications.

11. State machine and concurrent process models [12L]

Introduction- Models vs. languages, text vs. graphics- Models vs. languages-Textual languages versus graphical languages-An introductory example- A basic state machine model: finite-state machines (FSM)-
Finite-state machines with data path model: FSMD- Using state machines-Describing a system as a state machine-Comparing the state machine and sequential program model- Capturing a state machine model in a sequential programming language-Hierarchical/Concurrent state machine model (HCFSM) and the State charts language

12. Program-state machine model (PSM) [4L]

The role of an appropriate model and language

List of Books:

1. Embedded software primer by David Simon – Pearson
2. Art of embedded system by Jack Ganssle

3. Embedded systems Architecture by Tammy Noergaard – Elsevier publications
4. Embedded /Real time systems – by DR.K.V.K.K.Prasad. – Dreamtech
5. Esterel language by Gerard Berry (web site reference)
6. Embedded system design by Arnold S.Berger
7. model checking by Edmund M.clark
8. Embedded Systems Building Blocks by Jean LaBrosse
9. Embedded Systems Design by Arnold Berger
10. The Art of Programming Embedded Systems by Jack Ganssle

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Paper Title: Compiler Design

Marks: 100

Credits: 4

Course Pre-Requisites:

- An introductory course on theory of computation

Course Objectives:

- To enable the student to understand compiler construction and equip them with skills to write a compiler for a programming language.

Learning Outcomes:

- Understanding of the layers of the compiler design.
- Various tools such as Lex etc.

Syllabus:

1: Introduction **[6L]**

Lexical analysis, Regular Expressions, Finite automation. N.F.A., N.F.A. to D.F.A. conversion, D.F.A., minimization of D.F.A., Lex tool

2: Context Free Grammar **[9L]**

Derivations & Parse trees, Syntax analysis: Parsing, Top Down Parser, Recursive descent Parser, Predictive parsing, LL(1) Parsing table, Bottom Up Parsing, Shift Reduce parsing, Operator precedence parsing, LR Parsing methods, SLR, LRDL, LALR, YACC tool

3: Syntax Directed Translation **[9L]**

Syntax directed translation schemes, Implementation of syntax directed translation schemes, Intermediate codes, Post fix notation parse trees & syntax trees, three address codes, quadruples, triples, Translation of assignment statements, Boolean expression, statements that after flow of control, Post fix translation, Translation with Up down parsing

4: Error Detection & Recovery **[7L]**
Errors, lexical phase errors, Syntactic phase errors, semantic errors

5: Code Optimization **[8L]**
Loop optimization, DAG representation of basic block, value numbers & algebraic laws, Global data flow analysis, Dominators, Reducible flow graph, Depth first search, Loop invariant computation, Induction variable elimination

6: Data Flow Analysis **[7L]**
Reaching definition, Available Expression , copy propagation, Backward flow problems, Very busy, expression & code hoisting code

7: Code Generation **[7L]**
A simple code generation, code generation from DAG & labeled trees

8: Register Allocation **[7L]**
Coloring by implication, coalescing, graph coloring implementation, Register allocation for Trees

List of Books

1. Alfred V. Aho, Jeffreys D. Ullman &Ravi Sethi, "Principles of Computer Design" Narosa Publication
2. Trembley et al, " Theory & Practice of Compiler Writing ", McGraw Publication
3. Andrew W. Appel, " Modern Compilers Implementation in Java"
4. Dhamdhere " Compiler Principles"

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Paper Title: Computer Graphics

Marks:100

Credits:4

Course Pre-Requisites:

- An introductory course on Data Structures and Algorithms

Course Objectives:

- To understand the concepts of Graphic Algorithms, Geometrical transformations and Modeling

Learning Outcome:

- Describe the purpose of Computer Graphics and its applications
- Describe and implement methods for performing 2-Dimentional geometric transformations
- Describe the concept of 3-Dimentional Graphics and methods for performing 3-Dimensional geometric transformations.
- Discuss basic illumination models and surface rendering algorithms.

Course Contents:

1: Basic background **[5L]**

2D and 3D Transformations, Cyrus-Beck line clipping algorithm, Polygon clipping.

2: 3D Viewing **[5L]**

Viewing pipeline, Parallel and Perspective projections, view volumes, clipping

3: Representing Curves and Surfaces **[6L]**

Parametric, curves, continuity conditions, cubic splines, Hermite interpolation, Bezier curves and surfaces, B-spline Curves- uniform nonrational, cubic periodic, open uniform, uniform,non uniform rational types (NURBS), Subdividing curves, Displaying spline curves using forward difference scheme, parametric bicubic surfaces.

4: Solid Modeling **[7L]**

Sweep representation, Constructive solid geometry methods, representation through Octrees, Binary Space Partitioning trees.

5:Visible Surface Determination **[8L]**

Issues in Visible surface determination Coherence, perspective view, extents and bounding volume, backface culling, Z-Buffer and A-Buffer Algorithms, use of Binary Space Partitioning trees, representing 3D data using Octrees, Boolean operations on Octrees, marching cubes, Visible surface ray tracing.

6: Illumination Models & Rendering **[7L]**

Diffuse and Specular illumination model, reflection vector computation, Shading models for polygons – polygon mesh shading, Gouraud and Phong Shading, problems with interpolated shading, Bumpd mapping, Transparency, shadows, Ray tracing.

7: Introduction to Animation **[6L]**

Perception, Animation production, use in film and videos, orientation representation andinterpolation – Euler angle representation, motion display considerations.

8: Animation – Low Level Control [8L]

Motion along a curve – computing are length, speed control – sine interpolation User specifieddistance time functions, path following, key-frame systems – shape interpolation, free-formdeformations, Morphing – 2D object warping.

9: Animation – High Level Control [8L]

Hierarchical modeling and Kinematics – inverse kinematics, Jacobian, rigid body simulation,collision detection, Particle systems – particle generation, attributes, termination, rendering,Flocking behavior – interacting with other members, leader, collision avoidance, modelingwater, fire, explosions, waves, clouds.

List of Books

1. Foley, Van Dam, Feiner, Hughes, Computer Graphics – Principles and Practices , Addison Wesley.

2. Rick Parent, “Computer Animation: Algorithms and Techniques, Morgan-Kaufman,

3. Hearn & Baker, Computer Graphics, Prentice Hall of India.

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Paper Title: Natural Language Processing

Marks:100

Credits: 4

Course Pre-Requisites:

- None

Course Objectives:

- To study fundamental concepts of Natural Language Processing and to introduce the basics of Language processing from algorithmic viewpoint.

Learning Outcome:

- Compose key NLP elements to develop higher level processing chains
- Assess / Evaluate NLP based systems
- Choose appropriate solutions for solving typical NLP subproblems (tokenizing, tagging, parsing)

Course Contents:

1. **Introduction** **[4L]**
   Ambiguity, Models and algorithm, Language, thought and understanding

2. **Regular Expressions and Automata** **[7L]**
   Regular Expressions, Basic Regular Expression Patterns, Disjunction, Grouping, and Precedence, Advanced Operators, Regular Expression substitution, Memory, and ELIZA

3. **Finite-State Automata** **[4L]**
   Using an FSA for Recognition, Formal Languages, Non-Deterministic FSAs, Using an NFSA to Accept Strings, Recognition as Search

4. **Morphology and Finite-State Transducers** **[8L]**
   English Morphology, Inflectional Morphology, Derivational Morphology, Finite-State Morphological,Parsing, The Lexicon and Morphotactics, Morphological Parsing with Finite-State Transducers, Orthographic Rules and Finite-state Transducers, Combining FST Lexicon and Rules, Lexicon-free FSTs: The Porter Stemmer

5. **N-grams** **[7L]**
   Counting Words, Simple N-grams, Smoothing, Backoff, Deleted Interpolation, N-grams for Spellings, Entropy

6. **Word Classes and Part-of-Speech Tagging** **[5L]**
   English classes, tagsets POS tagging, Rule based POS tagging, Stochastic POS tagging, HMM tagging, Transformation based tagging, Multiple tags and multiple words, unknown words

7. **Features and Unification** **[4L]**
   Feature structures, Unification of feature structures, Feature structures in grammar, Implementing unification, Parsing with unification constraints, Types and inheritances

8. **Lexicalized and Probabilistic Parsing** **[3L]**
   Probabilistic Context free grammars. Problems with PCFGs, Probabilistic Lexicalized CFGs, Dependency Grammars, Human Parsing

9. **Representing Meaning** **[7L]**

Computational Desiderata for representation, Meaning Structure of Language, Some Linguistically relevant concepts: Categories, Events, Representing time, Aspects, Representing beliefs, Pitfalls. Alternative approaches to meaning

10. Semantic Analysis **[8L]**
Syntax-Driven Semantic Analysis, Semantic Augmentations to context-Free Grammar Rules, Quantifier Scoping and the Translation of Complex-Terms. Attachments for a Fragment of English. Sentences, Noun Phrases, Verb Phrases. Prepositional Phrases, Integrating Semantic Analysis into the Earley Parser. Idioms and Compositionality, Robust Semantic Analysis

11. Lexical Semantics **[3L]**
Relation among lexes and their senses, WordNet, Internal structure of Words, Creativity and the Lexicon

List of Books:

1. Natural Language processing by Daniel Jurafsky, James H Martin, Pearson Education Asia

2. Jurafsky, Dan and Martin, James, Speech and Language Processing, Second Edition, Prentice Hall, 2008

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Paper Title: Image Processing

Marks: 100

Credits: 4

Course Pre-Requisites:

- None

Course Objectives:
- To understand the basic image processing operations.

Learning Outcomes:

- Explain how digital images are represented and manipulated in a computer, including reading and writing from storage, and displaying.
- Analyze and implement image processing algorithms

Syllabus:

1. **Introduction** **[4L]**
   Image formation model, representation, spatial and Gray Level resolution, Colour models-RGB, CMY and HIS models

2. **Image Enhancement In Spatial Domain** **[8L]**
   Piecewise linear transformation, Histogram equalization, Histogram specification, image averaging, spatial filters – smoothing and sharpening, Laplacian filter, sobel operator, Canny edge detector

3. **Image Enhancement In Frequency Domain** **[8L]**
   2D Discrete Fourier transform and its inverse, filtering in frequency domain, Ideal and Gaussian Low pass filters, high pass filtering, separability property 0f 2D Fourier transform, Fast Fourier Transform

4. **Image Segmentation** **[6L]**
   Line detection, Edge detection, Edge linking and boundary detection, Hough Transform, Thresholding, Region based segmentation

5. **Morphological Image Processing** **[8L]**
   Logic operations involving binary images, Dilation and Erosion, Opening and closing, Applications to Boundary extraction, region filling, connected component extraction

6. **Image Compression** **[10L]**
   Coding redundancy- Huffman coding, LZW coding, run length coding, Lossy compression – Lossy predictive coding, transform coding- DCT, bit allocation, Compression standards – JPEG, video Compression

7. **Image Representation** **[6L]**
   Boundary description, Shape numbers, Fourier descriptors, Texture, principal Components based description

8. **3D Vision** **[10L]**
   Projective geometry, single perspective camera, stereopsis, the fundamental matrix – its estimation from image point correspondences, applications of epipolar geometry in vision, correlation based and feature based stereo correspondence, shape from motion, optical flow

List of Books:

1. Gonzalez and Woods, “Digital Image Processing”’ 2002, Pearson education, Asia

2. Sonka, Hlavac and Boyle Brooks/Cole, “Image Processing, Analysis, and Machine Vision”, 1999, Thomson Asia Pte Ltd Singapore

3. Jain and Rangachar, “Machine Vision”, 1999, McGraw Hill International Edition

4. Schalkoff, John Wiley and Sons, “Digital Image Processing & Computer Vision”, 1989, John Wiley and Sons

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Paper Title: Distributed Systems

Marks: 100

Credits: 4

Course Pre-Requisites:

- **None**

Course Objectives:

- To introduce basic principles and foundations of distributed systems.

Learning outcomes:

- Distinguish the theoretical and conceptual foundations of distributed computing.
- Recognize the feasibilities and the impossibilities in managing resources.
- Identify the problems in developing distributed applications.

Syllabus:

1. Introduction [12L]

Examples of Distributed Systems, Resource Sharing and the Web, Challenges System Models, Introduction to Architectural Models, Functional Models, Characterization of Distributed Systems, Client-Server Communication, Distributed Objects and Remote Invocation, Communication Between Distributed Objects, Remote Procedure Call, Events and Notifications.

2. Distributed Operating Systems [18L]

Introduction, Issues, Communication Primitives, Inherent Limitations, Lamport’s Logical Clock; Vector Clock; Causal Ordering; Global State; Cuts; Termination Detection. Distributed Mutual Exclusion, Non Token Based Algorithms, Lamport’s Algorithm Token, Based Algorithms, Suzuki Kasami’s Broadcast Algorithm, Distributed Deadlock Detection, Issues, Centralized, Agreement, Protocols, Classification, Solutions Applications.

3. Distributed Resource Management [10L]

Distributed File systems, Architecture, Mechanisms, Design Issues, Distributed Shared Memory, Architecture, Algorithm, Protocols, Design Issues. Distributed, Scheduling, Issues, Components, Algorithms.

4. Distributed Algorithms **[12L]**

Introduction to Distributed Algorithms, Kinds of Distributed Algorithm, Timing Models. Synchronous Network Algorithms: Synchronous Network Model, Leader Election in a synchronous Ring, Algorithms in a General Synchronous Networks, Distributed Consensus with Link Failures, Distributed Consensus with Process failures, More Consensus problems.

5. Resource Security and Protection **[8L]**

Introduction, The Access Matrix Model, Implementation of Access Matrix Model, Safety in the Access Matrix Model, Advanced Models of protection, Data Security.

List of Books:

1. George Coulouris, Jean Dellimore and Tim KIndberg, “Distributed Systems Concepts and Design”, Pearson Education, 4th Edition, 2005.

2. MukeshSinghal and N. G. Shivaratri, “Advanced Concepts in Operating Systems”, McGraw Hill, 2001.

3. Joshy Joseph and Craig Fellenstein, “Grid Computing”, IBM Press, 2004.

4. Ajay D. Kshemkalyani and MukeshSinghal, “ Distributed Computing Principles,
Algorithms and Systems”, Cambridge University Press, 2008.

5. Pradeep K. Sinha, Distributed Operating Systems, PHI, 2005.

6. Nancy A. Lynch, Distributed Algorithms, Morgan Kaufmann Publishers, 2000.

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Paper Title: Theory of Computation

Marks:100

Credits:4

Course Pre-Requisites:

- None

Course Objectives:

- To introduce the student to the concepts of theory of computation in computer science. The student should acquire insights into the relationship amongst formal languages, formal grammars and automata.

Learning Outcome:

- Logic and set theory, functions and relations, formal languages and grammars.
- Finite-state automata, pushdown automata
- Turing machines, Church's Thesis, undecidability
- Recursively Enumerable Languages and Unsolvable Problems.

1: Introduction [5L]

Sets, Logic, Functions, Relations, Languages, Proofs, Mathematical Induction, Recursive definitions, Structural Inductions

2: Regular Languages and Finite Automata [7L]

Regular Languages and Regular Expressions, The memory required to recognize a language Finite Automata (DFA),Distinguishing one string from another, Union, Intersection, and Complement.

3: Nondeterministic and Kleene's theorem [7L]

NFA, Converting NFA to DFA,€-NFA ,Kleene's theorem, Converting an €-NFA to an NFA Regular Languages, MyHill-Nerode theorem, Minimal finite Automata, The pumping lemma for regular languages, Closure properties, Decision Problem, Moore and Mealy Machine.

4: Context –free Grammars and Push down Automata [7L]

Context –Free Grammars and Languages, Derivation Trees and Ambiguity, An unambiguous CFG for algebraic Expression, Simplified forms and Normal Forms CNF, GNF Pumping Lemma, Closure Properties.

5: Push Down Automata [7L]

DPDA,PDA corresponding to a given CFG – Top-down PDA, Bottom-up PDA CFG corresponding to a given PDA, Closure properties of CFG.

6: Turing Machine and their languages [12L]

Turing Machine Introduction, Computing a Partial function with a Turing machine Combining Turing machine, Variations of Turing Machine, Nondeterministic Turing Machine Universal Turing Machine, Church-Turing Thesis

7: Recursively Enumerable Languages [8L]

Recursively Enumerable and Recursive, Enumerating a Language, General Grammars Unrestricted Grammars and Turing Machine, Context-Sensitive Language and Grammar Linear Bounded Automata, Chomsky Hierarchy

8: Unsolvable Problems [7L]

A non recursive language and unsolvable Decision problems, Reducing one problem to another ,The halting problem, Rice's Theorem, Closure Properties of families of language

List of Books:

1. Introduction to languages and the theory of computation, By John C. Martin, Tata McGraw Hill
2. Introduction to Automata Theory, Languages and Computation - By Hopcraft and Ullman, Narosa Publishing House.
3. Theoretical Science - By Krishnamurthy, AWEP.
4. Theory of Computer Science - By Brady, McGraw Hill.
5. Computations, Finite and Infinite Machines - By Minsky, Prentice Hall

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Paper Title: Data Mining and Data Warehousing

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, “Data Mining Concepts and Techniques,” 1st Edition Indian Reprint 2001, Harcourt India Private Limited, ISBN 1-55860-489-8

2. Vipin Kumar, Margaret Dunham, “Data Mining: Introductory and Advanced Topics,” 1st Edition, 2003, Prentice Hall (Pearson Publication), ISBN 0-13-088892-3
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, “Machine Learning”, 1997, McGraw Hill
7. S.M. Weiss and N. Indurkhya, “Predictive Data Mining”, 1998, Morgan Kaufmann
8. M. Jarke, M. Lenzerni, Y. Vassiliou, and P. Vassiladis, “Fundamentals of Data Warehouses”, 2000, Springer Verlag, Isbn 3-540-65365-1

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Paper Title: Middleware Technology

Marks: 100

Credits: 4

Course Pre-Requisites:

- Fundamental knowledge of Distributed Systems and knowledge of Java

Course Objectives:

- Understanding the characteristics of distributed systems, Asynchronous communication and Event based systems.
- Understanding of J2EE and Web services.

Learning Outcomes:

- Understand the distributed systems, asynchronous communication and event-based systems in detail.
- Gain knowledge of Servlet technology and Enterprise Java beans
- Understand web services and reflective middleware

Syllabus:

1. **Fundamentals of middleware** **[5L]**

   Introduction to middleware, MW definition, styles of MW, key players;

2. **Distributed systems characteristics** **[12L]**

System models-architectural and fundamental models. RPC, Distributed objects-RNI, .NET Remoting, Name services-DNS, Time and global states, synchronization, Coordination and agreement, distributed transactions and recovery, Consistency & Replication, Fault Tolerance, Security

3. **Asynchronous communication and Event based systems** **[7L]**

   Notifications, message Queuing systems, peer to peer systems

4. **Middleware and enterprise services in J2EE** **[15L]**

   Servlets and EJBs.

5. **SOA & Web services** **[11L]**

   XML,SOAP, WSDL, UDDI & other protocols;

6. **Reflective middleware** **[10L]**

   Introduction to reflective middleware,Middleware oriented architectural patterns for enterprise systems.

LIST OF BOOKS:

Main Reading

1. Distributed Systems- Concepts and Design: George Couloris, Jean Dollimore, Tim Kindberg, Tim Kindberg, Third Edition, Pearson Education, Addison Wesley

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Paper Title: Software Testing

Marks: 100

Credits: 4

Course Pre-Requisites:

- Knowledge of analysis, design and programming

Course Objectives:

- To provide a detailed study of testing software and automated tools.

Learning Outcomes:

- Revise fundamentals of testing and learn about Functional testing and Object Oriented testing methods.
- Gain knowledge of test case design, execution and report
- Understand testing of web applications and automated testing tools

Syllabus:

1. **Testing fundamentals** **[6L]**

   Software testing – Levels of software testing – Test activities – Testing Life Cycle – Test Organization – White Box testing – Basis Path Testing – Control Structure testing – Black Box Testing.

2. **Functional testing** **[11L]**

   Equivalence Class Partitioning - Boundary Value Analysis – Cause-effect Graphing – Special cases. Performance Testing – Stress testing – Configuration Testing – Security Testing – Recovery Testing – Integration Testing – Regression Testing – Acceptance Testing.

3. **Object oriented testing methods** **[12L]**

   Testing Methods at Class level – Interclass test case design- Testing for Specific Environment, architecture, and application - Testing patterns.

4. **Testing process** **[11L]**

   Comparison of different techniques- Test Plan – Test case Design Procedure Specification – Test Case Execution and Analysis - Test Documentation - Reporting test results - Final test report Test Driven Development & Refactoring

5. **Testing Web Application** **[12L]**

   Testing concepts for web apps – Content Testing – User Interface Testing – Component Level Testing – Navigation Testing – Configuration Testing – Security Testing – Performance Testing.

6. **Testing Tools** **[8L]**

   Need for automated testing tools - Selection of testing tool – Tools used at various phases.

LIST OF BOOKS

1. Srinivasan Desikan, Gopalswamy Ramesh , “Software Testing : Principles and Practices”,Pearson Education, 2006

2. Software Testing in the Real World, by E. Kit (1995)

3. The Web Testing Handbook, by S. Splaine and S. Jaskiel

4. Testing Applications on the Web, by H. Nguyen, R. Johnson, and M. Hackett

5. Software Testing and Continuous Quality Improvement, by W. Lewis, et al

6. How to Break Software Security, by J. Whittaker, et al

7. Web resources: http://www.softwareqatest.com

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Paper Title: Operating Systems, Kernel and Network Programming

Marks: 100

Credits: 4

Course Pre-Requisites:

- An introductory course on Operating Systems

Course Objectives:

- To introduce the student to Operating Systems, Kernel and Network Programming

Learning Outcomes:

- Explain Unix file system including advanced file processing.
- Understand the key communication protocols that support the Network.
- Have a detailed knowledge of the TCP/UDP Sockets

Syllabus:

1. **Introduction to UNIX OS** **[14L]**
   Organization of unix user interface. Programmer interfaces. The environment of a unix process, system calls, programming system calls. File I/O, File and Directories, standard I/O library, File related system calls. Process control, Process relationships. Process groups, sessions, controlling Terminal, Process related system calls.
   Signals, Signal concept, Reliable and unreliable signals, Signal sets, Signal related system calls.
   Terminal I/O multiplexing, Memory mapped I/O, related system calls
   Interprocess Communication, Pipes, Message queues,Semaphores and shared memory. .
   Advanced interprocess communication, stream pipes, open server

2. **File I/O and Directories** **[7L]**
   File descriptor and basic file I/O calls. Duplicating file descriptors. File Types, File accesspermissions, Set-user-id and set-group-id bits. Setting file permissions. Changing file ownership.Soft and hardlinks.Reading directories.Synchronising file contents.Standard I/O library.

3. **Process** **[6L]**
   Environment of UNIX process.Command Line arguments.Environment variables.Memory allocation. Process relationship, Process groups, sessions,

Controlling Terminal, Process related system calls. Foreground, Background Processes and Job control.Orphaned process groups.

4. **Signals** **[4L]**
   Signal concept, Reliable and unreliable signals, Signal sets, Signal related system calls. Non local jumps.Job control using signals.

5. **Terminal I/O** **[5L]**
   Special Input Characters.Canonical and Non canonical modes. Terminal Option flags. Getting and setting terminal attributes.Pseudo terminals. Opening and using pseudo Terminals.

6. **Advanced I/O** **[5L]**
   Nonbloking I/O, Record locking. Stream, I/O multiplexing, Memory mapped I/O, Asynchronous I/O.

7. **Inter-process communication** **[3L]**
   Pipes, Message queues, Semaphores and shared memory.

8. **Introduction to Computer Networks** **[4L]**
   Overview of computer networks, seven-layer architecture. Communication protocols, Internet protocols, SNA, Protocol comparison. Test networks and hosts, discovering network topology, 64 bit architecture

9. **Transport Layer** **[5L]**
   Introduction to TCP and UDP protocols, TCP port numbers and concurrent servers, protocol usage by common internet applications
   Berkeley Sockets: Socket address structures, socket functions for TCP Client /server, Day time client /server example

10. **I/O Multiplexing** **[3L]**
    Basic I/O model, asynchronous and synchronous I/O model

11. **Socket Options** **[4L]**
    Generic ,IPv4 , IPv6 and TCP.
    Elementary UDP socket programming: Name and address conversions

List of Books:

1. Steven W.R. "Advanced Programming in UNIX Environment" - Pearson Education

2. Steven W.R., UNIX Network Programming, Second Edition, Pearson education

3. Ralph Davis, Win 32 network programming, Addison Wesley

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Paper Title: Cloud Computing

Marks: 100

Credits: 4

Course Pre-Requisites:

- None

Course Objectives:

- To study important approaches in the field of Cloud Computing.

Learning Outcomes:

- Understand Cloud infrastructure models and grid computing
- Gain knowledge about Google App Engine and programming it with Python.
- Have knowledge about Amazon cloud, Windows Azure Platform and Security in cloud computing

Syllabus:

1. Introduction to cloud computing [6L]

How it all began – Grid computing –utility computing-automatic computing – dynamic data centre alliance-hosting/outsourcing . Cloud computing defined – the SPL frame work for cloud computing –traditional software model – virtualization –the cloud services delivery model-cloud deployment model – key drivers to adopting the cloud –the impact of cloud computing on users-governance in the cloud-the barrier to cloud computing adoption in the enterprise.

2. Developing cloud services [8L]

Cloud infrastructure models-types of cloud service development-softwar as a service-platform as a service – infrastructure as a service-web services – on-demand computing –discovering cloud services deployment services and tools – amazon EC2 –google app engine – Microsoft azure.

3. Google app engine [8L]

The java runtime environment-the python runtime environment – the data store-development workflow-Setting up a google app engine account –setting development enrvironment –starting to program in phython with app engine.

4. Programming google app engine with python [8L]

A first real cloud application –the basic example –chat application-the basics of HTTP –mapping chat into HTTP.

5. Programming google app engine with java [8L]

Google app engine and java-managing server side data – building user interface in java – building the server side of java application.

6. Amazon cloud computing [7L]

Amazon s3-amazon EC2-the simple storage service-simple queuing services

7. Window azure platform [7L]

Windows azure-SQL azur-windows azure app facric- additional online services

8. Security [8L]

Data security –network security-host security –compromise –response.

List of Books

1. George Reese ,cloud computing architecture ,O'Reilly publications.
2. Michael miller , cloud computing :web based application applications that change the way.
3. Tim mather, subra kumarswamryand sharhed Latif, cloud computing security and privacy, O'Reilly publication.
4. Mark C. chu carrol – code in the cloud –programming google app engine.
5. Using google app engine by Charles severance , O'Reilly publication.

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Paper Title: Network Security

Marks: 100

Credits: 4

Course Pre-Requisites:

- None

Course Objectives:

- To understand the concepts and theory of computer network security.

Learning Outcomes:

- Understand basics of Cryptography and security
- Gain knowledge about Block and Stream Ciphers, public key cryptography and asymmetric algorithms
- Have knowledge about authentication and web security protocols

Syllabus:

1. Foundations of Cryptography and Security [5L]

Ciphers and Secret Messages, Security Attacks and Services. Classical encryption techniques.

2. Mathematical Tools for Cryptography [6L]

Substitutions and Permutations, Modular Arithmetic, Euclid's Algorithm, Finite Fields, Polynomial Arithmetic.

3. Design Principal of Block Ciphers [10L]

Theory of Block ciphers, Feistel Cipher network Structures, DES and triple DES, Modes of Operation (ECB, CBC, OFB, CFB), Strength of DES., AES

4. Pseudo Random Numbers and Stream Ciphers [9L]

Pseudo random sequences, Liner Congruential generators, Cryptographic generators, Design of stream Ciphers, RC4.

5. Public Key Cryptography [6L]

Prime Numbers and testing for primality. Factoring large numbers, Discrete Logarithms.

6. Asymmetric Algorithms [5L]

RSA, Diffie-Hellman, ElGamal, Introduction of Ecliptics curve cryptosystems, Key Management, Key exchange algorithms, Public Key Cryptography Standards.

7. Hashes and Message Digests [5L]

Message Authentication, MD5, SHA-3, HMAC

8. Digital Signatures, Certificate and Standards [4L]

Digital signature standards (DSS and DSA), Public Key Infrastructures, Digital certificates and Basics of PKCS standards.

9.Authentication [5L]

Kerberos , X509 Authentication Service

10. Web Security protocols [3L]

IP Security, Transport Layer Security (TLS)., Wireless Security,

11. System Security [2L]

Intrusion detection , Password management. Firewalls management

List of Books

Main Reading

1. Stallings William, " Cryptography and Network Security: Principles and Practises", 5th edition, Prentice Hall
2. Kahate Atul, "Cryptography and Network Security" Tata McGraw-Hill.

Supplementary Reading

1. Menezes A. J., P.C. Van Oorschot and S.A. Vanstone, "Handbook of Applied Cryptrography"

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Annexure III

Parvatibai Chowgule College of Arts and Science
(Autonomous)
Margao, Goa

M.Sc IT - Dissertation Evaluation (300 marks)

- Students can be placed as interns by the college.
- People from industry can be added to the evaluation panel of external examiners. They must evaluate the student for 100 marks.
- Evaluation by External Examiner can be based on Project Report and Project Viva.
- Internal Guide evaluation can be based on:

➢ Regular Reporting
➢ Presentation
➢ Analysis and Design for the project
➢ Coding complexity
➢ Validation and Testing
➢ Evaluation by External Guide will be out of 100 marks. Department Council must approve external guide.
➢ Evaluation by Internal Guide will be out of 100 marks

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Annexure IV

Parvatibai Chowgule College of Arts and Science
(Autonomous)
Margao, Goa

Examination System - PGDCA/MSc (IT)

- 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 60% 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 60 marks and a SEE component of 40 marks. For a 75 marks theory course, the CA component shall be 45 marks and the SEE component shall be 30 marks.
- Students have to score a minimum of 40% marks(CA + SEE) to pass in each paper
- No grace marks are given to pass in an examination.
- 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.

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Annexure V

Parvatibai Chowgule College of Arts and Science
(Autonomous)
Margao, Goa

Panel of Examiners

Name	Designation	College	Phone No.	Email Id.	Subjects Taught
Mr.Edwin D souza	Associate Professor	St. Xavier College, Mapusa Goa.	9890185533	guruedwin@gmail.com	DBMS, Web Technology, Android Programming
Mr.Sanjay Karapurkar	Associate Professor	Bandekar College, Mapusa	9422739603	sanjaybk2@yahoo.co.in	Python Programming, C Programming, Object Oriented Programming, Web Technology
Mr.Omkar Ainapur	Associate Professor	Govt. College, Quepem	9422437693	ainapur@gmail.com	Operating System, Computer organization, MicroController and Programming, Simulation and Modelling, Analog Electronics, Digital Communication
Mr.Govind Kelkar	Associate Professor	Govt. College, Quepem	9421152501	govindkelkar@gmail.com	DBMS, Data structures, Object Oriented Programming, Computer Networking, Web Technology
Filipe	Asst. Professor	Govt. College, Quepem	9890134479	turbophil@gmail.com	DBMS, Web Technology, Modern Development Frameworks
Mr.Nilesh Natekar	Asst. Professor	Govt. College, Quepem	9689131279	nilnat@yahoo.com	Software engineering, Programming, Object Oriented

					Programming
Mr.Kisan desai	Asst. Professor	Govt. College, Quepem	9822169976		Programming, DBMS
Anita Raikar	Associate Professor	Govt. College, Quepem	9011370514	anita.raicar@rediffmail.com	Computer Networks, Computer Organization, Operating systems
Liana Dacosta	Asst. Professor	Govt. College, Quepem	9657568426	dacostalia@rediffmail.com	Computer Networks, Object Oriented Programming, Mathematical Foundation in Computer Science
Shilpa Deodhar	Asst. Professor	Dhempe College, Panjim	9404910800	shilpadeodhar@gmail.com	Simulation and Modelling, Data Structures, C Programming, Microcontroller Architecture & Programming using 8051
Sandra Fernandes		St. Xavier College, Mapusa Goa.	9822313843		C Programming, Data Structures, Computer Networks
Milton Pires	Asst. Professor	Rosary College, Navelim	9823874436	miltonpires@rediffmail.com	C Programming, Data Structures, Web Technology, Computer Networks, DBMS, MIS, E-Commerce, Multimedia, .net
Ekta Agarwal	Asst. Professor	Damodar College, Margao	9823232062	Ekta.agarwal2vvm.edu.in	DBMS, Software Engineering, Web Technology
Tracy Almeida	Asst. Professor	Rosary College, Navelim	9850454155	tracyalmeida@rediffmail.com	DBMS, Data Analysis, Software Testing
Mildred Lemos	Asst. Professor	Rosary College, Navelim	9823330965	mildred_lemos@rediffmail.com	C Programming, Data Structures and E-commerce

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Annexure III

Parvatibai Chowgule College of Arts and Science

(Autonomous)

DEPARTMENT OF COMPUTER SCIENCE

M.Sc[I.T.] COURSE STRUCTURE

Semester I (24 credits)

Course Code	Course Type	Course Name	Credits	Student (hrs/week)		
				L	T	P
MIT 11	Core – I	Data Structures and Algorithms	4	4	0	0
MIT 12	Core – II	Operating Systems and Networks	4	4	0	0
MIT 13	Elective - I	Elective Course	4	4	0	0
MIT 14	Elective – II	Elective Course	4	4	0	0
MIT 15	Elective - III	Elective Course	4	4	0	0
MIT 16	Core III Lab – I	Data Structures and Algorithms Lab	2	0	0	6
MIT 17	Core IV Lab – II	Operating Systems and Networks Lab	2	0	0	6

Semester II (24 credits)

Course Code	Course Type	Course Name	Credits	Student (hrs/week)		
				L	T	P
MIT 21	Core – V	Software Architecture, Design Patterns and Frameworks	4	4	0	0
MIT 22	Core – VI	Design and Analysis of Algorithms	4	4	0	0
MIT 23	Core VII	Advanced Database Management Systems	4	4	0	0
MIT 24	Elective – IV	Elective Course	4	4	0	0

MIT25	Elective V	Elective Course	2	2	0	0
MIT 26	Core VIII Lab – III	Software Architecture, Design Patterns and Frameworks Lab	2	0	0	6
MIT 27	Core IX Lab – IV	Design and Analysis of Algorithms Lab	2	0	0	6
MIT28	Core X LAB -V	Advanced Database Management Systems LAB	2	0	0	6

Semester III (24 credits)

Course Code	Course Type	Course Name	Credits	Student (hrs/week)		
				L	**T**	**P**
MIT 31	Core – XI	Data Mining	4	4	0	0
MIT 32	Core – XII	Information Retrieval	4	4	0	0
MIT 33	Elective VI	Elective Course	4	4	0	0
MIT 34	Elective – VII	Elective Course	4	4	0	0
MIT 35	Elective – VIII	Elective Course	4	4	0	0
MIT36	Elective IX	Elective Course	2	2	0	0
MIT 37	Core XIII Lab V	Data Mining & Information Retrieval Lab	2	0	0	6

Semester IV(8 credits)

Course Code	Course Type	Course Name	Credits	Student (hrs/week)		
				L	**T**	**P**
MIT 41	Elective X	Project/Dissertation	8	0	0	0

Legend:

L – Lectures
T – Tutorials

P – Practicals

Observations :

- The Elective Courses which have 2 credits can be framed as practical courses. They can be on any latest technology that is currently used in the IT sector. These courses can be conducted by using the hands-on approach. There must be 30 contact hours.
- Guidelines for process and evaluation of seminar.
    - Three different types of seminars can be done. (Theoretical/Practical/Research).
    - Tools can be studied. Guides have to be appointed and a record of contact hours must be maintained.

ANNEXURE V

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)
M.Sc. IT

Syllabi for New elective courses

Course Title: Machine Learning

Marks: 100

Credits: 4

Duration: 60 Hrs

Course Pre-Requisites:

- An introductory course on Probability & Statistics.

Course Objectives:

- Provide a broad introduction to artificial intelligence and machine learning techniques.

Course Outcomes:

At the end of the course students will be able to:

CO1: Understand the fundamentals of machine learning.

CO2: Understand the techniques for supervised learning and unsupervised learning.

CO3: Recognize various ways of selecting suitable model parameters for different machine learning techniques.

CO4: Perform experiments in Machine Learning using real-world data.

Syllabus:

1. **Introduction :** **[7Hrs]**

   What is Machine Learning, Examples of Machine learning applications, version space, Decision Trees, Artificial Neural Networks.

2. **Supervised Learning:** **[20Hrs]**

   Supervised learning setup, LMS, Logistic regression, Perceptron, Back propagation neural network, Exponential family, Generative learning algorithms, Gaussian discriminant analysis. Naive Bayes, Support vector machines, Model selection and feature selection, Ensemble methods: Bagging, boosting, Evaluating and debugging learning algorithms.

3. **Learning Theory:** **[8Hrs]**

   Bias/variance tradeoff, Union and Chernoff/Hoeffding bounds, VC dimension, Worst case (online) learning, Practical advice on how to use learning algorithms.

4. **Unsupervised Learning:** **[15Hrs]**

   Clustering. K-means, Hierarchical clustering, EM. Mixture of Gaussians, Factor analysis, Anomaly detection, PCA (Principal components analysis), ICA (Independent components analysis), Self-organizing map(SOM), Deep learning.

5. **Reinforcement Learning and Control:** **[10Hrs]**

   MDPs. Bellman equations, Value iteration and policy iteration, Linear quadratic regulation (LQR), LQG, Q-learning, Value function approximation, Policy search, Reinforce, POMDPs.

Text Book

1. EthemAlpaydin, Introduction to Machine Learning, PHI.

References:

1. Tom M. Mitchell, Machine Learning, McGraw Hill.
2. Richard O. Duda, Peter E. Hart and David G. Stork, Pattern Classification, Wiley
3. Elaine Rich, Artificial intelligence , Tata McGraw-Hill Education

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Course Title: Statistical Computing

Marks: 50

Credits: 2

Duration: 30 Hrs

Course Pre-Requisites: None

Course Objectives:

- To introduce Statistical Computing using a tool like R or equivalent.

Course Outcomes:

At the end of the course students will be able to:

CO1: Gain knowledge of various types of Plots and Charts.

CO2: Use various types of distributions and statistical tests for solving problems.

CO3: Configure software environment to develop programs to implement statistical concepts.

CO4: Use a tool to apply the theoretical concepts to practical problems.

Syllabus:

1. Introduction **[4Hrs]**

Downloading and Setting up the environment, Assigning objects to values, Basic Mathematical functions, Creating vectors and matrices, importing and exporting data, subsetting data, Logic statements and cbind and rbind commands, setting of working directory, scripts for reproducible research, installing packages, apply and functions.

2. **Understanding charts and plots** **[4Hrs]**

Bar Charts and Pie charts, Box Plots and Box Plots with Groups, Stratified Box Plots, Histograms, Stem and Leaf Plots, Stacked Bar Charts, Grouped Bar Charts, Mosaic Plots, Scatter Plots.

3. **Distributions & Tests** **[12Hrs]**

Introduction to Binomial, Poisson and normal distribution, computing probabilities.
Introduction to T scores and Z scores and their computation. Parametric tests such as ;One-Sample t-test, 2-Sample t-test, Paired t-test, Analysis of Variance, Cross Tabulations, Non parametric test : Chi Square Test, Fisher's Exact Test.

4. **Correlation and Regression** **[10Hrs]**

Introduction to bi-variate data, correlation coefficient , simple and multiple regression, Changing a Numeric to a categorical variable, Indicator variables, Variable Selection in Linear Regression using Partial F-Test, Polynomial Regression

Text Book:

1. Maria L Rizzo , Statistical Computing with R, CRC Press.

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Course Title: Educational Technology

Marks: 50

Credits: 2

Duration: 30 Hrs

Course Pre-Requisites: None

Course Objectives:

- To introduce the classroom applications of Educational Technologies.

Course Outcomes:

At the end of the course students will be able to:

CO1: Define educational technology and identify its role in teaching.

CO2: Determine the technology requirements and describe the teaching challenges and opportunities associated with integrating technology in the classroom.

CO3: Inculcate capability of carrying out research in the Educational Technology domain.

CO4: Master usage of ICT tools.

Syllabus:

1. Introduction **[2Hrs]**

Technology in Education: Meaning, Evolution and Development.

2. Educational Technology in Instructional Planning **[3Hrs]**

Multiple Intelligence, Learning Theories, Learning Objectives, Learning Styles, Blooms Taxonomy, Constructivist and situated theories of learning, Instructional Design Models.

3. Advanced topics in Cognition **[6Hrs]**

Role of Cognition in education, Behaviorism & Symbolic Cognition(Skinner's defence of behaviorism, Watson's argument against introspection), Miller's proposal on planning.Distributed Cognition, Situated Cognition, Embodied Cognition.

4. ICT in Education **[3Hrs]**

Computer, Internet, Multimedia/Hypermedia, Animations, Simulations, Projected Materials, Audio Materials, Interactive Materials.

5. Educational Tools **[8Hrs]**

LOGO, SCRATCH, LMS tools

6. Research Methods in Educational Technology **[8Hrs]**

Content of educational research: scientific method, planning educational research, ethics, identifying problem, variables, hypothesis. Strategies of data collection, Data analysis(distribution, statistical significance, statistical tests,SPSS.

Text Book:

1. Shelly & Gunter, Teachers Discovering Computers, Cengage Learning.

References:

2. M. D. Roblyer & Aaron H. Doering, Integrating Educational Technology into Teaching, Pearson.

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ANNEXURE A-M.Sc(IT)

(Summary of changes incorporated in the syllabus of M.Sc. IT at the Board of Studies meeting held on 13th October 2018)

Semester	Course Title	Existing (Indicate only the unit where the change is proposed)	Changes Proposed	Specify the reason for the change
II	Software Architecture, Design Patterns and Frameworks (Core)	Unit 1.	Elaboration was done on topics to be taught in this unit.	Elaboration is helpful to the Instructor teaching this course.
		Unit 2	Unit 2 is now Unit 4 in the restructured course. Units 2 and 3 consist of new topics	It is necessary to teach concepts of Class Diagram before teaching Design Patterns. Hence the shift. The new topics are required as they are relevant to this course.
		Units 3 and 4	Combined and included as Unit 5 in the restructured course.	Related topics.
		Unit 5	Unit 5 is now Unit 6 in the restructured course.	According to the sequential numbering of units.
		Unit 6	Unit 6 is now Unit 7 in the restructured course.	According to the sequential numbering of units.
		Unit 7	Removed	Not necessary

Semester	Course Title	Existing(Indicate only the unit where the change is proposed)	Changes proposed	Specify the reason for the change
III	Computer Graphics (Elective)	Unit I	Elaboration was done on the topics to be taught in this unit.	Elaboration is helpful to the instructor teaching this course
		Unit VIII & IX	Unit VIII & IX to be combined into Unit VIII and the content to be diluted..	Content was diluted as the lecture alloted were less to cover the topics in details

ANNEXURE VI

Parvatibai Chowgule College of Arts and Science

(Autonomous)

DEPARTMENT OF COMPUTER SCIENCE

M.Sc [Information Technology] COURSE STRUCTURE

Semester I (24 credits)

Course Code	Course Type	Course Title	Credits	Contact hours/week		
				L	**T**	**P**
MIT 11	Core – I	Data Structures and Algorithms	4	4	0	0
MIT 12	Core – II	Operating Systems and Networks	4	4	0	0
MIT 13	Elective - I	Elective Course	4	4	0	0
MIT 14	Elective – II	Elective Course	4	4	0	0
MIT 15	Elective - III	Elective Course	4	4	0	0
MIT 16	Core III Lab – I	Data Structures and Algorithms Lab	2	0	0	6
MIT 17	Core IV Lab – II	Operating Systems and Networks Lab	2	0	0	6

Semester II (24 credits)

Course Code	Course Type	Course Title	Credits	Contact hours/week		
				L	**T**	**P**
MIT 21	Core – V	Software Architecture, Design Patterns and Frameworks	4	4	0	0
MIT 22	Core – VI	Design and Analysis of Algorithms	4	4	0	0
MIT 23	Core VII	Advanced Database Management Systems	4	4	0	0
MIT 24	Elective –IV	Elective Course	4	4	0	0

MIT25	Elective V	Elective Course	2	2	0	0
MIT 26	Core VIII Lab – III	Software Architecture, Design Patterns and Frameworks Lab	2	0	0	6
MIT 27	Core IX Lab – IV	Design and Analysis of Algorithms Lab	2	0	0	6
MIT28	Core X LAB -V	Advanced Database Management Systems LAB	2	0	0	6

Semester III (24 credits)

Course Code	**Course Type**	**Course Title**	**Credits**	**Contact hours/week**		
				L	**T**	**P**
MIT 31	Core – XI	Data Mining	4	4	0	0
MIT 32	Core – XII	Information Retrieval	4	4	0	0
MIT 33	Elective VI	Elective Course	4	4	0	0
MIT 34	Elective – VII	Elective Course	4	4	0	0
MIT 35	Elective – VIII	Elective Course	4	4	0	0
MIT36	Elective IX	Elective Course	2	2	0	0
MIT 37	Core XIII Lab V	Data Mining & Information Retrieval Lab	2	0	0	6

Semester IV(8 credits)

Course Code	**Course Type**	**Course Title**	**Credits**	**Contact hours/week**		
				L	**T**	**P**
MIT 41	Elective X	Project/Dissertation	8	0	0	0

Legend:

L – Lectures
T – Tutorials
P – Practicals

Programme Specific Outcome (PSO) for M.Sc IT

At the end of the programme the students will be able to:

PSO1 : Develop deep theoretical and practical knowledge of important disciplines of Information Technology like Data Structures, Database Management Systems, Operating Systems and Networks, Design and Analysis of Algorithms, Software Architecture, Data Mining and Information Retrieval.

PSO2 : Imbibe the skill of writing optimal software programs independent of any particular programming language and platform so as to make the student self-reliant to learn and work in any programming language, tool or platform.

PSO3 :Inculcate Soft Skills and Mathematical skills in the student that are required in IT sector.

PSO4: Develop the ability of conducting research independently.

PSO5: Develop the skill of working in teams.

PSO6: Acquire an edge of having real-world experience by virtue of the internship in Software Industry/Research Organization being a mandatory part of the programme.

Detailed Syllabus

(From Academic year 2019-20)

Course Title: Data Structures and Algorithms

Course Code: MIT 11

Marks: 100

Credits: 4

Duration: 60 Hrs

Course Pre-Requisites:

- An introductory course on Data Structures.

Course Objectives:

- The objective of the course is to understand the real-life applications of data structures.
- Be familiar with writing recursive and iterative methods using Data Structure.

Course Outcomes:

At the end of the course students will be able to:

CO1: Have an idea of applications of algorithms in a variety of areas such as game theory etc.

CO2: Make foundation of writing programs using algorithms on trees, graphs etc.

CO3: Design and analyze the time and space efficiency of the data structure.

CO4: Identify the appropriate data structure for given problem.

Syllabus:

1. Algorithm Analysis: **[5Hrs]**

Mathematical Background, Big-O notation, Running Time computation, Introduction to different strategies of algorithm design – Divide and Conquer, Greedy, Dynamic Programming etc.

2. Review of Basics Data Structure: **[4Hrs]**

List, Doubly linked list, Circular list, Stack, Queue, Recursion.

3. Trees: **[17Hrs]**

The Huffman algorithm, Representing list and binary trees, Height balanced tree, Dictionaries, Optimal Binary Search Trees, AVL Tree, Red Black Tree, B tree, B+ tree, suffix trees, Splaytrees, Binary Tries, Compressed Binary Tries. Tries and Packet Forwarding, Quad Trees, R-Trees.

4. Sorting and searching: **[10Hrs]**

Radix Sort, Heap sort, Quick Sort, Merge Sort ,Interpolation search,TreeSearching,General Search Trees, Hashing, External Sorting Algorithm.

5. Graphs and their applications: **[12Hrs]**

Revision of basic graph traversal and search technique, spanning trees, Cut-sets and Cut-Vertices: Cut-Sets, Properties of Cut-sets, All Cut-sets in a Graph , Eulerian Graphs , Hamiltonian Graphs.

6. Storage management: **[6Hrs]**

General list, Automatic list management, Dynamic memory management.

7. Problem classification: **[3Hrs]**

Nondeterministic algorithm. The class of P, NP, NP-hard and NP- Complete problems

8. Introduction to Approximation and Randomized Algorithms **[3Hrs]**

Absolute Approximation,€ approximations and randomization.

Text Book:

1. Aaron M. Tenenbaum & Augenstein "Data structures using C and C++" PHI

References:

1. Sartaj Sahani "Data structures, Algorithms and Applications in C++"

2. Alfred V. Aho, John E Hoproft, Jeffrey D. Ullman, "Data structures and algorithms", Pearson
3. Narasingh Deo, Graph Theory with Applications to Engineering and Computer Science, PHI.

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Course Title: Operating Systems and Networks

Course Code: MIT 12

Marks: 100

Credits:4

Duration: 60 Hrs

Course Pre-Requisites:

- Basics of Operating Systems and Networks

Course Objectives:

- To understand Real time operating systems
- To gain understanding in specific areas of networking such as the design and maintenance of individual networks.

Course Outcomes:

At the end of the course students will be able to:

CO1: Analyze the structure of Operating system.

CO2: Analyze various Resource management and fault tolerance techniques for real time systems.

CO3: Discuss the fundamentals of IP addressing.

CO4: Apply subnet masking concepts to allocate space for host in subnet.

CO5: Examine techniques to protect the network.

Syllabus:

1. Overview of Operating Systems **[5Hrs]**

Processes and Threads - Process Scheduling -Synchronization Mechanisms –Deadlocks: Detection, Prevention and Recovery – Models of Resources – Memory Management Techniques.

2. Real time Operating systems **[10Hrs]**

Basic model of real time systems, Characteristics, Applications of real time systems, Real time task scheduling, handling resource sharing, Mobile operating systems, Micro kernel design, Processes and Threads, Memory Management, File system.Failure Recovery and Fault Tolerance:Types of faults, Issues, Failed system behavior, Failure detection, Approaches of fault tolerance

3. Overview of Network Service Design **[4Hrs]**

Introduction, Strategy for Network Service Implementation, Issues in Network design

1. TCP/IP **[8Hrs]**

Introduction to TCP/IP, Benefits of using TCP/IP,IP addressing, IP Network and Host addressing, Classfull and classless IP addresses, IPV6, Subnet mask, Subnet ting and super netting

2. Switch Technology **[5Hrs]**

Switch fundamentals (Bridges vs. Switches) – Spanning Tree Protocol: Overview, Spanning tree protocol, Rapid Spanning tree protocol.

3. VLANs and VLAN Trunking **[8Hrs]**

VLAN- concepts, broadcast domains with VLANs and routers, benefits, types, configuration (geographic, static, verifying, saving, deleting, troubleshooting), preventing broadcast storms. VLAN Trunking Protocol, VTP modes of operation, Routing between VLANs, Inter-VLAN routing-issues, solutions, interfaces (physical, logical), sub interfaces.

4. Routing **[8Hrs]**

Static V/s Dynamic routes, Adding and deleting static routes

Demand on dial routing, Routing protocol, RIP, OSPF, IGP, Secure IP routing.

5. Network administration **[8Hrs]**

SNMP & RMON - Overview and features, MIB Management Information base Installing SNMP Servers, SNMP communities, Authentication and securing Monitoring and analysis and troubleshooting, Overview and installation configuration: fire wall, NAT, E-mail (Send mail), Radius, Remote access servers, proxy servers.

6. Wireless Networking **[4Hrs]**

Overview, Infrastructure mode, Ad Hoc Mode, ESSID, wireless channels, wireless security, Authentication.

Text Book:

1. Mukesh Singhal and N.G Shivaratri, "Advanced concepts in operating systems", McGraw-Hill 2000.

References:

1. Jeffrey S. Beasley and Piyasat Nilkaew, A Practical Guide to advanced Networking, Pearson.
2. William Stallings, "Wireless Communications and networks" Pearson / Prentice Hall of India, 2nd Ed., 2007.

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Course Title: Data Structures and Algorithms Lab

Course Code: MIT 16

Marks:50

Credits:2

Duration: 90 Hrs.

Course Pre-Requisites:

- Theoretical Knowledge of Data Structures

Course Objective:

- Introduce students to a number of highly efficient algorithms and data structures for fundamental computational problems across a variety of areas.

Course Outcomes:

At the end of the course students will be able to:

CO1: Gain knowledge of key issues in advanced data structures, such as appropriateness of data structures and efficiency of their related algorithms.

CO2: Become proficient in applying knowledge from the theory of Data Structures to various application areas.

CO3: Design Algorithms to solve the problems.

CO4: Discuss different Data Structures to represent real world problems.

Syllabus:

List of suggested assignments:

1. Implementation of Basic Data Structure such as stack, Queue, Linked List etc. **[9 Hrs]**
2. Write a program to implement self organised linked list. **[6Hrs]**
3. Write a program to implement different sorting techniques. **[6Hrs]**
4. Write a program to implement Optimal Binary Search Tree. **[6Hrs]**
5. Write a program to generate a Huffman code for the text file. **[6Hrs]**
7. Write a program to implement insertion and deletion in AVL Tree. **[6Hrs]**
8. Write a program to implement Red Black tree. **[6Hrs]**
9. Write a program to implement B-Tree. **[6Hrs]**
10. Write a program to implement B+ Tree. **[6Hrs]**
11. Implementation of R-Tree and Quad Tree. **[9Hrs]**
12. Implementation of Tries. **[6Hrs]**
11. Implementation of Compressed Binary Tries. **[6Hrs]**
11. Implementation of Dictionaries. **[6Hrs]**
13. Implementation of Graph Traversal Techniques. **[3Hrs]**
14. Write a program to implement linear probing, quadratic hashing and Double hashing. **[3Hrs]**

Mini Project on the application of Data Structures.

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Course Title: Operating Systems and Networks Lab

Course Code: MIT 17

Marks: 50

Credits: 2

Duration: 90 Hrs.

Course Pre-Requisites:

- Theoretical Knowledge of operating systems and networks.

Course Objectives:

- To provide practical base in operating system and networks.

Course Outcomes:

At the end of the course students will be able to:

CO1: Manage processes, memory and file system using system calls.

CO2: Illustrate socket communication involving sender process and receiver process using TCP and UDP.

CO3: Analyze network traffic by using network analyzer tool.

CO4: Design and demonstrate VLAN’s by using simulation tool.

Syllabus:

1. Write a program to implement File I/O and efficiency, file system calls, dup functions, fcntl, stat functions, set uids, permissions, sticky bit, links, file times and time function, directory creation and reading, mkdir, chdiretc, special files. **[9Hrs]**

2. Implement Streams and file objects, positioning, reading and writing to streams, binary I/O, formatted I/O. **[9Hrs]**

3. Implement Identifiers, fork, exec, wait functions, race conditions, changing user and group ids, process accounting and times, controlling terminals. **[9Hrs]**

4. Implement an iterative TCP client and server application (eg. transfer file). **[6Hrs]**

5. Implement a concurrent TCP client and server application to transfer file. **[6Hrs]**

6. Implement UDP client and server application to reverse the given input sentence. **[6Hrs]**

7. Using port scanning to identify open ports and vulnerability detection. Using nmap command. **[6Hrs]**

8. Installing and configuring a Firewall. **[6Hrs]**

9. Installing and configuring Intrusion detection system**.** **[6Hrs]**

10. Using Network protocol analyzer tool like ethereal or tcp dump to analyze network traffic. **[9Hrs]**

11. Creating subnets and supernets using simulation tools. **[6Hrs]**

12. Configuring static route and dynamic route using routing tools. **[6Hrs]**

13. Configuring VLANs. **[6Hrs]**

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Course Title: Software Architecture, Design Patterns and Frameworks

Course Code: MIT 21

Marks: 100

Credits:4

Duration: 60 Hrs.

Course Pre-Requisites:

- Introductory course on Software Engineering

Course Objectives:

- Learning Software Development using good OO Design and Architecture
- Understanding of Design and Architectural patterns and Frameworks.

Course Outcomes:

At the end of the course students will be able to:

CO1: Examine the various concepts of Object-Oriented Analysis and Design.

CO2: Study Creational, Structural and Behavioural Design Patterns.

CO3: Analyze a given problem and study the applicability of Design Patterns to the problem.

CO4: Understand Software architecture and Frameworks.

CO5: Understand Anti Patterns and steps that should not be taken while developing software.

Syllabus:

1. Principles of good OO design **[3Hrs]**

Encapsulation, Abstraction, Implementation Hiding, Inheritance, Dynamic binding, Polymorphism, Overriding and Overloading, SOLID Principles of Object-Oriented Design.

2. Use case & Structural Modelling **[9Hrs]**

Scenarios, Actors & Use Cases, The include and extend relationships, Use Case Generalization, Writing Use Cases formally, Choosing System Boundary, Finding Actors and Use cases, Using use cases for Verification and Validation, Use-Case Realization Classes, Objects, Attributes and Operations, Visibility of attributes and operations, Class-Scope Attributes, Attributes with default values, Association, Multiplicity, Role-Name, Qualified Association, Association Class**,** Ternary Association, Recursive Association, Multiple Association between two classes, Composite and Shared Aggregation, Generalization and sub-class partitioning, Generalization Set, Interfaces and their realization, Packages and Grouping of classes into Packages , Parameterized Classes.

3. Dynamic Modelling **[6Hrs]**

Modelling object interaction using Interaction Diagrams, Modelling the behaviour of reactive objects using State chart diagrams; Modelling systems workflows or operations using Activity diagram.

4. Design Patterns **[8Hrs]**

Motivation, reusability, extendibility, cataloging patterns, "GoF" patterns

5. Software architecture & Architectural Patterns **[12Hrs]**

Software Architecture & its importance, Various types of Architectural Structures - Module, Conceptual, Process,Physical, Uses, Calls, Data Flow, Control flow, Class, System Quality attributes discernible at runtime, Business Qualities, Architecture Qualities, Architectural means for achieving architectural qualities, Data Flow Architecture, Virtual machine Architecture, Call & Return Architecture, Independent Component Architecture, Definition, advantages, components and connectors, views, documenting, evaluating, mining, Layered, pipe & filter, MVC, broker, Microkernel, Component and Deployment Diagrams.

6. Frameworks: **[10Hrs]**

Enterprise frameworks, EJBs.

7. Software product lines: **[6Hrs]**

Economies of scope, Product Line Development, Product Development.

8. **Anti-patterns** **[6Hrs]**

Case studies

Text Book:

1. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, Design Patterns: Elements of Reusable Object-Oriented Software, Pearson Education.

References:

1. Len Bass, Paul Clements, Rick Kazman, Software Architecture in Practice, Pearson Education.
2. Frank Buchmann, RegineMunier, Hans Rohnert, Peter Sommerland, Michael Stahl, Pattern Oriented Software Architecture-I, Pearson Education.

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Course Title: Design and Analysis of Algorithms

Course Code: MIT 22

Marks: 100

Credits:4

Duration: 60 Hrs.

Course Pre-Requisites: None

Course Objectives:

- Understand the basic concepts related to the design and analysis of algorithms
- Understand classical algorithms and their complexity
- Apply the algorithms to real-world problems

Course Outcomes:

At the end of the course students will be able to:

CO1: Analyze the running time of various Algorithms.

CO2: Apply the algorithms and techniques to solve various problems.

CO3: Analyze the complexities of various problems in different domains.

CO4: Design their own algorithmic strategies to Solve problem and analyze their correctness.

Syllabus:

1. Introduction **[9Hrs]**

The Role of Algorithm in computing, Framework for design and analysis of algorithms, Growth of functions: asymptotic notation; Recurrences: substitution method, recursion-tree method, master method; Probabilistic analysis and randomized algorithms, indicator random variables.
Advanced Design and Analysis Techniques.

2. Dynamic programming: **[9Hrs]**

Assembly line scheduling, matrix-chain multiplication, elements of DP, longest common subsequence, Optimal BST.

3. Greedy algorithms: **[7Hrs]**

Elements of greedy strategy, Huffman codes,.Optimal storage on tapes,Minimum cost spanning tree- Kruskal and Prim's algorithms, performance analysis.

4. Backtracking **[8Hrs]**

The general method,8 Queens problem , sum of subsets,Graphcoloring.

5. Amortized analysis: **[3Hrs]**

Aggregate analysis, accounting method, potential method, dynamic tables.

6: Graph Algorithms: **[8Hrs]**

Elementary graph algorithms- Minimum spanning tree: growing a spanning tree, Single-source shortest paths: Bellman-ford algorithm, Dijkstra's algorithm. All pairs shortest paths: shortest paths and matrix multiplication, floyd-warshall algorithm.

7. Internet Algorithms **[7Hrs]**

Strings and patterns matching algorithm.Tries.Text compression. Text similarity testing.

8. NP-Completeness: **[4Hrs]**

Polynomial time, polynomial time verification, NP-completeness and reducibility.

9. Approximation algorithms: **[5Hrs]**

The vertex cover problem, Traveling salesman problem, the set-covering problem.

Text Book:

1. Cormen Thomas, L. Charles, R. Ronald, S. Clifford, “Introduction to Algorithms”, Second Edition, EEE, PHI

References:

1. Knuth Donald, “The Art of Computer Programming Vol I, II, III”, Addison Wesley
2. Ellis Horowitz, SartajSahni&SanguthevarRajasekaran, Computer Algorithms, Galgotia, 2nd Edition
3. A. Aho, J. Hopcroft, & J. Ullman, The Design and Analysis of Computer Algorithms, Addison Wesley
4. Richard Gilberg & BehrouzForouzan, Data Structure: a Pseudo code Approach

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Course Title: Advanced Database Management Systems

Course Code: MIT 23

Marks: 100

Credits:4

Duration: 60 Hrs

Course Pre-Requisites:

- Introductory course on Database Management Systems

Course Objectives:

- Understand the concept of a database transaction and related database facilities, including concurrency control, journaling, backup and recovery, and data object locking and protocols.

Course Outcomes:

At the end of the course students will be able to:

CO1: Critically evaluate alternative designs and architectures for Databases and Data Warehouses.

CO2: Discuss and evaluate methods of storing, managing and interrogating complex data.

CO3: Analyze the background processes involved in queries and transactions, and explain how these impact on Database operation and design.

CO4: Develop a high-level understanding of major DBMS components and their function.

Syllabus:

1. Design Theory for Relational Database: **[7Hrs]**

Functional Dependencies, Decomposition of relational schemes, Normal forms for Relations, schemas, Multivalued and other forms of Dependencies.

2. Query Processing and Optimization: **[9Hrs]**

Basic algorithms for executing query operations, Basic optimization strategies, Algebraic manipulations, optimization of selections in system, Exact optimization for a subset of relational queries, Optimization under weak equivalence.

3. Concurrent operation on the database: **[9Hrs]**

Basic concepts, a simple transaction model, serializability, lock based protocols, Timestamp based protocol, concurrency for hierarchically structured items, Deadlock handling (Wait-die, wound-wait, no waiting, cautious waiting), optimistic concurrency control.

4. Database Recovery Techniques: **[8Hrs]**

NO-UNDO/REDO Recovery Based on differed update, Recovery technique based on immediate update, shadow paging, ARIES, Recovery in multidatabase system, Database backup and recovery from catastrophic Failures.

5. Distributed Database: **[10Hrs]**

Principles of Distributed Databases, Framework for distribution, translation of global queries into fragment queries, query optimization and management of distributed transaction, concurrency control and reliability in distributed databases, Administration of distributed databases. Future Trends in data models: Semantic data models, DM for loosely structured data items, Multimedia database.

6. Emerging Technologies: **[10Hrs]**

XML Databases: XML-Related Technologies-XML Schema- XML Query Languages- Storing XML in Databases-XML and SQL- Native XML Databases- Web Databases- Geographic Information Systems- Biological Data Management- Cloud Based Databases: Data Storage Systems on the Cloud- Cloud Storage Architectures-Cloud Data Models- Query Languages- Introduction to Big Data-Storage-Analysis.

7. NoSQL Database: **[7Hrs]**

Introduction of NoSQL databases: Document Database, GraphStores, Key value stores, Column stores, case study of Mongo DB(Document Based) and Neo 4J(Graph Based) databases

Text Book:

1. Elmasri&Navathe, Fundamentals of Database Systems, Addison Wesley

References:

1.Abraham Silberschatz, Henry F. Korth, Database System Concepts, McGraw Hill

2. J.D.Ullman, Principles of Database Systems,Galgotia,New Delhi
3. S.Ceri and G.Relagatti, Distributed Databases,McGraw Hill
4. C. Papadimitrious, The Theory of Database Concurrency Control,Computer Science Press

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Course Title: Software Architecture, Design Patterns and Frameworks Lab

Course Code: MIT 26

Marks: 50

Credits: 2

Duration: 90 Hrs.

Course Pre-Requisites:

- Introductory course on Software Engineering

Course Objectives:

- Implement the various concepts of Object Orientation.
- Implement the various Design Patterns.
- Usage of various Architectural patterns and Frameworks.

Course Outcomes:

At the end of the course students will be able to:

CO1: Implement the various concepts of Object-Oriented Programming.

CO2: Illustrate Creational, Structural and Behavioural Design Patterns.

CO3: Analyze a given problem and apply Design Patterns to it solve problems by using a framework.

CO4: Work with a framework.

This course will have programming assignments for the various types of patterns and frameworks discussed in the corresponding theory paper.

1. Implementation of various concepts of Object Orientation **[12Hrs]**
2. Implementation of the 21 Design patterns (Creational, Structural and Behavioural) **[24 Hrs]**

3. Experiments on Architectural Patterns **[27 Hrs]**

4. Experiments on Enterprise Frameworks [**27 Hrs]**

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Course Title: Design and Analysis of Algorithms Lab

Course Code: MIT 27

Marks: 50

Credits:2

Duration: 90 Hrs.

Course Pre-Requisites:

- Introductory course on Design and Analysis of Algorithms

Course Objectives:

- Understand the various algorithm design approach

Course Outcomes:

At the end of the course students will be able to:

CO1: Implement various algorithms using dynamic programming approach.

CO2: Implement various Internet algorithms.

CO3: Implement various graph Algorithms.

CO4: Implementation of algorithms for real life problem

List of suggested Assignments:

1. Implementation of algorithms using divide and conquer approach. **[15Hrs]**
   a. Binary Search
   b. Quick Sort
   c. Merge Sort
2. Implementaion of algorithms using dynamic programming approach. **[15Hrs]**
   a. Assembly Line Scheduling
   b. Longest Common Subsequence
   c. Matrix Chain Multiplication
   d. Optimal Binary Search Tree
3. Implementaion of algorithms using Greedy programming approach. **[15Hrs]**
   a. Huffman Codes
   b. Optimal Storage on Tapes
   c. Minimum Cost Spanning Tree(Prim's and Kruskal Algorithm)
4. Implementaion of Backtracking programming approach for various problems. **[15Hrs]**
   a. 8-Queen's Problem
   b. Sum of Subsets
   c. Graph Coloring
5. Implementaion of various Graph algorithms. **[15Hrs]**
   a. Dijikstra's Algorithm
   b. Bellman Ford Algorithm
   c. Floyd Warshall Algorithm
6. Implementation of various internet algorithms. **[15Hrs]**
   a. Tries
   b. Text Compression
   c. Text Similarity Testing

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Course Title: Advanced Database Management Systems Lab

Course Code: MIT 28

Marks: 50

Credits:2

Duration: 90 Hrs.

Course Pre-Requisites:

- Introductory course on Database Management Systems

Course Objectives:

- Understand the concept of a database transaction and related database facilities, including concurrency control, backup and recovery, and data object locking and protocols.

Course Outcomes:

At the end of the course students will be able to:

CO1: Populate and query a database using SQL,DML/DDL commands.

CO2: Declare and enforce integrity constraints on a database using a state-of-the-art RDBMS.

CO3: Design and implement a database scheme for a given problem-domain.

CO4: Represent the database using XML and working on it.

List of suggested Assignments:

1: Revision and Normalization	**[9Hrs]**
2: Advance SQL- Dynamic SQL, Triggers, Assertions	**[9Hrs]**
3: Advance SQL- Stored Procedures	**[6Hrs]**
4: Indexing	**[3Hrs]**

5: Views,Roles,Grants **[9Hrs]**

6: Data recovery techniques in databases. **[6Hrs]**

7: Design XML Schema and perform queries using Xquery and Xpath **[9Hrs]**

8: Introduction to Indexed DB **[6Hrs]**

9: Introduction to NO SQL database **[3Hrs]**

10: Creating Documents,Collection,inserting records,embedding documents **[6Hrs]**

11: Querying the documents **[6Hrs]**

13: Aggregation Framework **[6Hrs]**

14: Sharding **[6Hrs]**

15: Application development on No SQL Database using Java/PHP or equivalent. **[6Hrs]**

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Course Title: Data Mining

Course Code : MIT31

Marks: 100

Credits: 4

Duration: 60 Hrs.

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

Course Outcomes:

At the end of the course students will be able to:

CO1: Understand the evolution of Data Mining and Data Warehousing.

CO2:Study various Association Rules Mining Algorithms.

CO3: Study Decision Trees, Bayesian Classification, Artificial Neural Networks, Fuzzy Set Theory and Genetic Algorithms.

CO4: Apply various types of Clustering Algorithms, Web Mining Techniques and techniques of mining complex types of data

Syllabus:

1. Introduction and Background **[6Hrs]**

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 **[8Hrs]**

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 **[8Hrs]**

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 **[9Hrs]**

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 **[12Hrs]**

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 **[11Hrs]**

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 **[6Hrs]**

Exploration of web sites on data ware housing and data mining applications including bibliography data bases, Corporate Houses and Research labs

Text Book:

1. Jiawei Han and MichelineKamber, "Data Mining Concepts and Techniques," Indian Reprint, Harcourt India Private Limited, ISBN 1-55860-489-8,1st Edition, 2001.

References:

1.Vipin Kumar, Margaret Dunham, "Data Mining: Introductory and Advanced Topics," Prentice Hall (Pearson Publication), ISBN 0-13-088892-3, 1st Edition, 2003.

2. Arun K Pujari, "Data Mining Techniques". Universities Press

3. Pang-Ning Tan, Michael Steinbach,Vipin Kumar, Introduction to Data Mining, Pearson Education

4. Tom Mitchell, "Machine Learning", McGraw Hill

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Course Title: Information Retrieval

Course Code: MIT 32

Marks: 100

Credits: 4

Duration: 60 Hrs.

Course Pre-Requisites: None

Course Objectives:

- Introduce students to the theoretical underpinnings of information retrieval (IR), an active and rapid growing branch of applied computational science.
- Impart knowledge on document representation, document indexing, digital information storage, retrieval, and distribution.
- Emphasise application of IR theories and practices to web indexing and web search engines

Course Outcomes:

At the end of the course students will be able to:

CO1: Develop system for IR using various models.

CO2: Perform Query evaluation and Relevance feedback.

CO3: Design systems that include hyperlinks, multimedia and the web.

CO4: Understand XML, Parallel, Distributed and Multimedia IR.

Syllabus:

1.Overview of Information Retrieval **[3Hrs]**

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 **[6Hrs]**

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 **[6Hrs]**

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 **[5Hrs]**

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 **[6Hrs]**

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 **[6Hrs]**

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 **[7Hrs]**

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 **[6Hrs]**

Parallel Computing, Performance Measures, MIMD and SIMD architectures, Distributed Computing, Collection partitioning, source selection, Query processing, web issues

9. Multimedia IR **[8Hrs]**

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 **[7Hrs]**

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

Text Book:

1. Christopher Manning, PrabhakarRaghavan and HinrichSchutze: Introduction to Information Retrieval, Cambridge University Press

References:

1.D. Grossman and O. Frieder, Information Retrieval: Algorithms and Heuristics, Kluwer, Second Edition

2.RicardoBaeza-Yates and BerthierRibeiro-Neto: Modern Information Retrieval, Pearson Education

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Course Title: Data Mining & Information Retrieval LAB

Course Code: MIT 37

Marks: 50

Credits: 2

Duration: 90 Hrs.

Course Pre-Requisites: None

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.

Course Outcomes:

At the end of the course students will be able to:

CO1: Illustrate Stop-Word removal, Stemming and Lemmatization techniques.

CO2: Employ techniques of Index Construction like Soundex Codes and Permuterms.

CO3: Implement Vector Space and Probabilistic Models to identify similarities between Queries and documents.

CO4: Demonstrate various Clustering, Classification and Association Rules Mining Algorithms.

List of Experiments

1. Programs to implement Association Rule Mining Algorithms **[6Hrs]**

2. Programs to implement Clustering Algorithms **[15Hrs]**

3. Programs to implement Classification Algorithms **[12Hrs]**

4. Program to implement Sequential Pattern Matching **[9Hrs]**

5. Program to implement Temporal Pattern Mining **[9Hrs]**

6. Program to compare and contrast Association Measures **[3Hrs]**

7. Program to implement Boolean Model (Generate Term Incidence Matrix along with frequency) **[3Hrs]**

8. Program to implement stop word removal. **[3Hrs]**

9. Program to implement Porter's stemming algorithm. **[3Hrs]**

11. Program to implement Permuterm Indexes **[6Hrs]**

12. Program to implement Vector Space Model (Similarity Coefficient) **[9Hrs]**

13. Program to implement Vector Space Model (Cosine Similarity) **[6Hrs]**

14. Program to implement Probabilistic Model **[6Hrs]**

Use of Apache Lucene and NLTK tools is recommended.

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Department of Computer Science

LIST OF ELECTIVES FOR M.Sc. IT

(To be Offered from 2019-20)

1) Software Metrics & Project Management

2) Mobile Computing

3) Compiler Design

4) Computer Graphics

5) Natural Language Processing

6) Image Processing

7) Middleware Technology

8) Software Testing

9) Cloud Computing

10) Network Security

11) Communication Skills Course

12) Applied Probability and Statistics

13) Machine Learning

14) Statistical Computing

15) Educational Technology

Course Title: Software Metrics & Project Management

Marks: 100

Credits: 4

Duration: 60 Hrs

Course Pre-Requisites:

- Introductory course on Software Engineering

Course Objectives:

- Provide a deeper understanding of various software metrics and project management concepts

Course Outcomes:

At the end of the course students will be able to:

CO1: Understand the various types of management namely scope, time, cost, quality, human resource, communication, risk, procurement and integration management.

CO2: Understand software metrics and quality standards.

CO3: Plan a metrics measurement programme

CO4: Enforce Quality standards in projects

Syllabus:

1. Introduction **[3Hrs]**

Introduction to Project and Project management, Project phases and project life cycle, organizational structure, Qualities of Project Manager.

2. Project Management Components. **[6Hrs]**

Project Integration Management-Project plan development and execution, change controls, configuration management.

3. Scope & Time Management **[6Hrs]**

Strategic planning, scope planning, definition ,verification and control, Activity planning, schedule development and control.

4. Cost & Quality Management **[6Hrs]**

Cost estimation and Control, Quality planning and assurance.

5. Human Resource & Communication Management **[9Hrs]**

Organizational planning, staff acquisition, Information distribution, reporting.

6. Risk Management **[6Hrs]**

Risk identification, Quantification and control.

7. Procurement Management **[4Hrs]**

Solicitation, contract administration.

8. Software Metrics **[6Hrs]**

The scope of software metrics, software metrics data collection, analyzing software data, measuring size, structure, external attributes.

9. Software Reliability **[4Hrs]**

Measurement and prediction, resource measurement, productivity, teams and tools.

10. Planning a measurement program. **[6Hrs]**

Metrics plan: Developing goals, questions and metrics. Where and When: Mapping measures to activities. How: Measurement tools. Who: Measurers , analyst, tools revision plans.

11. Quality Standards – CMM, PSP/TSP **[4Hrs]**

Text Book:

1. Kathy Schwalbe, Information Technology Project Management, Cengage Learning

References:

1. Norman Fenton, James Bieman, Software Metrics A rigorous and practical approach, CRC Press

2. Roger Pressman, Software Engineering – A Practitioner's Approach, McGraw Hill

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Course Title: Mobile Computing

Marks: 100

Credits: 4

Duration: 60 Hrs

Course Pre-Requisites: None

Course Objectives:

- To understand the basic concepts of Mobile Computing

Course Outcomes:

At the end of the course students will be able to:

CO1: Apply data communicating methods and networking protocols for wireless and mobile environments.

CO2: Understand positioning techniques and location based services and applications.

CO3: Utilize and employ application frameworks for developing mobile applications.

CO4: Use java for wireless devices and understand wireless messaging.

Syllabus:

1. Introduction to Mobile Computing **[4Hrs]**

i. Introduction and need for Mobile computing
ii. Mobility and portability
iii.Mobile and Wireless devices
iv.Applications
v. Brief History of wireless communication

2. Wireless Transmission **[4Hrs]**

i. General Concepts of multiplexing and modulation
ii. Spread Spectrum
iii. Cellular Systems
iv. Cellular Phone Array
v. Mobile Phone Technologies (1G, 2G, 2.5G, 3G, 4G)

3. Medium Access Control Layer **[4Hrs]**

i. Why specialized MAC? - hidden and exposed terminals- near and far terminals
ii.General Concepts and comparison of SDMA, FDMA, TDMA ,CDMA

4. Global System for Mobile Communication **[10Hrs]**

i. Mobile Services (Bearer, Tele-and-supplementary services).
ii. System Architecture- Radio subsystem - Network and switching subsystem - Operation subsystem
iii. Protocols - Localization and calling – Handover.
iv. Value Added Services- SMS Architecture, Mobile Originated and Mobile Terminated ,procedures - Cell Broadcast Service Architecture, Message Transfer Procedure – MMS Architecture, Protocol framework, Message Transfer. Procedure - Location Services, Logical Reference Model, Control Procedures, Network Architecture, determination of Location Information, Location based services.
v. GPRS

5. Mobile IP **[6Hrs]**

i. Goals, assumptions and requirements
ii. Entities and terminologies
iii. Agent Discovery
iv. Registration
v. Tunnelling and encapsulation
vi. Reverse Tunnelling
vii. IPv6
viii. IP micro-mobility support – Cellular IP, Hawaii, Hierarchical mobile IPv6
ix. Mobile Routing : Destination sequence distance Vector, Dynamic Source Routing, Alternative Matrix, Ad hoc Routing Protocols -Flat, Hierarchical, Geographic-position-assisted

6. Mobile TCP **[6Hrs]**

i. Traditional TCP - Congestion Control, Slow start, Fast retransmit / Fast recovery - Implications on mobility.
ii. Classical TCP improvements Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit / Fast recovery, Transmission / Timeout freezing, Selective Retransmission, Transaction oriented TCP.
iii. TCP over 2.5/3G wireless networks.

7. Wireless Application Protocol **[6Hrs]**

i. Architecture
ii. Wireless datagram protocol
iii. Wireless transport layer security
iv. Wireless transaction protocol
v. Wireless session protocol
vi. Wireless application environment
vii. WML
viii. WML Scripts
ix. Push Architecture
x. Push – Pull Services

8. Platform/Operating Systems **[4Hrs]**

i. Palm OS
ii. Windows CE
iii. Embedded Linux
iv. J2ME (Introduction)
v. Symbian (Introduction)

vi. File Systems (Book1)

9. Java for Wireless Devices **[2Hrs]**

i. Setting up the development environment
ii. Basic Data types, Libraries (CLDC, MIDP)

10. UI Controls **[4Hrs]**

i. Displayable and Display
- Image
- Events and Event Handling
- List and choice
  - Text box
  - Alerts

11. Persistent Storage **[2Hrs]**

i. Record Stores
ii. Records
iii. Record Enumeration

12. Network MIDlets **[4Hrs]**

i. The Connection Framework
ii. Connection Interface
iii. Making a connection using HTTP
iv. Using datagram connection

13. Wireless Messaging **[4Hrs]**

i. Architecture for Messaging application
ii. Messaging API
iii. Types of applications
iv. Pros and cons of messaging

Text Book:

1. Jochen Schiller, Mobile Communications, Pearson Education, 2nd Edition

References:

1. Yu Feng and Dr. Jun Zhu,Wireless Java Programming with J2ME,Techmedia Publications, 1st edition .

2. Asoke K Talukdar&Roopa R. Yavagal, Mobile Computing, TataMcGrawHill

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Course Title: Compiler Design

Marks: 100

Credits:4

Duration: 60 Hrs

Course Pre-Requisites: None

Course Objectives:

- To enable the student to understand compiler construction and equip them with skills to write a compiler for a programming language.

Course Outcomes:

At the end of the course students will be able to:

CO1: Understand the different phases of a compiler.

CO2: Use tools such as Lexand YACC etc.

CO3: Apply the concepts of Register allocation.

CO4: Design and code a compiler for a programming language.

Syllabus:

1. Introduction [6Hrs]

Lexical analysis, Regular Expressions, Finite automation. N.F.A., N.F.A. to D.F.A. conversion, D.F.A., minimization of D.F.A., Lex tool.

2. Context Free Grammar [9Hrs]

Derivations & Parse trees, Syntax analysis: Parsing, Top Down Parser, Recursive descent Parser, Predictive parsing, LL(1) Parsing table, Bottom Up Parsing, Shift Reduce parsing, Operator precedence parsing, LR Parsing methods, SLR, LRDL, LALR, YACC tool.

3. Syntax Directed Translation [9Hrs]

Syntax directed translation schemes, Implementation of syntax directed translation schemes, Intermediate codes, Post fix notation parse trees &syntax trees, three address codes, quadruples, triples, Translation of assignment statements, Boolean expression, statements that after flow of control, Post fix translation, Translation with Up down parsing.

4. Error Detection & Recovery [7Hrs]

Errors, lexical phase errors, Syntactic phase errors, semantic errors.

5. Code Optimization [8Hrs]

Loop optimization, DAG representation of basic block, value numbers & algebraic laws, Global data flow analysis, Dominators, Reducible flow graph, Depth first search, Loop invariant computation, Induction variable elimination.

6. Data Flow Analysis [7Hrs]

Reaching definition, Available Expression, copy propagation, Backward flow problems, Very busy, expression & code hoisting code.

7. Code Generation [7Hrs]

A simple code generation, code generation from DAG & labeled trees.

8. Register Allocation **[7Hrs]**

Coloring by implication, coalescing, graph coloring implementation, Register allocation for Trees.

Text Book

1. Alfred V. Aho, Jeffreys D. Ullman &Ravi Sethi, "Principles of Computer Design" Narosa Publication.

References:

1.Trembley et al, " Theory& Practice of Compiler Writing ", McGraw Publication

2. Andrew W. Appel, " Modern Compilers Implementation in Java"

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Course Title: Computer Graphics

Marks: 100

Credits: 4

Duration: 60 Hrs

Course Pre-Requisites:

- An introductory course on Data Structures and Algorithms

Course Objectives:

- To understand the concepts of Graphic Algorithms, Geometrical transformations and Modeling

Course Outcomes:

At the end of the course students will be able to :

CO1: Describe the purpose of Computer Graphics and its applications.

CO2: Describe and implement methods for performing 2-Dimentional geometric transformations.

CO3: Describe the concept of 3-Dimentional Graphics and methods for performing 3-Dimensional geometric transformations.

CO4: Discuss basic illumination models and surface rendering algorithms.

CO5: Develop familiarity with key algorithms for modelling and rendering graphical data.

CO6: Gain experience in constructing interactive computer graphics programs like Babylon JS.

Syllabus:

1. Introduction to Computer Graphics **[4Hrs]**

History of Computer Graphics, graphics primitives, scan conversion.

2. Transformation and clipping **[8Hrs]**

2D Transformations, composite transformation, view ingtransformation, clipping algorithms.

3. 3D Transformation and 3D viewing **[8Hrs]**

Viewing pipeline, Parallel and Perspective projections, view volumes, clipping

4. Representing Curves and Surfaces **[8Hrs]**

Parametric, curves, continuity conditions, cubic splines, Hermite interpolation, Bezier curves and surfaces, B-spline Curves- uniform non rational, cubic periodic, open uniform, uniform, non uniform rational types (NURBS), Subdividing curves, Fractals.

5. Solid Modeling **[7Hrs]**

Regularized Boolean operators, Sweep methods, Boundary Methods Constructive solid geometry methods, representation through quad trees and Octrees.

6. Visible Surface Determination **[9Hrs]**

Issues in Visible surface determination Coherence, backface culling, Z-Buffer and A-Buffer Algorithms, use of Binary Space Partitioning trees, Boolean operations on Octrees, Visible surface ray tracing.

7. Illumination Models & Rendering **[7Hrs]**

Diffuse and Specular illumination model, reflection vector computation, Shading models for polygons – polygon mesh shading, Gouraud and Phong Shading, problems with interpolated shading, Transparency, shadows, Ray tracing.

8. Introduction to Animation **[9Hrs]**

Perception, Animation production, use in film and videos, orientation representation and interpolation – Euler angle representation, motion display considerations, Motion along a curve – computing are length, speed control – sine interpolation, rigid body simulation, collision detection, Particle systems – particle generation, modeling water, fire, explosions.

Text Book

1. Foley, Van Dam, Feiner, Hughes, Computer Graphics – Principles and Practices , Addison Wesley.

References:

1. Rick Parent, “Computer Animation: Algorithms and Techniques, Morgan-Kaufman,

2. Hearn & Baker, Computer Graphics, Prentice Hall of India.

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Course Title: Natural Language Processing

Marks: 100

Credits: 4

Duration: 60 Hrs

Course Pre-Requisites: None

Course Objectives:

- To study fundamental concepts of Natural Language Processing and to introduce the basics of Language processing from algorithmic viewpoint.

Course Outcomes:

At the end of the course students will be able to:

CO1: Compose key NLP elements to develop higher level processing chains.

CO2: Assess / Evaluate NLP based systems.

CO3: Choose appropriate solutions for solving typical NLP sub problems (tokenizing, tagging, parsing).

CO4: Perform Lexical and Semantic Analysis.

Syllabus:

1. Introduction **[4Hrs]**

Ambiguity, Models and algorithm, Language, thought and understanding.

2. Regular Expressions and Automata **[7Hrs]**

Regular Expressions, Basic Regular Expression Patterns, Disjunction, Grouping, and Precedence, Advanced Operators, Regular Expression substitution, Memory, and ELIZA.

3. Finite-State Automata **[4Hrs]**

Using an FSA for Recognition, Formal Languages, Non-Deterministic FSAs, Using an NFSA to Accept Strings, Recognition as Search.

4. Morphology and Finite-State Transducers **[8Hrs]**

English Morphology, Inflectional Morphology, Derivational Morphology, Finite-State Morphological, Parsing, The Lexicon and Morphotactics, Morphological Parsing with Finite-State Transducers, Orthographic Rules and Finite-state Transducers, Combining FST Lexicon and Rules, Lexicon-free FSTs: The Porter Stemmer.

5. N-grams **[7Hrs]**

Counting Words, Simple N-grams, Smoothing, Backoff, Deleted Interpolation, N-grams for Spellings, Entropy.

6. Word Classes and Part-of-Speech Tagging **[5Hrs]**

English classes, tagsets POS tagging, Rule based POS tagging, Stochastic POS tagging, HMM tagging, Transformation based tagging, Multiple tags and multiple words, unknown words.

7. Features and Unification **[4Hrs]**

Feature structures, Unification of feature structures, Feature structures in grammar, Implementing unification, Parsing with unification constraints, Types and inheritances.

8. Lexicalized and Probabilistic Parsing **[3Hrs]**

Probabilistic Context free grammars. Problems with PCFGs, Probabilistic Lexicalized CFGs, Dependency Grammars, Human Parsing.

9. Representing Meaning **[7Hrs]**

Computational Desiderata for representation, Meaning Structure of Language, Some Linguistically relevant concepts: Categories, Events, Representing time, Aspects, Representing beliefs, Pitfalls. Alternative approaches to meaning.

10. Semantic Analysis **[8Hrs]**

Syntax-Driven Semantic Analysis, Semantic Augmentations to context-Free Grammar Rules, Quantifier Scoping and the Translation of Complex-Terms. Attachments for a Fragment of English. Sentences, Noun Phrases, Verb Phrases. Prepositional Phrases, Integrating Semantic Analysis into the Earley Parser. Idioms and Compositionality, Robust Semantic Analysis.

11. Lexical Semantics **[3Hrs]**

Relation among lexes and their senses, WordNet, Internal structure of Words, Creativity and the Lexicon.

Text Book:

1. Daniel Jurafsky and James H Martin,Natural Language Processing, Pearson Education.

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Course Title: Image Processing

Marks: 100

Credits: 4

Duration: 60 Hrs

Course Pre-Requisites: None

Course Objectives:

- To understand the basic image processing operations.

Course Outcomes:

At the end of the course students will be able to:

CO1: Understand how digital images are represented and manipulated in a computer, including reading and writing from storage, and display.

CO2: Analyze and implement image processing algorithms.

CO3: Perform Image Compression.

CO4: Apply Morphological Image Processing.

Syllabus:

1. **Introduction** **[4Hrs]**

   Image formation model, representation, spatial and Gray Level resolution, Colour models-RGB, CMY and HIS models.

2. **Image Enhancement In Spatial Domain** **[8Hrs]**

   Piecewise linear transformation, Histogram equalization, Histogram specification, image averaging, spatial filters – smoothing and sharpening, Laplacian filter, sobel operator, Canny edge detector.

3. **Image Enhancement In Frequency Domain** **[8Hrs]**

   2D Discrete Fourier transform and its inverse, filtering in frequency domain, Ideal and Gaussian Low pass filters, high pass filtering, separability property 0f 2D Fourier transform, Fast Fourier Transform.

4. **Image Segmentation** **[6Hrs]**

   Line detection, Edge detection, Edge linking and boundary detection, Hough Transform, Thresholding, Region based segmentation.

5. **Morphological Image Processing** **[8Hrs]**

   Logic operations involving binary images, Dilation and Erosion, Opening and closing, Applications to Boundary extraction, region filling, connected component extraction.

6. **Image Compression** **[10Hrs]**

   Coding redundancy- Huffman coding, LZW coding, run length coding, Lossy compression – Lossy predictive coding, transform coding- DCT, bit allocation, Compression standards – JPEG, video Compression.

7. **Image Representation** **[6Hrs]**

   Boundary description, Shape numbers, Fourier descriptors, Texture, principal Components based description.

8. **3D Vision** **[10Hrs]**

Projective geometry, single perspective camera, stereopsis, the fundamental matrix – its estimation from image point correspondences, applications of epipolar geometry in vision, correlation based and feature based stereo correspondence, shape from motion, optical flow.

Text Book:

1. Gonzalez and Woods, "Digital Image Processing", Pearson Education.

References:

1. Milan Sonka, Vaclav Hlavac and Roger Boyle, "Image Processing, Analysis, and Machine Vision", Thomson Asia Pvt Ltd Singapore
2. Jain and Rangachar, "Machine Vision", McGraw Hill International Edition
3. Schalkoff, John Wiley and Sons, "Digital Image Processing & Computer Vision", John Wiley and Sons

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Course Title: Middleware Technology

Marks: 100

Credits:4

Duration: 60 Hrs

Course Pre-Requisites:

- Fundamental knowledge of Distributed Systems and knowledge of Java

Course Objectives:

- Understanding the characteristics of distributed systems, Asynchronous communication and Event based systems.
- Understanding of J2EE and Web services.

Course Outcomes:

At the end of the course students will be able to:

CO1: Understand the distributed systems, asynchronous communication and event-based systems in detail.

CO2: Gain knowledge of Servlet technology and Enterprise Java beans.

CO3: Understand web services and reflective middleware.

CO4: Apply concepts that are learnt while working in live projects that involve Web Component and Business Component Programming.

Syllabus:

1. **Fundamentals of middleware** **[5Hrs]**

   Introduction to middleware, MW definition, styles of MW, key players.

2. **Distributed systems characteristics** **[12Hrs]**

   System models-architectural and fundamental models. RPC, Distributed objects-RNI, .NET Remoting, Name services-DNS, Time and global states, synchronization, Coordination and agreement, distributed transactions and recovery, Consistency & Replication, Fault Tolerance, and Security.

3. **Asynchronous communication and Event based systems** **[7Hrs]**

   Notifications, message Queuing systems, peer to peer systems.

4. **Middleware and enterprise services in J2EE** **[15Hrs]**

   Servlets and EJBs.

5. **SOA & Web services** **[11Hrs]**

   XML,SOAP, WSDL, UDDI & other protocols.

6. **Reflective middleware** **[10Hrs]**

   Introduction to reflective middleware, Middleware oriented architectural patterns for enterprise systems.

Text Book:

1. George Couloris, Jean Dollimore, TimKindberg, Distributed Systems- Concepts and Design, Pearson Education.

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Course Title: Software Testing

Marks: 100

Credits:4

Duration: 60 Hrs

Course Pre-Requisites:

- Knowledge of analysis, design and programming

Course Objectives:

- To provide a detailed study of testing software and automated tools.

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:

1. **Testing fundamentals** **[6Hrs]**

   Software testing – Levels of software testing – Test activities – Testing Life Cycle – Test Organization – White Box testing – Basis Path Testing – Control Structure testing – Black Box Testing.

2. **Functional testing** **[11Hrs]**

   Equivalence Class Partitioning - Boundary Value Analysis – Cause-effect Graphing – Special cases. Performance Testing – Stress testing – Configuration Testing – Security Testing – Recovery Testing – Integration Testing – Regression Testing – Acceptance Testing.

3. **Object oriented testing methods** **[12Hrs]**

   Testing Methods at Class level – Interclass test case design- Testing for Specific Environment, architecture, and application - Testing patterns.

4. **Testing process** **[11Hrs]**

   Comparison of different techniques- Test Plan – Test case Design Procedure Specification – Test Case Execution and Analysis - Test Documentation - Reporting test results - Final test report Test Driven Development & Refactoring.

5. **Testing Web Application** **[12Hrs]**

   Testing concepts for web apps – Content Testing – User Interface Testing – Component Level Testing – Navigation Testing – Configuration Testing – Security Testing – Performance Testing.

6. **Testing Tools** **[8Hrs]**

   Need for automated testing tools - Selection of testing tool – Tools used at various phases.

Text Book:

1. SrinivasanDesikan, GopalswamyRamesh , “Software Testing : Principles and Practices”,Pearson Education

References:

1. William E. Lewis, Software Testing and Continuous Quality Improvement, CRC Press

2. Web resources: http://www.softwareqatest.com

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Course Title: Cloud Computing

Marks: 100

Credits: 4

Duration: 60 Hrs

Course Pre-Requisites: None

Course Objectives:

- To study important approaches in the field of Cloud Computing.

Course Outcomes:

At the end of the course students will be able to:

CO1: Understand cloud infrastructure model and cloud deployment model.

CO2: Gain knowledge about the underlying principles of cloud virtualization.

CO3: Explore different cloud programming platforms and tools.

CO4: Develop and deploy applications by utilizing cloud platforms.

Syllabus:

1. Introduction to cloud computing **[6Hrs]**

How it all began – Grid computing –utility computing-automatic computing – dynamic data centre alliance-hosting/outsourcing . Cloud computing defined –the SPL frame work for cloud computing –traditional software model –virtualization –the cloud services delivery model-cloud deployment model –

key drivers to adopting the cloud –the impact of cloud computing on users-governance in the cloud-the barrier to cloud computing adoption in the enterprise.

2. Developing cloud services **[8Hrs]**

Cloud infrastructure models-types of cloud service development-softwar as a service-platform as a service – infrastructure as a service-web services – on-demand computing –discovering cloud services deployment services and tools – amazon EC2 –google app engine – Microsoft azure.

3. Google app engine **[8Hrs]**

The java runtime environment-the python runtime environment – the data store-development workflow-Setting up a google app engine account –setting development environment –starting to program in phython with app engine.

4. Programming google app engine with python **[8Hrs]**

A first real cloud application –the basic example –chat application-the basics of HTTP –mapping chat into HTTP.

5. Programming google app engine with java **[8Hrs]**

Google app engine and java-managing server side data – building user interface in java – building the server side of java application.

6. Amazon cloud computing **[7Hrs]**

Amazon s3-amazon EC2-the simple storage service-simple queuing services.

7. Window azure platform **[7Hrs]**

Windows azure-SQL azur-windows azure app facric- additional online services.

8. Security **[8Hrs]**

Data security –network security-host security –compromise –response.

Text Book

1. GerogeReese ,Cloud Computing Architecture ,O’Reilly publications.

References:

1. Michael Miller , Cloud Computing, Pearson

2. Tim Mather, SubraKumarswamry and SharhedLatif, Cloud Computing Security and Privacy, O'Reilly publication.
3. Mark C. Chu Carrol, " Code in the Cloud –Programming Google App Engine, The Pragmatic Programmers.
4. Charles Severance, Using Google AppEngine by, O'Reilly publication.

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Course Title: Network Security

Marks: 100

Credits: 4

Duration: 60 Hrs

Course Pre-Requisites: None

Course Objectives:

- To understand the concepts and theory of computer network security.

Course Outcomes:

At the end of the course students will be able to:

CO1: Understand fundamentals of Cryptography and security.

CO2: Gain knowledge about Block and Stream Ciphers, public key cryptography and asymmetric algorithms.

CO3: Acquire knowledge about authentication and web security protocols.

CO4: Implement Cryptographic Algorithms in a programming language.

Syllabus:

1. Foundations of Cryptography and Security **[5Hrs]**

Ciphers and Secret Messages, Security Attacks and Services. Classical encryption techniques.

2. Mathematical Tools for Cryptography **[6Hrs]**

Substitutions and Permutations, Modular Arithmetic, Euclid's Algorithm, Finite Fields, Polynomial Arithmetic.

3. Design Principal of Block Ciphers **[10Hrs]**

Theory of Block ciphers, Feistel Cipher network Structures, DES and triple DES, Modes of Operation (ECB, CBC, OFB, CFB), Strength of DES., AES

4. Pseudo Random Numbers and Stream Ciphers **[9Hrs]**

Pseudo random sequences, Liner Congruential generators, Cryptographic generators, Design of stream Ciphers, RC4.

5. Public Key Cryptography **[6Hrs]**

Prime Numbers and testing for primality.Factoring large numbers, Discrete Logarithms.

6. Asymmetric Algorithms **[5Hrs]**

RSA, Diffie-Hellman, ElGamal, Introduction of Ecliptics curve cryptosystems, Key Management, Key exchange algorithms, Public Key Cryptography Standards.

7. Hashes and Message Digests **[5Hrs]**

Message Authentication, MD5, SHA-3, HMAC

8. Digital Signatures, Certificate and Standards **[4Hrs]**

Digital signature standards (DSS and DSA), Public Key Infrastructures, Digital certificates and Basics of PKCS standards.

9. Authentication **[5Hrs]**

Kerberos , X509 Authentication Service

10. Web Security protocols **[3Hrs]**

IP Security, Transport Layer Security (TLS)., Wireless Security,

11. System Security **[2Hrs]**

Intrusion detection , Password management. Firewalls management

Text Book:

1. Stallings William, “ Cryptography and Network Security: Principles and Practises”, 5th edition, Prentice Hall

References:

1. KahateAtul, “Cryptography and Network Security” Tata McGraw-Hill.

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Course Title: Communication Skills Course

Marks: 100

Credits: 4

Duration: 60 Hrs

Course Pre-Requisites: None

Course Objectives:

- To understand the essential elements of Written Communication, and the process of writing.
- To learn various subgenres of workplace communication, including business & technical writing
- To learn the dynamics involved in oral communication, including non- verbal interaction.
- To use language effectively in public oral communication.

Course Outcomes:

At the end of the course students will be able to:

CO1: Apply creative thinking abilities necessary for effective communication at a modern workplace.

CO2: Demonstrate clarity, precision, conciseness and coherence in the use of language.

CO3: Learn to make one's writing better, faster and more successful.

CO4: Produce successful documents in any given situation in different formats, while considering the writer's objectives, the reader's needs, the reader-writer relationship and the context.

CO5: Increase personal confidence in delivering speeches to small & large audiences.

CO6: Understand and gain non-verbal skills essential to effective speaking.

CO7: Make proper presentations that disseminate information, conduct negotiations and use persuasion.

Syllabus:

1. Introduction & theory of Written Communication **[6Hrs]**

Process of Communication, Language as a Tool of Communication, Levels of Communication, Flow of Communication, Communication Networks, Barriers to Communication.

2. The Writing process **[5Hrs]**

Features of academic communication, Prewriting (Invention), Stasis Theory, Creating a Thesis Statement, Developing an Outline, Proofreading, Avoiding Plagiarism.

3. Constituents of Effective Writing **[8Hrs]**

Words & phrases, Sentence Construction, Paragraph Development, Précis Writing, Reading Comprehension.

4. Business Writing **[9Hrs]**

Letters, Memos, Emails, Proposals, Reports, Analysis and Presentation of Data, Documentation and Document Design.

5. Technical Writing **[4Hrs]**

Defining Technical Writing, Technical Description, Process Description, Instruction Manuals, User Manuals, Audience Awareness.

6. Introduction to Oral Communication **[6Hrs]**

Theory of Verbal Communication Features of Verbal Communication, Listening Skills.

7. Non-verbal communication **[6Hrs]**

Kinesics, Proxemics, Paralinguistics, Chronemics.

8. Public Speaking **[8Hrs]**

Preparation for Public Speaking, Speech Writing, Delivery of Speech, Anxiety Management

9. Meetings / group activity **[8Hrs]**

Interviews, Group Communication and Discussion, Team work, Leadership Skills.

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Course Title: Applied Probability and Statistics

Marks: 100

Credits:4

Duration: 60 Hrs

Course Pre-Requisites: None

Course Objectives:

- To provide the foundation of Probability theory and Statistical inference in order to apply statistical methods to various fields such as Statistical Quality Control.

Course Outcomes:

At the end of the course students will be able to:

CO1: Gain knowledge about the probability theory.

CO2: Solve problems containing Discrete and Continuous Random variables.

CO3: Apply the concepts of Statistical Inference to Mathematical problems.

CO4: Provide statistical quality control.

Syllabus:

1. **Introduction:** **[6Hrs]**

   Probability models, sample space events, algebra of events, graphical methods of representing events, probability axioms, combinational problems, conditional probability, independence of events, Baye's rule, Bernoulli trials

2. **Discrete Random Variables:** **[10Hrs]**

   Introduction, random variables and their spaces, the probability mass function, distribution functions, special discrete distributions, analysis of program, the probability generating function, Discrete Random Vectors, independent random variables.

3. **Continuous Random Variables:** **[10Hrs]**

   Introductions, the exponential distribution, some important distribution, functions of a random variable, jointly distributed random variables, distributions of sums, functions of normal random variables.

4. **Expectation:** **[10Hrs]**

   Introduction moments, expectation of functions of more than one random variable, moments and transforms of some important distributions, computations of mean time to failure, inequalities and limits theorems.

5. **Conditional Distribution and Conditional Expectation:** **[2Hrs]**

   Conditional Expectation.

6. **Statistical Inference:** **[14Hrs]**

Introduction, Parameter Estimation, Hypothesis testing: z, t, chi square, F test, Regression, correlation and 'analysis of variance: Introduction, least squares curve fitting, the coefficient of Determination, confidence Intervals in linear Regression, correlation analysis, simple nonlinear regression, Higher dimensional least-squares fit, Analysis of variance; Non parametric tests: sign test, u test, Rank test, Median test.

7. Statistical Quality Control: **[8Hrs]**

Control charts, Mean chart, R chart, sigma chart, C chart.

Text Book:

7. Gupta S.G. and V.K.Kapoor, Fundamentals of Mathematical Statistics, S Chand and Sons

References:

1. Sheldon M. Ross, A First Course in Probability, Pearson

8. P. S. Mann, Introduction to Statistics, Willey Student Edition

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Course Title: Machine Learning

Marks: 100

Credits: 4

Duration: 60 Hrs

Course Pre-Requisites:

- An introductory course on Probability & Statistics.

Course Objectives:

- Provide a broad introduction to artificial intelligence and machine learning techniques.

Course Outcomes:

At the end of the course students will be able to:

CO1: Understand the fundamentals of machine learning.

CO2: Understand the techniques for supervised learning and unsupervised learning.

CO3: Recognize various ways of selecting suitable model parameters for different machine learning techniques.

CO4: Perform experiments in Machine Learning using real-world data.

Syllabus:

1. **Introduction :** **[7Hrs]**

   What is Machine Learning, Examples of Machine learning applications, version space, Decision Trees, Artificial Neural Networks.

2. **Supervised Learning:** **[20Hrs]**

   Supervised learning setup, LMS, Logistic regression, Perceptron, Back propagation neural network, Exponential family, Generative learning algorithms, Gaussian discriminant analysis. Naive Bayes, Support vector machines, Model selection and feature selection, Ensemble methods: Bagging, boosting, Evaluating and debugging learning algorithms.

3. **Learning Theory:** **[8Hrs]**

   Bias/variance tradeoff, Union and Chernoff/Hoeffding bounds, VC dimension, Worst case (online) learning, Practical advice on how to use learning algorithms.

4. **Unsupervised Learning:** **[15Hrs]**

   Clustering. K-means, Hierarchical clustering, EM. Mixture of Gaussians, Factor analysis, Anomaly detection, PCA (Principal components analysis), ICA (Independent components analysis), Self-organizing map(SOM), Deep learning.

5. **Reinforcement Learning and Control:** **[10Hrs]**

MDPs. Bellman equations, Value iteration and policy iteration, Linear quadratic regulation (LQR), LQG, Q-learning, Value function approximation, Policy search, Reinforce, POMDPs.

Text Book

1. EthemAlpaydin, Introduction to Machine Learning, PHI.

References:

1. Tom M. Mitchell, Machine Learning, McGraw Hill.
2. Richard O. Duda, Peter E. Hart and David G. Stork, Pattern Classification, Wiley
3. Elaine Rich, Artificial intelligence , Tata McGraw-Hill Education

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Course Title: Statistical Computing

Marks: 50

Credits: 2

Duration: 30 Hrs

Course Pre-Requisites: None

Course Objectives:

- To introduce Statistical Computing using a tool like R or equivalent.

Course Outcomes:

At the end of the course students will be able to:

CO1: Gain knowledge of various types of Plots and Charts.

CO2: Use various types of distributions and statistical tests for solving problems.

CO3: Configure software environment to develop programs to implement statistical concepts.

CO4: Use a tool to apply the theoretical concepts to practical problems.

Syllabus:

1. Introduction **[4Hrs]**

Downloading and Setting up the environment, Assigning objects to values, Basic Mathematical functions, Creating vectors and matrices, importing and exporting data, subsetting data, Logic statements and cbind and rbind commands, setting of working directory, scripts for reproducible research, installing packages, apply and functions.

2. Understanding charts and plots **[4Hrs]**

Bar Charts and Pie charts, Box Plots and Box Plots with Groups, Stratified Box Plots, Histograms, Stem and Leaf Plots, Stacked Bar Charts, Grouped Bar Charts, Mosaic Plots, Scatter Plots.

3. Distributions & Tests **[12Hrs]**

Introduction to Binomial, Poisson and normal distribution, computing probabilities.
Introduction to T scores and Z scores and their computation. Parametric tests such as ;One-Sample t-test, 2-Sample t-test, Paired t-test, Analysis of Variance, Cross Tabulations, Non parametric test : Chi Square Test, Fisher's Exact Test.

4. Correlation and Regression **[10Hrs]**

Introduction to bi-variate data, correlation coefficient , simple and multiple regression, Changing a Numeric to a categorical variable, Indicator variables, Variable Selection in Linear Regression using Partial F-Test, Polynomial Regression

Text Book:

1. Maria L Rizzo , Statistical Computing with R, CRC Press.

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Course Title: Educational Technology

Marks: 50

Credits: 2

Duration: 30 Hrs

Course Pre-Requisites: None

Course Objectives:

- To introduce the classroom applications of Educational Technologies.

Course Outcomes:

At the end of the course students will be able to:

CO1: Define educational technology and identify its role in teaching.

CO2: Determine the technology requirements and describe the teaching challenges and opportunities associated with integrating technology in the classroom.

CO3: Inculcate capability of carrying out research in the Educational Technology domain.

CO4: Master usage of ICT tools.

Syllabus:

1. Introduction **[2Hrs]**

Technology in Education: Meaning, Evolution and Development.

2. Educational Technology in Instructional Planning **[3Hrs]**

Multiple Intelligence, Learning Theories, Learning Objectives, Learning Styles, Blooms Taxonomy, Constructivist and situated theories of learning, Instructional Design Models.

3. Advanced topics in Cognition **[6Hrs]**

Role of Cognition in education, Behaviorism & Symbolic Cognition(Skinner's defence of behaviorism, Watson's argument against introspection), Miller's proposal on planning.Distributed Cognition, Situated Cognition, Embodied Cognition.

4. ICT in Education **[3Hrs]**

Computer, Internet, Multimedia/Hypermedia, Animations, Simulations, Projected Materials, Audio Materials, Interactive Materials.

5. Educational Tools **[8Hrs]**

LOGO, SCRATCH, LMS tools

6. Research Methods in Educational Technology **[8Hrs]**

Content of educational research: scientific method, planning educational research, ethics, identifying problem, variables, hypothesis. Strategies of data collection, Data analysis(distribution, statistical significance, statistical tests,SPSS.

Text Book:

1. Shelly & Gunter, Teachers Discovering Computers, Cengage Learning.

References:

2. M. D. Roblyer & Aaron H. Doering, Integrating Educational Technology into Teaching, Pearson.

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Programme Specific Outcome (PSO) for M.Sc. (IT)

At the end of the programme the students will be able to:

PSO1 : Develop deep theoretical and practical knowledge of important disciplines of Information Technology like Data Structures, Database Management Systems, Operating Systems and Networks, Design and Analysis of Algorithms, Software Architecture, Data Mining and Information Retrieval.

PSO2 : Imbibe the skill of writing optimal software programs independent of any particular programming language and platform so as to make the student self-reliant to learn and work in any programming language, tool or platform.

PSO3 :Inculcate Soft Skills and Mathematical skills in the student that are required in IT sector.

PSO4: Develop the ability of conducting research independently.

PSO5: Develop the skill of working in teams.

PSO6: Acquire an edge of having real-world experience by virtue of the internship in Software Industry/Research Organization being a mandatory part of the programme.

ANNEXURE V

Parvatibai Chowgule College of Arts and Science

(Autonomous)

DEPARTMENT OF COMPUTER SCIENCE
M.Sc [Information Technology] COURSE STRUCTURE
(2020-2021)

Semester I (24 credits)

Course Code	Course Type	Course Title	Credits	Contact hours/week		
				L	T	P
MIT 11	Core – I	Data Structures and Algorithms	4	4	0	0
MIT 12	Core – II	Operating Systems and Networks	4	4	0	0
MIT 13	Elective - I	Elective Course	4	4	0	0
MIT 14	Elective – II	Elective Course	4	4	0	0
MIT 15	Elective - III	Elective Course	4	4	0	0
MIT 16	Core III Lab – I	Data Structures and Algorithms Lab	2	0	0	6
MIT 17	Core IV Lab – II	Operating Systems and Networks Lab	2	0	0	6

Semester II (24 credits)

Course Code	Course Type	Course Title	Credits	Contact hours/week		
				L	T	P
MIT 21	Core – V	Software Architecture, Design Patterns and Frameworks	4	4	0	0
MIT 22	Core – VI	Design and Analysis of Algorithms	4	4	0	0
MIT 23	Core VII	Advanced Database Management Systems	4	4	0	0
MIT 24	Elective –IV	Elective Course	4	4	0	0

MIT25	Elective V	Elective Course	2	2	0	0
MIT 26	Core VIII Lab – III	Software Architecture, Design Patterns and Frameworks Lab	2	0	0	6
MIT 27	Core IX Lab – IV	Design and Analysis of Algorithms Lab	2	0	0	6
MIT28	Core X LAB -V	Advanced Database Management Systems LAB	2	0	0	6

Semester III (24 credits)

Course Code	Course Type	Course Title	Credits	Contact hours/week		
				L	T	P
MIT 31	Core – XI	Data Mining	4	4	0	0
MIT 32	Core – XII	Information Retrieval	4	4	0	0
MIT 33	Elective VI	Elective Course	4	4	0	0
MIT 34	Elective – VII	Elective Course	4	4	0	0
MIT 35	Elective – VIII	Elective Course	4	4	0	0
MIT36	Elective IX	Elective Course	2	2	0	0
MIT 37	Core XIII Lab V	Data Mining & Information Retrieval Lab	2	0	0	6

Semester IV(8 credits)

Course Code	Course Type	Course Title	Credits	Contact hours/week		
				L	T	P
MIT 41	Elective X	Project/Dissertation	8	0	0	0

Legend:

L– Lectures
T – Tutorials
P – Practicals

Course Title: Data Structures and Algorithms
Course Code: MIT 11
Marks: 100
Credits: 4
Duration: 60 Hrs

Course Pre-Requisites:

- An introductory course on Data Structures.

Course Objectives:

- The objective of the course is to understand the real-life applications of data structures.
- Be familiar with writing recursive and iterative methods using Data Structure.

Course Outcomes:

At the end of the course students will be able to:

CO1: Demonstrate advantages and disadvantages of specific algorithms and data structures
CO2:Evaluate algorithms and data structures in terms of time and memory complexity of basic operations.
CO3: Design and analyze the time and space efficiency of the data structure.
CO4: Formulate new solutions for programing problems or improve existing code using learned algorithms and data structures,

Syllabus:

Unit I: Linear Data Structure [15 HRS]

ADT, Array application and representations: Polynomials, Sparse matrices, String-pattern Matching Linked Lists: Linked list applications, Representation and Implementation, Use of Header and Trailer Nodes, Doubly linked list, Circular linked list. Stack and Queues: Need and justification of the study, Representation and implementation, Multiple stacks and queues, Implementation of recursion using stack.

Unit II: Non Linear Data Structure [20 HRS]

Trees: Definitions, terminologies and properties, Binary tree representation, traversals and applications, Threaded binary trees, Binary Search Trees, AVL Trees, Red Black Tree, suffix trees, Splay trees ,M-way Search Trees, B-trees, B*-trees, B+-trees. Graphs: Graph representations; Graph Traversals, spanning trees, Cut-sets and Cut-Vertices: Cut Sets, Properties of Cut-sets, All Cut-sets in a Graph , Eulerian Graphs , Hamiltonian Graphs. Priority Queues, Heap Structures.

Unit III: Complexity of Sorting and Searching Algorithms [10 HRS]

Mathematical Background, Big-O notation, Running Time computation, Radix Sort, Heap sort, Quick Sort, Merge Sort ,Shell Sort, Interpolation search, External Sorting Algorithm, Symbol Tables.

Unit IV: File Organization and Processing [15 HRS]

General list, Automatic list management, Dynamic memory management. Sequential files: Organization, Creation, Update and Maintenance; Relative files: Organization, Hashing techniques: Approaches to collision problem, Indexed sequential files: organization, Creation, Update and Maintenance, Multi-key files, Inverted file, Multi-list file, Tries: Standard Tries and Compressed Tries, Suffix tree,Huffman Algorithm.

REFERENCES:

Mandatory:

1. R. Venkatesan , S. Lovelyn Rose (2019) "Data structures" (2nd Ed) Wiley.
2. Prof Peter Brass (2014) "AdvancedData Structures ",(1st Ed), Cambridge University Press.

Supplementary:

1. Alfred V. Aho, John E Hoproft, Jeffrey D. Ullman, "Data structures and algorithms",(2nd Ed) Pearson Education India Delhi,
2. Jean-Paul Tremblay, Paul Sorenson (2017), An Introduction to Data Structures with Application, (2nd Ed), McGraw Hill Education.

Web References:

1: http://www.cs.cmu.edu/~ab/15-121N11/
2: https://www.cse.iitb.ac.in/~ranade/cs213/
3: http://cse.iitrpr.ac.in/ckn/courses/f2015/csl201/w4.pdf
4: https://www.cpp.edu/~ftang/courses/CS241/notes/b-tree.htm
5: https://www.cs.usfca.edu/~galles/visualization/Algorithms.htm

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Course Title: Operating Systems and Networks
Course Code: MIT 12
Marks: 100
Credits:4
Duration: 60 Hrs

Course Pre-Requisites:

- Basics of Operating Systems and Networks

Course Objectives:

- To understand Real time operating systems
- To gain understanding in specific areas of networking such as the design and maintenance of individual networks.

Course Outcomes:

At the end of the course students will be able to:

CO1: Analyze the structure of Operating system.
CO2: Analyze various Resource management and fault tolerance techniques for real time systems.
CO3: Discuss the fundamentals of IP addressing.
CO4: Apply subnet masking concepts to allocate space for host in subnet.
CO5: Examine techniques to protect the network.

Syllabus:

Unit I: Overview of Operating Systems [15 HRS]

Processes and Threads - Process Scheduling -Synchronization Mechanisms –Deadlocks: Detection, Prevention and Recovery – Models of Resources – Memory Management Techniques.
Real time Operating systems: Basic model of real time systems, Characteristics, Applications of real time systems, Real time task scheduling, handling resource sharing, Mobile operating systems, Micro kernel design, Processes and Threads, Memory Management, File system. Failure Recovery and Fault Tolerance: Types of faults, Issues, Failed system behavior, Failure detection, Approaches of fault tolerance

Unit II: Network Service Design [15 HRS]

Introduction, Strategy for Network Service Implementation, Issues in Network design
TCP/IP: Introduction to TCP/IP, Benefits of using TCP/IP,IP addressing, IP Network and Host addressing, Classfull and classless IP addresses, IPV6, Subnet mask, Subnetting and super netting
Switch Technology: Switch fundamentals (Bridges vs. Switches) – Spanning Tree Protocol: Overview, Spanning tree protocol, Rapid Spanning tree protocol.

Unit III: Routed Networks [15 HRS]

VLANs and VLAN Trunking:VLAN- concepts, broadcast domains with VLANs and routers, benefits, types, configuration (geographic, static, verifying, saving, deleting, troubleshooting), preventing broadcast storms. VLAN Trunking Protocol, VTP modes of operation, Routing between VLANs, Inter-VLAN routing issues, solutions, interfaces (physical, logical), sub interfaces.
Routing: Static V/s Dynamic routes, Adding and deleting static routes, Demand on dial routing, Routing protocol, RIP, OSPF, IGP, Secure IP routing.

Unit IV: Network Administration [15 HRS]

Network administration:SNMP & RMON - Overview and features, MIB Management Information base Installing SNMP Servers, SNMP communities, Authentication and securing Monitoring and analysis and troubleshooting, Overview and installation configuration: fire wall, NAT, E-mail (Send mail), Radius, Remote access servers, proxy servers.
Wireless Networking: Overview, Infrastructure mode, Ad Hoc Mode, ESSID, wireless channels, wireless security, Authentication.

References:

Mandatory:

1. Singhal, M. &Shivaratri, N.G (2000), *Advanced concepts in operating systems.* Delhi, India: McGraw-Hill.
2. Beasley, J S. & Nilkaew, P. (2015), *A practical guide to advanced networking*, Chennai, India: Pearson.

Supplementary:

1. Stallings, W.(2009), *Wireless communications and networks,* (2nd Ed), New Delhi, India: Prentice Hall of India

Web Resources:

1. https://swayam.gov.in/nd1_noc20_cs16/preview
2. https://swayam.gov.in/nd1_noc20_cs23/preview
3. http://study-ccna.com/
4. http://www.packettracernetwork.com/

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Course Title: Data Structures and Algorithms Lab
Course Code: MIT 16
Marks: 50
Credits: 2
Duration: 60 Hrs.

Course Pre-Requisites:

- Theoretical Knowledge of Data Structures

Course Objective:

- Introduce students to a number of highly efficient algorithms and data structures for fundamental computational problems across a variety of areas.
- Analyze a problem and determine the appropriate data structure for the problem.
- Analyze the asymptotic performance of algorithms.

Course Outcomes:

At the end of the course students will be able to:

CO1: Select algorithm design approaches in a problem specific manner.
CO2: Become proficient in applying knowledge from the theory of Data Structures to various application areas.
CO3: Design Algorithms to solve the problems.
CO4: Discuss different Data Structures to represent real world problems.

Syllabus:

List of suggested assignments:

1. Implementation of Basic Data Structure such as stack, Queue, Linked List etc. [6 HRS]

2. Implementation of self organized linked list. [5 HRS]

3. Implementation of different sorting techniques. [4 HRS]

4. Implementation of Optimal Binary Search Tree. [6 HRS]

5. Implementation of a Huffman code for the text file. [6 HRS]

7. Implementation of AVL Tree. [7 HRS]

8. Implementation of Red Black tree. [6 HRS]

9. Implementation of B-Tree. [4 HRS]

10. Implementation of B+ Tree. [3 HRS]

11. Implementation of R-Tree and Quad Tree. [3 HRS]

12. Implementation of Tries. [3 HRS]

11. Implementation of Compressed Binary Tries. [2 HRS]

11. Implementation of Dictionaries. [1 HRS]

13. Implementation of Graph Traversal Techniques. [2 HRS]

14. Implementation of linear probing, quadratic hashing and Double hashing. [2 HRS]

Mini Project on the application of Data Structures.

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Course Title: Operating Systems and Networks Lab
Course Code: MIT 17
Marks: 50
Credits: 2
Duration: 60 Hrs.

Course Pre-Requisites:

- Theoretical Knowledge of operating systems and networks.

Course Objectives:

- To provide practical base in operating system and networks.

Course Outcomes:

At the end of the course students will be able to:

CO1: Manage processes, memory and file system using system calls.
CO2: Illustrate socket communication involving sender process and receiver process using TCP and UDP.
CO3: Analyze network traffic by using network analyzer tool.
CO4: Design and demonstrate VLAN's by using simulation tool.

Syllabus:
Implementation of:

1. File operations. [6 HRS]

2. Streams and file objects [6 HRS]

3. Identifiers, fork, exec, and wait functions [6 HRS]
4. Iterative TCP client and server application [6 HRS]
5. Concurrent TCP client and server application [6 HRS]
6. UDP client and server application [6 HRS]
7. Using nmap for port scanning and vulnerability detection. [3 HRS]
8. Configuration of a Firewall. [3 HRS]
9. Configuration of Intrusion detection system. [3 HRS]
10. Using ethereal or tcp dump to analyze network traffic. [3 HRS]
11. Creating subnets and supernets using simulation tools. [3 HRS]
12. Configuring static and dynamic route using routing tools. [6 HRS]
13. Configuring VLANs. [3 HRS]

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Course Title: Software Architecture, Design Patterns and Frameworks
Course Code: MIT 21
Marks: 100
Credits: 4
Duration: 60 Hrs.

Course Pre-Requisites:

- Introductory course on Software Engineering

Course Objectives:

- Learning Software Development using good OO Design and Architecture
- Understanding of Design and Architectural patterns and Frameworks.

Course Outcomes:

At the end of the course students will be able to:

CO1: Apply various concepts of Object-Oriented Analysis and Design while solving problems.

CO2: Analyze a problem scenario and prepare various models of the solution.
CO3: Analyze a given problem and study the applicability of Design Patterns to the problem.
CO4: Generate code skeletons in any OO programming language from UML class diagram.

Syllabus:

Unit I OO Design, Use case & Structural Modelling [15 HRS]

Encapsulation, Abstraction, Implementation Hiding, Inheritance, Dynamic binding, Polymorphism, Overriding and Overloading, SOLID Principles of Object-Oriented Design. Scenarios, Actors & Use Cases, The include and extend relationships, Use Case Generalization, Writing Use Cases formally, Choosing System Boundary, Finding Actors and Use cases, Using use cases for Verification and Validation, Use-Case Realization Classes, Objects, Attributes and Operations, Visibility of attributes and operations, Class-Scope Attributes, Attributes with default values, Association, Multiplicity, Role-Name, Qualified Association, Association Class, Ternary Association, Recursive Association, Multiple Association between two classes, Composite and Shared Aggregation, Generalization and sub-class partitioning, Generalization Set, Interfaces and their realization, Packages and Grouping of classes into Packages , Parameterized Classes.

Unit II Dynamic Modelling and Design Patterns [15 HRS]

Modelling object interaction using Interaction Diagrams, Modelling the behaviour of reactive objects using State chart diagrams; Modelling systems workflows or operations using Activity diagram. Motivation, reusability, extendibility, cataloging patterns, “GoF” patterns

Unit III Software architecture & Architectural Patterns [15 HRS]

Software Architecture & its importance, Various types of Architectural Structures - Module, Conceptual, Process,Physical, Uses, Calls, Data Flow, Control flow, Class, System Quality attributes discernible at runtime, Business Qualities, Architecture Qualities, Architectural means for achieving architectural qualities, Data Flow Architecture, Virtual machine Architecture, Call & Return Architecture, Independent Component Architecture, Definition, advantages, components and connectors, views, documenting, evaluating, mining, Layered, pipe & filter, MVC, broker, Microkernel, Component and Deployment Diagrams.

Unit IV Frameworks, Software Product Lines and AntiPatterns [15 HRS]

Enterprise frameworks, EJBs, Economies of scope, Product Line Development, Product Development. Anti-patterns Case Studies

References:

Mandatory:

1. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, Design Patterns: Elements of Reusable Object-Oriented Software, Pearson Education, First Edition.

Supplementary:

1. Bass L, Clements P & Kazman R (2019), *Software Architecture in Practice* (3rd Ed), Westford, USA: Pearson Education.
2. Buchmann F, Munier R, Rohnert H, Sommerland P & Stahl M (2008), *Pattern Oriented Software Architecture-I* (First Ed), Wiley.

Web References:

1. https://www.coursera.org/learn/object-oriented-design
2. https://cosmolearning.org/courses/software-architecture-design/video-lectures/
3. https://swayam.gov.in/nd1_noc19_cs69/

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Course Title: Design and Analysis of Algorithms
Course Code: MIT 22
Marks: 100
Credits: 4
Duration: 60 Hrs.

Course Pre-Requisites: Programming Basics, Data Structures

Course Objectives:

- Understand the basic concepts related to the design and analysis of algorithms
- Understand classical algorithms and their complexity
- Apply the algorithms to real-world problems

Course Outcomes:

At the end of the course students will be able to:

CO1: Analyze the running time of various algorithms.
CO2: Apply the algorithms and techniques to solve various problems.
CO3: Analyze the complexities of various problems in different domains.
CO4: Design their own algorithmic strategies to solve problems and analyze their correctness.

Syllabus:

Unit I: Foundations for Design and Analysis of Algorithms [20 HRS]

Introduction: The Role of Algorithm in computing, Framework for design and analysis of algorithms, Growth of functions: asymptotic notation; Recurrences: substitution method, recursion-tree method, master method; Probabilistic analysis and randomized algorithms, indicator random variables.
Advanced Design and Analysis Techniques.
Dynamic programming: Assembly line scheduling, matrix-chain multiplication, elements of DP, longest common subsequence, Optimal BST.

Unit II: Advanced Design and Analysis Techniques [15 HRS]

Greedy algorithms: Elements of greedy strategy, Huffman codes, Optimal storage on tapes,Minimum cost spanning tree- Kruskal and Prim's algorithms, performance analysis.
Backtracking: The general method,8 Queens problem , sum of subsets,Graph coloring.
Amortized analysis: Aggregate analysis, accounting method, potential method, dynamic tables.

Unit III: Graph and Internet Algorithms [15 HRS]

Graph Algorithms: Elementary graph algorithms- Minimum spanning tree: growing a spanning tree, Single-source shortest paths: Bellman-ford algorithm, Djikstra's algorithm. All pairs shortest paths: shortest paths and matrix multiplication, Floyd-Warshall algorithm.
Internet Algorithms: Strings and patterns matching algorithms, Tries, Text compression. Text similarity testing.

Unit IV: Limitations to Design of Efficient Algorithms [10 HRS]

NP-Completeness: Polynomial time, polynomial time verification, NP-completeness and reducibility.
Approximation algorithms: The vertex cover problem, Traveling salesman problem, the set-covering problem.

References

Mandatory:

1. Cormen, T. H., Leisorson, C. E., Rivest, R. L.& Stein, C., (2010), *Introduction to algorithms*, (3rd ed), New Delhi, India: PHI, Eastern Economy Edition

Supplementary:

1. Knuth, D. E. (2011), *The art of computer programming Vol I, II, III*, Boston, United States: Addison Wesley

2. Horowitz, E., Sahni, S., Rajasekaran, S. (2008), *Fundamentals of computer algorithm* (2nd ed), New Delhi, India: Galgotia Publications
3. Aho, A., Hopcroft, J., Ullman, J. (2004),*The design and analysis of computer algorithms*, New Delhi, India: Pearson Education, LPE
4. Gilberg, R., Forouzan, B. (2004).*Data Structure: a pseudo code approach with C*, USA: Thomas Learning Inc.

Web Resources:
1. https://nptel.ac.in/courses/106106131/
2. https://www.geeksforgeeks.org/fundamentals-of-algorithms/
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-006-introduction-to-algorithms-fall-2011/
4. https://www.udemy.com/course/introduction-to-algorithms-and-data-structures-in-c/

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Course Title: Advanced Database Management Systems
Course Code: MIT 23
Marks: 100
Credits: 4
Duration: 60 Hrs

Course Pre-Requisites:

- Introductory course on Database Management Systems.

Course Objectives:

- Understand the concept of a database transaction and related database facilities.
- Introduce research development ability in databases through technical survey and presentation.

Course Outcomes:

At the end of the course students will be able to:

CO1: Critically evaluate alternative designs and architectures for Databases and Data Warehouses.
CO2:Evaluate methods of storing, managing and interrogating complex data.
CO3: Analyze the background processes involved in optimizing queries and transactions.
CO4: Develop a high-level understanding of major DBMS components and their function.

Syllabus:

Unit I: Database Design and Query Processing [15 HRS]

Functional Dependencies, Decomposition of relational schemes, Normal forms for Relations, schemas, Multivalued and other forms of Dependencies. Basic algorithms for executing query operations, Basic optimization strategies, Algebraic manipulations, optimization of selections in system, Exact optimization for a subset of relational queries, Optimization under weak equivalence.

Unit II: Database Concurrency and Recovery Techniques [15 HRS]

Basic concepts, a simple transaction model, serializability, lock based protocols, Timestamp based protocol, concurrency for hierarchically structured items, Deadlock handling (Wait-die, wound-wait, no waiting, cautious waiting), optimistic concurrency control. NO-UNDO/REDO Recovery Based on differed update, Recovery technique based on immediate update, shadow paging, ARIES, Recovery in multidatabase system, Database backup and recovery from catastrophic Failures.

Unit III: Distributed Database [15 HRS]

Principles of Distributed Databases, Framework for distribution, translation of global queries into fragment queries, query optimization and management of distributed transaction, concurrency control and reliability in distributed databases, Administration of distributed databases. Future Trends in data models: Semantic data models, DM for loosely structured data items, Multimedia database.

Unit IV: Emerging Technologies [15 HRS]

XML Databases: XML-Related Technologies-XML Schema- XML Query Languages- Storing XML in Databases-XML and SQL- Native XML Databases- Web Databases- Geographic Information Systems-Biological Data Management- Cloud Based Databases: Data Storage Systems on the Cloud- Cloud Storage Architectures-Cloud Data Models- Query Languages- Introduction to Big Data-Storage-Analysis. Introduction of NoSQL databases: Document Database, GraphStores, Key value stores, Column stores, case study of Mongo DB(Document Based) and Neo 4J(Graph Based) databases

References:

Mandatory:

1. Elmasri & Navathe(2016), *Fundamentals of Database Systems*,(7th Ed),Pearson Arlington.
2. Abraham Silberschatz, Henry F. Korth(2016), *Database System Concepts*,(6th Ed), McGraw Hill Pennsylvania.

Supplementary:

1. Rini Chakrabarti , Shilbhadra Dasgupta(2011), *Advanced Database Management System*, 2nd Ed) Dreamtech Press,Kolkota India
2. S.Ceri and G.Relagatti(2017), *Distributed Databases*,(1st Ed),McGraw Hill Education India Private Limited New Delhi,

Web References:

1: https://link.springer.com/10.1007%2F978-0-387-39940-9_712
2: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.71.1311&rep=rep1&type=pdf
3: https://rubygarage.org/blog/neo4j-database-guide-with-use-cases
4: http://datasys.cs.iit.edu/events/ScienceCloud2013/p02.pdf
5: http://www.iitkgp.ac.in/research-areas/Big%20Data%20Analytics

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Course Title: Software Architecture, Design Patterns and Frameworks Lab
Course Code: MIT 26
Marks: 50
Credits: 2
Duration: 60 Hrs.

Course Pre-Requisites:

- Introductory course on Software Engineering

Course Objectives:

- Implement the various concepts of Object Orientation.
- Implement the various Design Patterns.
- Usage of various Architectural patterns and Frameworks.

Course Outcomes:

At the end of the course students will be able to:

CO1: Implement the various concepts of Object-Oriented Programming.
CO2: Illustrate Creational, Structural and Behavioural Design Patterns.
CO3: Analyze a given problem and apply Design Patterns to it solve problems by using a framework.
CO4: Work with a framework.

This course will have programming assignments for the various types of patterns and frameworks discussed in the corresponding theory paper.

1. Implementation of various concepts of Object Orientation [09 HRS]

2. Implementation of the 21 Design patterns (Creational, Structural and Behavioural)
[18 HRS]

3. Experiments on Architectural Patterns
[09 HRS]

4. Experiments on Enterprise Frameworks
[24 HRS]

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Course Title: Design and Analysis of Algorithms Lab
Course Code: MIT 27
Marks: 50
Credits:2
Duration: 60 Hrs.

Course Pre-Requisites:

- Introductory course on Design and Analysis of Algorithms

Course Objectives:

- Understand the various algorithm design approach

Course Outcomes:
At the end of the course students will be able to:

CO1: Implement various algorithms using dynamic programming approach.
CO2: Implement various Internet algorithms.
CO3: Implement various graph Algorithms.
CO4: Implement algorithms for real life problems

List of suggested Assignments:

1. Implementation of algorithms using divide and conquer approach.
[09 HRS]
   a. Binary Search
   b. Quick Sort
   c. Merge Sort

2. Implementation of algorithms using dynamic programming approach.
[12 HRS]

   a. Assembly Line Scheduling
   b. Longest Common Subsequence
   c. Matrix Chain Multiplication
   d. Optimal Binary Search Tree

3. Implementation of algorithms using Greedy programming approach.
[09 HRS]

   a. Huffman Codes
   b. Optimal Storage on Tapes
   c. Minimum Cost Spanning Tree(Prim's and Kruskal Algorithm)

4. Implementation of Backtracking programming approach for various problems.
[12 HRS]

   a. 8-Queen's Problem
   b. Sum of Subsets
   c. Graph Coloring

5. Implementation of various Graph algorithms. [09 HRS]

   a. Djikstra's Algorithm
   b. Bellman Ford Algorithm
   c. Floyd War shall Algorithm

6. Implementation of various internet algorithms. [09 HRS]

a. Tries
b. Text Compression
c. Text Similarity Testing

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Course Title: Advanced Database Management Systems Lab
Course Code: MIT 28

Marks: 50
Credits:2
Duration: 60 Hrs.

Course Pre-Requisites:

- Introductory course on Database Management Systems

Course Objectives:

- Understand the concept of a database transaction
- To understand Schema representation methods in Relational and NO SQL Databases
- To present the concept and techniques related to query processing and optimization.

Course Outcomes:

At the end of the course students will be able to:

CO1: Populate and query a database using SQL,DML/DDL commands.
CO2: Perform PL/SQL programming using concept of Cursor Management, Error Handling, Package and Triggers.
CO3: Execute various advance SQL queries related to Transaction Processing & Locking using concept of Concurrency control.
CO4: Represent the database using XML and working on it.

List of suggested Assignments:

1: Revision and Normalization [07 HRS]

2: Advance SQL- Dynamic SQL, Triggers, Assertions [09 HRS]

3: Advance SQL- Stored Procedures [06 HRS]

4: Indexing [01 HRS]

5: Views,Roles,Grants [06 HRS]

6: Data recovery techniques in databases. [06 HRS]

7: Design XML Schema and perform queries using Xquery and Xpath [09 HRS]

8: Introduction to Indexed DB [02 HRS]

9: Introduction to NO SQL database [01 HRS]

10: Creating Documents,Collection,inserting records,embedding documents [03 HRS]

11: Querying the documents [03 HRS]

13: Aggregation Framework [03 HRS]

14: Sharding [01HR]

15: Application development on No SQL Database using Java/PHP [03 HRS]

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Course Title: Data Mining
Course Code: MIT31
Marks: 100
Credits: 4
Duration: 60 Hrs.

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

Course Outcomes:

At the end of the course students will be able to:

CO1: Identify appropriate data mining algorithms to solve real world problems
CO2: Apply various Association Rules Mining Algorithms.
CO3: Use Decision Trees, Bayesian Classification, Artificial Neural Networks and Fuzzy Set Theory while solving classification problems.
CO4: Apply various types of Clustering Algorithms, Web Mining Techniques and techniques of mining complex types of data.

Syllabus:

Unit I Introduction to Data Warehousing and Data Mining [15 HRS]

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, 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, 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

Unit II Association Analysis, Classification and Prediction: [15 HRS]

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. 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

Unit III Clustering and Web Mining: [15 HRS]

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.

Unit IV Applications of Data Warehousing And Data Mining [15 HRS]

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
Exploration of web sites on data ware housing and data mining applications including bibliography data bases, Corporate Houses and Research labs

References:

Mandatory:
1. Han J &Kamber M (2011), *Data Mining Concepts and Techniques* (3rd Ed), New Delhi, India: Morgan Kaufmann Publishers.

Supplementary:

1. Kumar V & Dunham M (2006), *Data Mining: Introductory and Advanced Topics*(1st Ed), New Delhi, India: Prentice Hall (Pearson Publication).

2. Tan P, Steinbach M & Kumar V (2016), *Introduction to Data Mining* (1st Ed), New Delhi, India: Pearson Education.

Web References:

1. https://nptel.ac.in/courses/106/105/106105174/
2. https://www.coursera.org/specializations/data-mining
3. https://www.tutorialspoint.com/data_mining/

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Course Title: Information Retrieval
Course Code: MIT 32
Marks: 100
Credits: 4
Duration: 60 Hrs.

Course Pre-Requisites: None

Course Objectives:

- Introduce students to the theoretical underpinnings of information retrieval (IR), an active and rapid growing branch of applied computational science.
- Impart knowledge on document representation, document indexing, digital information storage, retrieval, and distribution.
- Emphasize application of IR theories and practices to web indexing and web search engines

Course Outcomes:

At the end of the course students will be able to:

CO1: Develop system for IR using various models.
CO2: Perform Query evaluation and Relevance feedback.
CO3: Design systems that include hyperlinks, multimedia and the web.
CO4: Apply XML, Parallel, Distributed and Multimedia IR concepts to relevant problems.

Syllabus:

Unit I Introduction, Boolean Model and Tolerant Retrieval [15 HRS]

Function of an IR system, Kinds of IR system, Components of an IR system, Problems in designing an IR system, 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, 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

Unit II Indexes, Models, Evaluation, Relevance Feedback and Query Expansion [15 HRS]

Blocked sort-based indexing, Single-pass in-memory indexing, Distributed and Dynamic indexing, Statistical properties of terms, Dictionary compression, Postings file compression, 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, 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

Unit III Parallel, Distributed and Multimedia IR [15 HRS]

Parallel Computing, Performance Measures, MIMD and SIMD architectures, Distributed Computing, Collection partitioning, source selection, Query processing, web issues, 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

Unit IV XML and Web IR [15 HRS]

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
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

References:

Mandatory:

1. Manning C, Raghavan P & Schutze H (2008): *Introduction to Information Retrieval* (1st Ed), Delhi,India: Cambridge University Press.

Supplementary:

1. Grossman D & Frieder O (2008), *Information Retrieval: Algorithms and Heuristics* (2nd Ed), Hyderabad, India: Springer

2.Yates R & Ribeiro-Neto B (2003), *Modern Information Retrieval* (1st Ed), New Delhi, India:Pearson Education.

Web References:

1. https://www.coursera.org/learn/text-retrieval

2. https://www.youtube.com/watch?v=q0srNT_XM_Y&list=PL0ZVw5-GryEkGAQT7lX7oIHqyDPeUyOMQ

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Course Title: Data Mining & Information Retrieval LAB
Course Code: MIT 37
Marks: 50
Credits: 2
Duration: 60 Hrs.

Course Pre-Requisites: None

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.

Course Outcomes:

At the end of the course students will be able to:

CO1: Illustrate Stop-Word removal, Stemming and Lemmatization techniques.
CO2: Employ techniques of Index Construction like Soundex Codes and Permuterms.
CO3: Implement Vector Space and Probabilistic Models to identify similarities between Queries and documents.
CO4: Demonstrate various Clustering, Classification and Association Rules Mining Algorithms.

List of Experiments

1. Program to implement Boolean Model (Generate Term Incidence Matrix along with frequency)

[03 HRS]
2. Program to implement stop word removal.
[03 HRS]
3. Program to implement Porter's stemming algorithm.
[03 HRS]

4. Program to implement Permuterm Indexes
[03 HRS]
5. Program to implement Vector Space Model (Similarity Coefficient)
[06 HRS]
6. Program to implement Vector Space Model (Cosine Similarity)
[06 HRS]
7. Program to implement Probabilistic Model
[06 HRS]
8.Programs to implement Association Rule Mining Algorithms
[06 HRS]
9. Programs to implement Clustering Algorithms [12 HRS]
10. Programs to implement Classification Algorithms
[09 HRS]
11. Program to compare and contrast Association Measures
[03 HRS]

Use of Apache Lucene and NLTK tools is recommended.

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Department of Computer Science
LIST OF ELECTIVES FOR M.Sc. IT
(To be Offered from 2019-20)

1) Software Metrics & Project Management
2) Mobile Computing
3) Compiler Design
4) Computer Graphics
5) Natural Language Processing
6) Image Processing
7) Middleware Technology
8) Software Testing
9) Cloud Computing
10) Network Security
11) Communication Skills Course
12) Applied Probability and Statistics
13) Machine Learning
14) Statistical Computing
15) Educational Technology

Course Title: Software Metrics & Project Management
Course Code: EL1
Marks: 100
Credits: 4
Duration: 60 Hrs

Course Pre-Requisites:

- Introductory course on Software Engineering

Course Objectives:

- Provide a deeper understanding of various software metrics and project management concepts

Course Outcomes:

At the end of the course students will be able to:

CO1: Identify and describe the key phases of project management.
CO2: Apply Scope, Time and Cost Management process to Software Development.

CO3: Define software metrics and quality standards.

CO4: Plan a metrics measurement program

CO5: Enforce Quality standards in projects

SYLLABUS:

Unit I: [15 HRS]

Introduction
Introduction to Project and Project management, Project phases and project life cycle, organizational structure, Qualities of Project Manager.
Project Management Components
Project Integration Management-Project plan development and execution, change controls, configuration management
Scope and Time Management
Strategic planning, scope planning, definition ,verification and control, Activity planning, schedule development and control.

Unit II: [15 HRS]
Cost and Quality Management
Cost estimation and Control, Quality planning and assurance
Human Resource and Communication Management.
Organizational planning, staff acquisition, Information distribution, reporting.

Unit III: [15 HRS]

Risk Management
Risk identification, Quantification and control.
Procurement Management
Solicitation, contract administration
Software Metrics
The scope of software metrics, software metrics data collection, analyzing software data, measuring size, structure, external attributes.

Unit IV: [15 HRS]

Software Reliability
Measurement and prediction, resource measurement, productivity, teams and tools.
Planning a measurement program
Metrics plan: Developing goals, questions and metrics. Where and When: Mapping measures to activities. How: Measurement tools. Who: Measurers , analyst, tools revision plans.
Quality Standards – CMM, PSP/TSP.

References:

Mandatory:
1. Kathy S. *Information Technology Project Management*, Boston : Course Technology Press.

Supplementary:
1.Norman F., James B. (2014). *Software Metrics A rigorous and practical approach(Third Edition)*, CRC Press.
1. Roger P. *Software Engineering – A Practitioner's Approach*, United States : McGraw Hill.

Web References:

1.www.tutorialspoint.com/software_engineering/software_project_management.htm
2.https://www.javatpoint.com/software-engineering-software-metrics
3.https://www.geeksforgeeks.org/software-measurement-and-metrics/

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Course Title: Mobile Computing
Course Code: EL2
Marks: 100
Credits: 4
Duration: 60 Hrs

Course Pre-Requisites: None

Course Objectives:

- To understand the basic concepts of Mobile Computing

Course Outcomes:

At the end of the course students will be able to:

CO1: Apply data communicating methods and networking protocols for wireless and mobile environments.
CO2: Understand positioning techniques and location based services and applications.

CO3: Utilize and employ application frameworks for developing mobile applications.
CO4: Use java for wireless devices and understand wireless messaging.

Syllabus:

Unit I: Introduction to Mobile Computing **[15 HRS]**

Introduction and need for Mobile computing, Mobility and portability, Mobile and Wireless devices, Applications, Brief History of wireless communication
Wireless Transmission: General Concepts of multiplexing and modulation, Spread Spectrum, Cellular Systems, Cellular Phone Array, Mobile Phone Technologies (1G, 2G, 2.5G, 3G, 4G)
Medium Access Control Layer: Why specialized MAC? - hidden and exposed terminals- near and far terminals, General Concepts and comparison of SDMA, FDMA, TDMA ,CDMA

Unit II: Mobile Telecommunication Systems **[15 HRS]**

Global System for Mobile Communication: Mobile Services (Bearer, Tele-and-supplementary services). System Architecture- Radio subsystem - Network and switching subsystem - Operation subsystem, Protocols - Localization and calling – Handover. Value Added Services- SMS Architecture, Mobile Originated and Mobile Terminated ,procedures - Cell Broadcast Service Architecture, Message Transfer Procedure – MMS Architecture, Protocol framework, Message Transfer. Procedure - Location Services, Logical Reference Model, Control Procedures, Network Architecture, determination of Location Information, Location based services.GPRS
Wireless Messaging : Architecture for Messaging application, Messaging API, Types of applications, Pros and cons of messaging

Unit III: Mobile Internet **[15 HRS]**

Mobile IP: Goals, assumptions and requirements, Entities and terminologies, Agent Discovery
iv. Registration, Tunnelling and encapsulation, Reverse Tunnelling, IPv6, IP micro-mobility support – Cellular IP, Hawaii, Hierarchical mobile IPv6 , Mobile Routing : Destination sequence distance Vector, Dynamic Source Routing, Alternative Matrix, Ad hoc Routing Protocols -Flat, Hierarchical, geographic-position-assisted
Mobile TCP: Traditional TCP - Congestion Control, Slow start, Fast retransmit / Fast recovery - Implications on mobility. Classical TCP improvements Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit / Fast recovery, Transmission / Timeout freezing, Selective Retransmission, Transaction oriented TCP.TCP over 2.5/3G wireless networks.
Wireless Application Protocol: Architecture, Wireless datagram protocol, Wireless transport layer security, Wireless transaction protocol, Wireless session protocol, Wireless application environment, WML, WML Scripts, Push Architecture, Push – Pull Services

Unit IV: Mobile Platforms and Support **[15 HRS]**

Operating Systems: Palm OS, Windows CE, Embedded Linux, J2ME (Introduction), Symbian (Introduction) vi. File Systems (Book1)
Java for Wireless Devices: Setting up the development environment, Basic Data types,Libraries (CLDC, MIDP)
UI Controls : Displayable and Display- Image, Events and Event Handling, List and choice, Text box, Alerts
Persistent Storage: Record Stores, Records, Record Enumeration

Network MIDlets: The Connection Framework, Connection Interface, Making a connection using HTTP, Using datagram connection

References

Mandatory:

1. Schiller, J. (2008) *Mobile communications*(2nd ed), New Delhi, India: Pearson Education

Supplementary:

1. Feng, Y. &Zhu, J.(2001) *Wireless Java programming with J2ME*,New Delhi, India: Techmedia Publications.
2. Talukdar, A. K., Ahmed, H. &Yavagal, R. R. (2011) *Mobile computing: technology, applications and service creation* (2nd ed), New Delhi, India: TataMcGrawHill
3. Hansmann, U., Merk, L., Nicklons, M. S. & Stober, T. (2006)*Principles of mobile computing*(2nd ed), New York, USA: Springer
4. Lee, W.C.Y. (2017) *Mobile cellular telecommunications-Analog and digital systems*, (2nd ed), New Delhi, India: Tata Mc Graw Hill Edition
5. Toh, C.K. (2007) *AdHoc mobile wireless networks*, New Delhi, India: Pearson Education,

Web References

1. http://ftp.mi.fu-berlin.de/pub/schiller/
2. Android Developers : http://developer.android.com/index.html
3. Apple Developer : https://developer.apple.com/
4. Windows Phone Dev Center : http://developer.windowsphone.com
5. BlackBerry Developer : http://developer.blackberry.com/
6. https://nptel.ac.in/courses/106/106/106106147/

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Course Title: Compiler Design
Course Code: EL3
Marks: 100
Credits: 4
Duration: 60 Hrs

Course Pre-Requisites: None

Course Objectives:

- To enable the student to understand compiler construction and equip them with skills to write a compiler for a programming language.

Course Outcomes:

At the end of the course students will be able to:

CO1: Convert a NFA to DFA and minimize the DFA.
CO2: Perform Lexical Analysis using tools such as Lex and YACC.
CO3: Apply the concepts of Register allocation.
CO4: Design and code a simple compiler for a programming language.

Syllabus:

Unit I. Introduction and Context Free Grammars [15 HRS]

Lexical analysis, Regular Expressions, Finite automata. N.F.A., N.F.A. to D.F.A. conversion, D.F.A., minimization of D.F.A., Lex tool, Derivations & Parse trees, Syntax analysis: Parsing, Top Down Parser, Recursive descent Parser, Predictive parsing, LL(1) Parsing table, Bottom Up Parsing, Shift Reduce parsing, Operator precedence parsing, LR Parsing methods, SLR, LRDL, LALR, YACC tool.

Unit II Syntax Directed Translation, Error Detection and Recovery [15 HRS]

Syntax directed translation schemes, Implementation of syntax directed translation schemes, Intermediate codes, Post fix notation parse trees &syntax trees, three address codes, quadruples, triples, Translation of assignment statements, Boolean expression, statements that after flow of control, Post fix translation, Translation with Up down parsing. Errors, lexical phase errors, Syntactic phase errors, semantic errors.

Unit III Code Optimization and Data Flow Analysis [15 HRS]
Loop optimization, DAG representation of basic block, value numbers & algebraic laws, Global data flow analysis, Dominators, Reducible flow graph, Depth first search, Loop invariant computation, Induction variable elimination, Reaching definition, Available Expression, copy propagation, Backward flow problems, Very busy, expression & code hoisting code.

Unit IV Code Generation and Register Allocation [15 HRS]

A simple code generation, code generation from DAG & labeled trees, Coloring by implication, coalescing, graph coloring implementation, Register allocation for Trees.

References:

Mandatory:
1. Aho A, Ullman J, Lam M & Sethi R (2006), *Compilers - Principles, Techniques, and Tools* (2^{nd} Ed), New Delhi, India: Pearson Education.

Supplementary:

1. Tremblay J & Sorenson P (2014), Theory& Practice of Compiler Writing (4^{th} Ed), New Delhi, India: B. S. Publication

Web References:

- https://nptel.ac.in/courses/106105190/
- https://www.tutorialspoint.com/compiler_design/index.htm
- https://www.geeksforgeeks.org/compiler-design-tutorials/
- https://www.javatpoint.com/compiler-tutorial

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Course Title: Computer Graphics
Course Code: EL4
Marks: 100
Credits: 4
Duration: 60 Hrs

Course Pre-Requisites:

- An introductory course on Data Structures and Algorithms

Course Objectives:

- To understand the concepts of Graphic Algorithms, Geometrical transformations and Modeling

Course Outcomes:

At the end of the course students will be able to :

CO1: Describe the purpose of Computer Graphics and its applications.
CO2:Comprehend and analyze the fundamentals of animation, underlying principles, and applications.
CO3: Apply 3D Transformation on the object.
CO4: Extract scene with different clipping methods and its transformation to graphics display device.
CO5: Develop familiarity with key algorithms for modelling and rendering graphical data.
CO6: Design interactive computer graphics programs using Babylon JS.

Syllabus:

Unit I: Introduction to Computer Graphics and Graphics Transformation [15 HRS]

History of Computer Graphics, graphics primitives, scan conversion. 2D Transformations, composite transformation, viewing transformation, clipping algorithms.

Unit II: 3D Transformation and Representation of Curve [15 HRS]

Viewing pipeline, Parallel and Perspective projections, view volumes, clipping ,Parametric, curves, continuity conditions, cubic splines, Hermite interpolation, Bezier curves and surfaces, B-spline Curves-uniform non rational, cubic periodic, open uniform, uniform, non uniform rational types (NURBS), Subdividing curves, Fractals.

Unit III: Visible Surface Detection and Rendering Algorithm [15 HRS]

Regularized Boolean operators, Sweep methods, Boundary Methods Constructive solid geometry methods, representation through quad trees and Octrees. Issues in Visible surface determination Coherence, backface culling, Z-Buffer and A-Buffer Algorithms, use of Binary Space Partitioning trees, Boolean operations on Octrees, Visible surface ray tracing. Diffuse and Specular illumination model, reflection vector computation, Shading models for polygons –polygon mesh shading, Gouraud and Phong Shading, problems with interpolated shading, Transparency, shadows, Ray tracing.

Unit IV: Animation [15 HRS]

Perception, Animation production, use in film and videos, orientation representation and interpolation –Euler angle representation, motion display considerations, Motion along a curve – computing are length, speed control – sine interpolation, rigid body simulation, collision detection, Particle systems – particle generation, modeling water, fire, explosions.

References:

Mandatory:

1. Foley, Van Dam, Feiner, Hughes(2013), *Computer Graphics – Principles and Practices* (3rd Ed), Pearson Education India New Delhi.

Supplementary:

1. Rick Parent(2012), "*Computer Animation: Algorithms and Techniques(3rd Ed)*, Morgan-Kaufman California.
2. Hearn & Baker(2010), *Computer Graphics with OpenGL(4th Ed)*, Prentice Hall of India Delhi.

Web References:

1: https://nptel.ac.in/courses/106106090/
2: http://cs.wellesley.edu/~cs110/lectures/M01-color/graphics.pdf
3: http://gamma.cs.unc.edu/graphicscourse/solid_modeling.pdf
4: https://link.springer.com/chapter/10.1007%2F978-3-642-77263-4_20
5: http://math.hws.edu/graphicsbook/c8/s1.html

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Course Title: Natural Language Processing
Course Code: EL5
Marks: 100
Credits: 4
Duration: 60 Hrs

Course Pre-Requisites: None

Course Objectives:

- To study fundamental concepts of Natural Language Processing and to introduce the basics of Language processing from algorithmic viewpoint.

Course Outcomes:

At the end of the course students will be able to:

CO1: Compose key NLP elements to develop higher level processing chains.
CO2: Assess / Evaluate NLP based systems.
CO3: Choose appropriate solutions for solving typical NLP sub problems (tokenizing, tagging, parsing).
CO4: Perform Lexical and Semantic Analysis.

Syllabus:

Unit I: Introduction to Natural Language Processing [15 HRS]

Introduction: Ambiguity, Models and algorithm, Language, thought and understanding.
Regular Expressions and Automata:Regular Expressions, Basic Regular Expression Patterns, Disjunction, Grouping, and Precedence, Advanced Operators, Regular Expression substitution, Memory, and ELIZA.
Finite-State Automata:Using an FSA for Recognition, Formal Languages, Non-Deterministic FSAs, Using an NFSA to Accept Strings, Recognition as Search.

Unit II: Morphology [15 HRS]

Morphology and Finite-State Transducers:English Morphology, Inflectional Morphology, Derivational Morphology, Finite-State Morphological, Parsing, The Lexicon and Morphotactics, Morphological Parsing with Finite-State Transducers, Orthographic Rules and Finite-state Transducers, Combining FST Lexicon and Rules, Lexicon-free FSTs: The Porter Stemmer.
N-grams:Counting Words, Simple N-grams, Smoothing, Backoff, Deleted Interpolation, N-grams for Spellings, Entropy.

Unit III: Part of speech Tagging [15 HRS]

Word Classes and Part-of-Speech Tagging:English classes, tagsets POS tagging, Rule based POS tagging, Stochastic POS tagging, HMM tagging, Transformation based tagging, Multiple tags and multiple words, unknown words.
Features and Unification:Feature structures, Unification of feature structures, Feature structures in grammar, Implementing unification, Parsing with unification constraints, Types and inheritances.
Lexicalized and Probabilistic Parsing:Probabilistic Context free grammars. Problems with PCFGs, Probabilistic Lexicalized CFGs, Dependency Grammars, Human Parsing.

Unit IV: Semantics [15 HRS]

Representing Meaning:Computational Desiderata for representation, Meaning Structure of Language, Some Linguistically relevant concepts: Categories, Events, Representing time, Aspects, Representing beliefs, Pitfalls. Alternative approaches to meaning.

Semantic Analysis: Syntax-Driven Semantic Analysis, Semantic Augmentations to context-Free Grammar Rules, Quantifier Scoping and the Translation of Complex-Terms. Attachments for a Fragment of English. Sentences, Noun Phrases, Verb Phrases. Prepositional Phrases, Integrating Semantic Analysis into the Earley Parser. Idioms and Compositionality, Robust Semantic Analysis.
Lexical Semantics: Relation among lexes and their senses, WordNet, Internal structure of Words, Creativity and the Lexicon.

References

Mandatory:
1. Jurafsky, D. &Martin, J.H. (2013) *Speech and language processing: an introduction to natural language processing, computational linguistics and speech recognition*(2nd ed), New Delhi, India: Pearson Education.

Supplementary:
1. Allen, J. (2002) *Natural language understanding* (2nd ed), New Delhi, India: Pearson Education, 1994
2. Bharati A., Sangal R., &ChaitanyaV. (2000). *Natural language processing: a Paninian perspective*, New Delhi, India: PHI
3. Siddiqui T., &Tiwary U. S. (2008)*Natural language processing and Information retrieval*, Noida, India: Oxford University Press

Web References
1. https://nptel.ac.in/courses/106105158/
2. Natural Language Toolkit http://www.nltk.org/
3. The Stanford Natural Language Processing Group https://nlp.stanford.edu/software/
4. https://www.lltacademia.com/courses/course/1/introduction-to-natural-language-processing/

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Course Title: Image Processing
Course Code: EL6
Marks: 100
Credits: 4

Duration: 60 Hrs

Course Pre-Requisites: None

Course Objectives:

- To understand the basic image processing operations.

Course Outcomes:

At the end of the course students will be able to:

CO1:Comprehend how digital images are represented and manipulated in a computer, including reading and writing from storage, and display.
CO2: Analyze and implement image processing algorithms.
CO3: Perform Image Compression.
CO4: Apply Morphological Image Processing.

Syllabus:

Unit I: Image Formation and Enhancement [15 HRS]

Introduction:Image formation model, representation, spatial and Gray Level resolution, Colour models-RGB, CMY and HIS models.
Image Enhancement In Spatial Domain:Piecewise linear transformation, Histogram equalization, Histogram specification, image averaging, spatial filters – smoothing and sharpening, Laplacian filter, sobel operator, Canny edge detector.

Unit II: Image Enhancement In Frequency Domain [15 HRS]

2D Discrete Fourier transform and its inverse, filtering in frequency domain, Ideal and Gaussian Low pass filters, high pass filtering, separability property 0f 2D Fourier transform, Fast Fourier Transform.
Image Segmentation:Line detection, Edge detection, Edge linking and boundary detection, Hough Transform, Thresholding, Region based segmentation.

UNIT III: Morphological Image Processing [15 HRS]

Logic operations involving binary images, Dilation and Erosion, Opening and closing, Applications to Boundary extraction, region filling, connected component extraction.
Image Compression:Coding redundancy- Huffman coding, LZW coding, run length coding, Lossy compression – Lossy predictive coding, transform coding- DCT, bit allocation, Compression standards – JPEG, video Compression.

UNIT IV: Image Representation [15 HRS]

Boundary description, Shape numbers, Fourier descriptors, Texture, principal Components based description.
3D Vision:Projective geometry, single perspective camera, stereopsis, the fundamental matrix – its estimation from image point correspondences, applications of epipolar geometry in vision, correlation based and feature based stereo correspondence, shape from motion, optical flow.

References

Mandatory:

1. Gonzalez, R.C.& Woods, R.E. (2018) *Digital Image Processing*(4th ed), New Delhi, India: Pearson Education.

Supplementary:

1. Sonka, M., Hlavac, V. & Roger Boyle, R. (2017).*Image processing, analysis, and machine vision with MindTap*(4th ed), Singapore: Cengage Learning
2. Jain, R.C., Kasturi, R. & Schunk, B. G. *Introduction to Machine Vision* McGraw Hill International Edition
3. Schalkoff, R. J. *Digital Image Processing & Computer Vision*, John Wiley and Sons

Web References:

1. https://nptel.ac.in/courses/117/105/117105079/
2. https://nptel.ac.in/courses/117/105/117105135/
3. https://www.udemy.com/course/image-processing-from-ground-uptm-in-c/

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Course Title: Middleware Technology
Marks: 100

Course Code: EL7
Credits:4
Duration: 60 Hrs

Course Pre-Requisites:

- Fundamental knowledge of Distributed Systems and knowledge of Java

Course Objectives:

- Understanding the characteristics of distributed systems, Asynchronous communication and Event based systems.

- Understanding of J2EE and Web services.

Course Outcomes:

At the end of the course students will be able to:

CO1: Apply the concepts of distributed systems, asynchronous communication and event-based systems to real-world problems.
CO2: Develop Web programs using the Servlet technology and Enterprise Java beans.
CO3: Use web services and reflective middleware concepts for real-world problems.
CO4: Apply concepts that are learnt while working in live projects that involve Web Component and Business Component Programming.

Syllabus:

UNIT I: Foundation of Middleware [15 HRS]

Introduction to middleware, MW definition, styles of MW, key players.
Distributed systems characteristics System models-architectural and fundamental models. RPC, Distributed objects-RNI, .NET Remoting, Name services-DNS, Time and global states, synchronization, Coordination and agreement, distributed transactions and recovery, Consistency & Replication, Fault Tolerance, and Security.

UNIT II: Asynchronous communication and Event based systems [15 HRS]

Notifications, message Queuing systems, peer to peer systems.

UNIT III: Enterprise services in J2EE [15 HRS]
Servlets and EJBs.

UNIT IV: Reflective Middleware [15 HRS]

SOA & Web services XML,SOAP, WSDL, UDDI & other protocols.
Reflective middleware Introduction to reflective middleware, Middleware oriented architectural patterns for enterprise systems.

Text Book:

1. Couloris G, Dollimore J & Kindberg T (2017), *Distributed Systems- Concepts and Design* (5th Edition), New Delhi, India:Pearson Education.

References:

1. Chris Britton and Peter Eye (2004), *IT Architectures and Middleware: Strategies for Building Large, Integrated Systems* (2nd Ed), New Delhi, India: Pearson Education

2. Qusay H. Mahmoud (2014), *Middleware for Communications* (2nd Ed), New Delhi, India: John Wiley and Sons.

Web References

1. https://www.coursera.org/courses?query=distributed%20systems
2. https://online.stanford.edu/courses/cs244b-distributed-systems
3. https://www.globalonlinetrainings.com/courses/middleware-tools-training

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Course Title: Software Testing

Course Code: EL8
Marks: 100
Credits: 4
Duration: 60 Hrs

Course Pre-Requisites: Knowledge of analysis, design and programming

Course Objectives:

- To provide a detailed study of testing software and automated tools.

Course Outcomes:

At the end of the course students will be able to:

CO1: Define Software Testing process for applications.
CO2: Apply Software Testing process in relation to Software Development and Project Management.
CO3: Create Test Strategies and plans, design test cases, prioritize and execute them.
CO4: Identify various Software Testing problems and solve them.
CO5: Identify the needs of software test automation, and define and develop a test tool to support test automation.
CO6: Use software testing methods and modern software testing tools for their testing projects.

SYLLABUS:

Unit I: [15 HRS]

Testing fundamentals
Software testing, Levels of software testing, Test activities, Testing Life Cycle, Test Organization, White Box testing, Basis Path Testing, Control Structure testing, Black Box Testing,Equivalence Class Partitioning, Boundary Value Analysis, Cause-effect Graphing, Special cases.

Unit II: [15 HRS]

Functional Testing
Performance Testing, Stress testing, Configuration Testing, Security Testing, Recovery Testing, Integration Testing, Regression Testing, Acceptance Testing.
Object oriented testing methods
Testing Methods at Class level – Interclass test case design- Testing for Specific Environment, architecture, and application Testing patterns.

Unit III: [15 HRS]

Testing Processes
Comparison of different techniques- Test Plan – Test case Design Procedure Specification – Test Case Execution and Analysis - Test Documentation - Reporting test results - Final test report Test Driven Development & Refactoring.

Unit IV: [15 HRS]

Testing Web Application
Testing concepts for web apps, Content Testing, User Interface Testing , Component Level Testing, Navigation Testing, Configuration Testing , Security Testing – Performance Testing.
Testing Tools
Need for automated testing tools - Selection of testing tool – Tools used at various phases.

References

Mandatory:

1. Desikan S., Gopalswamy R. (2006). *Software Testing : Principles and Practices*, India: Pearson Education.

Supplementary:

1.Kit E. *Software Testing in the Real World,* United States: Addison-Wesley Publishing Co.
2.William E. *Software Testing and Continuous Quality Improvement,* Auerbach Publications.

Web References :

1. www.guru99.com/software-testing.html
2. https://www.tutorialspoint.com/software_testing/index.htm
3. https://www.javatpoint.com/software-testing-tutorial

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Course Title: Cloud Computing
Course Code: EL9
Marks: 100
Credits: 4
Duration: 60 Hrs

Course Pre-Requisites: None

Course Objectives:

- To study important approaches in the field of Cloud Computing.

Course Outcomes:

At the end of the course students will be able to:

CO1:Define main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for cloud computing.
CO2:Identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.
CO3:Explain the core issues of cloud computing such as security, privacy, and interoperability.
CO4: Provide the appropriate cloud computing solutions and recommendations according to the applications used.
CO5: Implement Virtualization

Syllabus:

Unit I: Introduction to cloud computing and Developing cloud services [15 HRS]

How it all began, Grid computing, utility computing-automatic computing, dynamic data centre alliance-hosting/outsourcing, Cloud computing defined, the SPL frame work for cloud computing, traditional software model, virtualization, the cloud services delivery model, cloud deployment model, key drivers to adopting the cloud, the impact of cloud computing on users, governance in the cloud-the barrier to cloud computing adoption in the enterprise, Cloud infrastructure models-types of cloud service development, software as a service, platform as a service, infrastructure as a service-web services, on-demand computing, discovering cloud services deployment services and tools, amazon EC2, google app engine , Microsoft azure.

Unit II: Programming google app engine with python [15 HRS]

The java runtime environment-the python runtime environment – the data store-development workflow-Setting up a google app engine account –setting development environment –starting to program in python with app engine. A first real cloud application –the basic example –chat application-the basics of HTTP –mapping chat into HTTP.

Unit III: Programming google app engine with java and Amazon cloud computing [15 HRS]

Google app engine and java-managing server side data – building user interface in java – building the server side of java application. Amazon s3-amazon EC2-the simple storage service-simple queuing services.

Unit IV: Window Azure Platform and Security [15 HRS]

Windows azure-SQL azure-windows azure app fabric- additional online services. Data security –network security-host security –compromise –response.

References

Mandatory :

1. Hill, R., Hirsch, L., Lake, P., & Moshiri, S. (2012). *Guide to cloud computing: principles and practice*. Springer Science & Business Media.

Supplementary:

1. Buyya, R., Broberg, J., & Goscinski, A. M. (Eds.). (2010). *Cloud computing: Principles and paradigms* (Vol. 87). John Wiley & Sons.

Web References

1. https://www.geeksforgeeks.org/cloud-computing/
2. https://www.tutorialspoint.com/cloud_computing/index.htm
3. https://www.javatpoint.com/cloud-computing-tutorial

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Course Title: Network Security
Course Code: EL10
Marks: 100
Credits: 4
Duration: 60 Hrs

Course Pre-Requisites: None

Course Objectives:

- To understand the concepts and theory of computer network security.

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: Implement Cryptographic Algorithms in a programming language.

Syllabus:

Unit I: Foundations of Cryptography and Security [15 HRS]

Ciphers and Secret Messages, Security Attacks and Services. Classical encryption techniques. Substitutions and Permutations, Modular Arithmetic, Euclid's Algorithm, Finite Fields, Polynomial Arithmetic. Theory of Block ciphers, Feistel Cipher network Structures, DES and triple DES, Modes of Operation (ECB, CBC, OFB, CFB), Strength of DES., AES, Pseudo random sequences, Liner Congruential generators, Cryptographic generators, Design of stream Ciphers, RC4.

Unit II: Public Key Cryptography and Asymmetric Algorithm [15 HRS]

Prime Numbers and testing for primality.Factoring large numbers, Discrete Logarithms.
RSA, Diffie-Hellman, ElGamal, Introduction of Ecliptics curve cryptosystems, Key Management, Key exchange algorithms, Public Key Cryptography Standards.

Unit III: Message Digest and Digital Signature [15 HRS]

Message Authentication, MD5, SHA-3, HMAC, Digital signature standards (DSS and DSA), Public Key Infrastructures, Digital certificates and Basics of PKCS standards.

Unit IV: Authentication and Security [15 HRS]

Kerberos , X509 Authentication Service, IP Security, Transport Layer Security (TLS)., Wireless Security, Intrusion detection , Password management. Firewalls management

References:

Mandatory:

1. Stallings William(2019), " *Cryptography and Network Security: Principles and Practises*", (8th Ed), Pearson Education India Delhi

Supplementary:

1. KahateAtul(2013), "*Cryptography and Network Security*" (3rd Edition)Tata McGraw-Hill Education Pvt. Ltd Noida

Web References:

1: https://nptel.ac.in/courses/106/105/106105031/
2: https://engineering.purdue.edu/kak/compsec/NewLectures/Lecture8.pdf
3: https://www.us-cert.gov/ncas/tips/ST04-018
4: http://www.iet.unipi.it/g.dini/Teaching/sanna/lecturenotes/applied-cryptography-digital-signature.pdf
5: http://www.cs.man.ac.uk/~banach/COMP61411.Info/CourseSlides/Wk4.2.MAC.pdf

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Course Title: Communication Skills Course
Course Code: EL11
Marks: 100
Credits: 4
Duration: 60 Hrs

Course Pre-Requisites:None

Course Objectives:

- To understand the essential elements of Written Communication, and the process of writing.
- To learn various subgenres of workplace communication, including business & technical writing
- To learn the dynamics involved in oral communication, including non- verbal interaction.
- To use language effectively in public oral communication.

Course Outcomes:

At the end of the course students will be able to:

CO1: Apply creative thinking abilities necessary for effective communication at a modern workplace.
CO2: Demonstrate clarity, precision, conciseness and coherence in the use of language.
CO3: Learn to make one's writing better, faster and more successful.
CO4: Speak effectively while using non-verbal skills.
CO5: Design effective presentations that disseminate information, conduct negotiations and use persuasion.

Syllabus:

Unit I :Introduction,Theory of Written Communication and The Writing process [15 HRS]

Process of Communication, Language as a Tool of Communication, Levels of Communication, Flow of Communication, Communication Networks, Barriers to Communication, Features of academic communication, Prewriting (Invention), Stasis Theory, Creating a Thesis Statement, Developing an Outline, Proofreading, Avoiding Plagiarism.

Unit II : Constituents of Effective Writing and Business Writing [15 HRS]

Words & phrases, Sentence Construction, Paragraph Development, Précis Writing, Reading Comprehension Letters, Memos, Emails, Proposals, Reports, Analysis and Presentation of Data, Documentation and Document Design.

Unit III : Technical Writing, Oral Communication and Public Speaking. [15 HRS]

Defining Technical Writing, Technical Description, Process Description, Instruction Manuals, User Manuals, Audience Awareness. Kinesics, Proxemics, Paralinguistics, Chronemics, Theory of Verbal Communication Features of Verbal Communication, Listening Skills.

Unit IV :Non-verbal communication, Meetings and group activity [15 HRS]

Preparation for Public Speaking, Speech Writing, Delivery of Speech, Anxiety Management, Interviews, Group Communication and Discussion, Team work, Leadership Skills.

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Course Title: Applied Probability and Statistics
Course Code: EL12
Marks: 100
Credits:4
Duration: 60 Hrs

Course Pre-Requisites:None

Course Objectives:

- To provide the foundation of Probability theory and Statistical inference in order to apply statistical methods to various fields such as Statistical Quality Control.

Course Outcomes:

At the end of the course students will be able to:

CO1: Apply knowledge about the probability theory to solve mathematical problems.
CO2: Solve problems containing Discrete and Continuous Random variables.
CO3: Apply the concepts of Statistical Inference to Mathematical problems.
CO4: Provide statistical quality control.

Syllabus:

Unit I: Introduction and Discrete Random Variables [15 HRS]

Probability models, sample space events, algebra of events, graphical methods of representing events, probability axioms, combinational problems, conditional probability, independence of events, Baye's rule, Bernoulli trials, Introduction, random variables and their spaces, the probability mass function, distribution functions, special discrete distributions, analysis of program, the probability generating function, Discrete Random Vectors, independent random variables.

Unit II : Continuous Random Variables and Expectation [15 HRS]

Introductions, the exponential distribution, some important distribution, functions of a random variable, jointly distributed random variables, distributions of sums, functions of normal random variables. Introduction moments, expectation of functions of more than one random variable, moments and transforms of some important distributions, computations of mean time to failure, inequalities and limits theorems.

Unit III : Conditional Distribution and Statistical Inference. [15 HRS]

Conditional Expectation, Introduction, Parameter Estimation, Hypothesis testing: z, t, chi square, F test, Regression, correlation and 'analysis of variance: Introduction, least squares curve fitting, the coefficient of Determination, confidence Intervals in linear Regression, correlation analysis, simple nonlinear regression, Higher dimensional least-squares fit, Analysis of variance; Non parametric tests: sign test, u test, Rank test, Median test.

Unit IV : Statistical Quality Control [15 HRS]

Control charts, Mean chart, R chart, sigma chart, C chart.

References:

Mandatory:

1. Gupta S.G. and Kapoor K. V, (2014), *Fundamentals of Mathematical Statistics* (10^{th} Ed), New Delhi, India: S Chand and Sons

Supplementary:

1. Ross S (2019), *A First Course in Probability* (Ninth Ed), New Delhi, India: Pearson

Web References:

1. https://www.tutorialspoint.com/statistics/index.htm
2. https://www.tutorialspoint.com/statistics/probability.htm

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Course Title: Machine Learning
Course Code: EL13
Marks: 100
Credits: 4
Duration: 60 Hrs

Course Pre-Requisites:

- An introductory course on Probability & Statistics.

Course Objectives:

- Provide a broad introduction to artificial intelligence and machine learning techniques.

Course Outcomes:

At the end of the course students will be able to:

CO1: Design and Implement Machine Learning solutions to real-world problems.
CO2: Evaluate and interpret the result of Machine Learning Algorithms.
CO3: Recognize various ways of selecting suitable model parameters for different machine learning techniques.
CO4: Perform experiments in Machine Learning using real-world data.

Syllabus:

Unit I Introduction [15 HRS]

Introduction to Machine Learning, Examples of Machine learning applications, version space, Decision Trees, Artificial Neural Networks.

Unit II Supervised Learning [15 HRS]

Supervised learning setup, LMS, Logistic regression, Perceptron, Back propagation neural network, Exponential family, Generative learning algorithms, Gaussian discriminant analysis. Naive Bayes, Support vector machines, Model selection and feature selection, Ensemble methods: Bagging, boosting, Evaluating and debugging learning algorithms.

Unit III Learning Theory [15 HRS]

Bias/variance tradeoff, Union and Chernoff/Hoeffding bounds, VC dimension, Worst case (online) learning, Practical advice on how to use learning algorithms.

Unit IV Unsupervised and Reinforcement Learning [15 HRS]

Clustering.K-means, Hierarchical clustering, EM. Mixture of Gaussians, Factor analysis, Anomaly detection, PCA (Principal components analysis), ICA (Independent components analysis), Self-organizing map(SOM), Deep learning. MDPs. Bellman equations, Value iteration and policy iteration, Linear quadratic regulation (LQR), LQG, Q-learning, Value function approximation, Policy search, Reinforce, POMDPs.

References:

Mandatory:
1. Alpaydin E (2015), *Introduction to Machine Learning* (3rd Ed), New Delhi, India: PHI Learning Pvt. Ltd.

Supplementary:
1. Mitchell T (2017), *Machine Learning* (1st Ed), New Delhi, India: McGraw Hill Education.
2. Duda R, Hart P & Stork D (2012), *Pattern Classification* (2nd Ed), New Delhi, India: Wiley

3. Rich E, Knight K & Nair S (2017), *Artificial Intelligence* (3rd Ed), New Delhi, India: McGraw-Hill Education.

Web References:
1. https://nptel.ac.in/courses/106106139/
2. https://nptel.ac.in/courses/106/106/106106202/
3. https://nptel.ac.in/courses/106/106/106106198/
4. https://www.coursera.org/learn/machine-learning

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Course Title: Statistical Computing
Course Code: EL14
Marks: 50
Credits: 2
Duration: 30 Hrs

Course Pre-Requisites: None

Course Objectives:

- ➢ To introduce Statistical Computing using a tool like R or equivalent.

Course Outcomes:

At the end of the course students will be able to:
CO1: Configure software environment to develop programs to implement statistical concepts.
CO2: Generate various types of plots and charts.
CO3: Determine and apply relevant statistical test for real-life problems.
CO4: Use various types of distributions and statistical tests for solving problems.

Syllabus:
Unit I Introduction, Charts and Plots [15 HRS]

Downloading and Setting up the environment, Assigning objects to values, Basic Mathematical functions, Creating vectors and matrices, importing and exporting data, subsetting data, Logic statements and cbind and rbind commands, setting of working directory, scripts for reproducible research, installing packages, apply and functions. Bar Charts, Stacked Bar Charts, Grouped Bar Charts, Pie Charts, Box Plots and Box Plots with Groups, Stratified Box Plots, Histograms, Stem and Leaf Plots, Mosaic Plots, Scatter Plots.

Unit II Distributions, Tests, Correlation and Regression [15 HRS]

Introduction to Binomial, Poisson and normal distribution, computing probabilities, Introduction to T scores and Z scores and their computation. Parametric tests such as ;One-Sample t-test, 2-Sample t-test, Paired t-test, Analysis of Variance, Cross Tabulations, Non parametric test : Chi Square Test, Fisher's Exact Test, Introduction to bi-variate data, correlation coefficient , simple and multiple regression, Changing a Numeric to a categorical variable, Indicator variables, Variable Selection in Linear Regression using Partial F-Test, Polynomial Regression

References:
Mandatory:
1. Rizzo M (2019), *Statistical Computing with R* (2nd Ed), Florida, USA: CRC Press.

Supplementary:
1.Srinivasa K, Siddesh G, Shetty C & J Soumya (2017), *Statistical Programming in R* (1st Ed), Noida, Uttar Pradesh, India: Oxford University Press

Web References:
1. https://www.tutorialspoint.com/r/index.htm
2. https://www.w3schools.in/r/

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Course Title: Educational Technology
Course Code: EL15
Marks: 50
Credits: 2
Duration: 30 Hrs

Course Pre-Requisites: None

Course Objectives:

- To introduce the classroom applications of Educational Technologies.

Course Outcomes:
At the end of the course students will be able to:

CO1: Identify the role of educational technology in teaching.
CO2: Integrate technology in the classroom after determining technology requirements
CO3: Perform research in the Educational Technology domain.
CO4: Use ICT tools in a particular course.

Syllabus:

Unit I Educational Technology in Instructional Planning [15 HRS]

Technology in Education: Meaning, Evolution and Development, Multiple Intelligence, Learning Theories, Learning Objectives, Learning Styles, Blooms Taxonomy, Constructivist and situated theories of learning, Instructional Design Models, Role of Cognition in education, Behaviorism & Symbolic Cognition(Skinner's defence of behaviorism, Watson's argument against introspection), Miller's proposal on planning.Distributed Cognition, Situated Cognition, Embodied Cognition.

Unit II ICT in Education, Educational Tools and Research Methods [15 HRS]

Computer, Internet, Multimedia/Hypermedia, Animations, Simulations, Projected Materials, Audio Materials, Interactive Materials, LOGO, SCRATCH, LMS tools, Content of educational research: scientific method, planning educational research, ethics, identifying problem, variables, hypothesis. Strategies of data collection, Data analysis(distribution, statistical significance, statistical tests,SPSS.

References:

Mandatory:
1. Shelly G, Gunter G & Gunter R (2015), *Teachers Discovering Computers* (8th Ed), Kentucky, USA: Cengage Learning.

Supplementary:
1. Roblyer M & Doering A (2019), *Integrating Educational Technology into Teaching* (8th Ed), New Delhi, India:Pearson.

Web References:
1. https://nptel.ac.in/courses/121105010/
2. https://scratch.mit.edu/explore/projects/tutorials/
3. https://www.tutorialspoint.com/logo/index.htm

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ANNEXURE - VA

Summary of changes incorporated in the syllabus of M.Sc(IT) at the board of studies meeting held on 1st February 2020.

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.

Semester	Course Title	Existing(indicate only the unit where the change is proposed)	Changes proposed	Specify the reason for the change.
I	Data Structure and Algorithms	Unit I and Unit IV	Algorithm Stratergies, Complexity classes and Approximation algorithms topics are removed from the syllabus	Algorithm Stratergies, Complexity classes and Approximation algorithms are present in the Design and Analysis course(Semester III)

M.Sc. Geoinformatics

Parvatibai Chowgule College of Arts and Science
(Autonomous)
DEPARTMENT OF GEOGRAPHY & RESEARCH CENTER
COURSE STRUCTURE
MASTER'S OF SCIENCE IN GEOINFORMATICS

Course Code	Course Title	Credits		
		Theory	Practical	Total
SEMESTER I				
GC 101	Basics of Remote Sensing & GIS	2	2	4
GC 102	Computer Programming Methodology	2	2	4
GO 101	Fundamentals of Photogrammetry	2	2	4
GO 102	Basics of Digital Cartography	2	2	4
GO 103	Basics of Geo-statistics	2	2	4
SEMESTER II				
GC 201	Advanced Remote Sensing and GIS	2	2	4
GC 202	Spatial Analysis & Modeling	2	2	4
GO 201	Fundamentals of GPS & Applications	2	2	4
GO 202	Digital Image Processing	2	2	4
GO 203	GIS Programming	2	2	4
SEMESTER III				
GC 301	GIS for Environmental Management	2	2	4
GC 302	GIS for Urban and Regional Planning	2	2	4
GO 301	GIS for Business and Service Planning	2	2	4
GO 302	GIS for Precision Agriculture and Rural Planning	2	2	4
GO 303	GIS for Resource Management	2	2	4
SEMESTER IV				
GC 401	**Project Work**	16		

Note:

1) Duration – 1 lecture of One hour each and One practical/ Laboratory session is equivalent to one contact hour in class room.
2) Each paper will have four instructional contact hours consisting three theory and one practical
3) Total Marks: 1600 (entire course is divided into 12 papers consisting 100 marks each for first 3 semester and a 400 marks project work in 4th semester.
4) GC 101, GC 102 of Semester I and GC 201 and GC 202 of Semester II and GC 301 and GC 302 are compulsory courses.
5) GO 101, GO 102 and GO 103 of Semester I and GO 201, GO 202, GO 203 of Semester II and GO 301, GO 302 and GO 303 of Semester III are optional courses.
6) Student can select any two courses from the given optional paper list for Sem. I
7) Student can select any two courses from the given optional paper list for Sem. II
8) Student can select any two courses from the given optional paper list for Sem. III
9) Student can select any one course from GO201 and GO202 of Sem. II
10) Student can select any one subject from GO 203, GO 204 and GO 205.
11) Project is the part of paper GC 401. Fourth semester is fully devoted to project work.

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)
MARGAO – GOA 403601

POSTGRADUATE DEPARTMENT OF GEOGRAPHY

MASTER OF SCIENCE
In
GEOINFORMATICS

SYLLABUS

To be implemented from 2015-2016

The objective of this degree course is to impart instruction and training to candidates in specialized field of techniques and resources and also intended to develop capacity building for employment, teaching and research.

SEMESTER I

CORE
Course Title: BASICS OF REMOTE SENSING AND GIS
Course Code: GC 101
Marks: 100 (50 Theory+50 Practical)
Credits: 4

Course outline

The course focuses on the fundamentals of Remote Sensing, Geographical Information System, and Global Positioning System by introducing the concept, techniques, hardware and software used in collection, processing and analysis of geospatial data.

Details of course contents and allotted time

No.	Topic	Allotted time (hours)	
		L	P
1.	Introduction to Remote Sensing, definition, development and recent trends	2	
2.	Concept of black body, EMR and Sources of EMR interaction with matter, law of radiation, reflectance, transmittance and absorption, atmospheric window Spectral Signatures	3	
3.	Remote Sensing Systems, Sensors and Platforms, and applications	2	
4.	Introduction to photo products and digital products Image quality, Resolutions	2	
5.	Elements of Image Interpretation, Interpretation of Satellite images, Visual Interpretation	3	4
6.	Introduction to GIS and History and development, Components and Applications trends of GIS	2	
7.	Data type, Structure, Spatial and attribute, point, line, polygon- arc, nodes, vertices, and topology. Attribute data, sources and types	4	6
8.	Input and output devices, editing and attributing and linking	1	6
9.	Data Cleaning, Import & Export formats, Value Added Products	4	4
10.	Open source GIS	2	5
	Total	**25**	**25**

Reference Books:

1. Bolstad, P. (2005) GIS Fundamentals: A first text on Geographic Information Systems, Second Edition. White Bear Lake, MN: Eider Press, 543 pp.
2. Chang, K. (2007) Introduction to Geographic Information System, 4th Edition. McGraw Hill.
3. Elangovan,K (2006) GIS: Fundamentals, Applications and Implementations. New India Publishing Agency, New Delhi"208 pp.
4. Heywood, I., Cornelius, S., and Carver, S. (2006) An Introduction to Geographical Information Systems. Prentice Hall. 3rd edition.
5. Joseph, George Fundamentals of Remote Sensing Universities Press India
6. Lillesand, T.M.; R.W. Kiefer, and J.W. Chipman (2003). Remote sensing and image interpretation, 5th ed., Wiley. ISBN 0-471-15227-7.
7. Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W. (2005) Geographic Information Systems and Science. Chichester: Wiley. 2nd edition.
8. Richards, J.A.; and X. Jia (2006). Remote sensing digital image analysis: an introduction, 4th ed., Springer. ISBN 3-540-25128-6.

CORE
Course Title: COMPUTER PROGRAMMING METHODOLOGY
Course Code: GC 102
Marks: 100 (50 Theory+50 Practical)
Credits: 4

Course outline

The course will explore the fundamentals of computer science, RDBMS and programming for GIS customization. It include: introduction to computers; R/DBMS; programming languages etc.

Details of course contents and allotted time

No.	Topic	Allotted time (hours)	
		L	P
1	Introduction to Computers, Operating systems and Computer Applications	2	
2	Introduction to Algorithms and Programming in Computers, Flow Charts	4	1
3	Introduction to Data Base Management System, (DBMS) and Relational Data Base Management System (RDBMS)	4	
4	MS Access and MySQL		8
5	Introduction to programming, Programming Languages, Variables, Procedures, Methods, Functions, Class Module, Programming Workflow	4	
6	Visual Basics and VB.Net	3	8
7	Developing programming techniques and solutions for spatial algorithms and problem-solving using VBA	4	6
8	Getting started with HTML, Flash	4	2
	Total	25	25

Reference Books:

1. Benjamin C. Pierce (2002). Types and Programming Languages, The MIT Press.
2. Daniel P. Friedman and Mitchell Wand (2001). Christopher Thomas Haynes: Essentials of Programming Languages, The MIT Press.
3. John C. Mitchell (2002). Concepts in Programming Languages, Cambridge University Press.
4. Michael L. Scott (2005). Programming Language Pragmatics, Morgan Kaufmann Publishers.
5. James S. McKeown (2010), Programming in Visual Basic 2010: The Very Beginner's Guide
6. Richard Mansfield (2003), Visual Basic .NET All in One Desk Reference for Dummies

ELECTIVE
Course Title: BASICS OF DIGITAL CARTOGRAPHY
Course Code: GO 101
Marks: 100 (50 Theory+50 Practical)
Credits: 4

Course outline

The course gives emphasis on the art of map making. It develops the user's ability to understand how maps are created and used to represent spatial phenomena and their relationships.

Details of course contents and allotted time

No.	Topic	Allotted time (hours)	
		L	P
1.	Introduction to Cartography, Basics of Map, Fundamentals of direction, scale, types, sources	2	3
2.	Coordinate systems, Spheroid and Geoid, datum and map projections. Coordinates transformations.	2	3
3.	Thematic Cartography–Symbolizing spatial data, Visual Graphics, and Map Composition	2	4
4.	Principles of colour perception, Colour scheme for choropleth and Isorithmic maps, proportional symbol, Dot Density	4	2
5.	Interpolation, methods of Interpolation, symbolizing Interpolated Surfaces, Dot and asymmetric mapping.	4	3
6.	Introduction to Digital Cartography	2	2
7.	Pre-processing of Analog data, Importing Data, Formats, Layouts	3	4
8.	Map Templates and Map Layouts	2	2
9.	Printing technology, Map Printing, Maintenance, Updating	4	2
	Total	25	25

Reference Books:

1. ESRI. 2004. ESRI Cartography: Capabilities and Trends. Redlands, CA. White Paper
2. Imus, D. and Dunlavey, P. 2002. Back to the Drawing Board: Cartography vs the Digital Workflow. MT. Hood, Oregon.
3. Kraak, Menno-Jan and Allan Brown (2001): Web Cartography – Developments and prospects, Taylor & Francis, New York, ISBN 0-7484-0869-X.
4. Pickles, John (2003). A History of Spaces: Cartographic Reason, Mapping, and the Geo-Coded World. Taylor & Francis. ISBN 0-415-14497-3.
5. Sircar, D.C.C. (January 1990). Studies in the Geography of Ancient and Medieval India. Motilal Banarsidass Publishers. ISBN 8120806905.
6. Slocum, T. (2003). Thematic Cartography and Geographic Visualization. Upper Saddle River, New Jersey: Prentice Hall. ISBN 0-130-35123-7. Wilford, John Noble (2000). The Mapmakers. Vintage Books. ISBN 0-375-70850-2.
7. MJ Kraak, F Ormeling - 2003 - Cartography: visualization of geospatial data Addison-Wesley Longman Ltd

ELECTIVE
Course Title: FUNDAMENTALS OF PHOTOGRAMMETRY
Course Code: GO 102
Marks: 100 (50 Theory+50 Practical)
Credits: 4

Course outline

The course gives emphasis Digital Photogrammetric workflow and 3D Mapping. It develops the user's ability to understand how machine stereo vision cerates 3D maps out of 2D data.

No.	Topic	Allotted time (hours)	
		L	P
1.	Introduction to Photogrammetry, History of Aerial Photographs	2	2
2.	Aerial Cameras and Photographs, Geometry of Aerial Photograph, Types, acquisition, scanning, quality	4	3
3.	Planning Aerial Photography and elements of aerial photograph measurement and calculation of scale, coverage, area, and parallax	4	4
4.	Stereoscopic photographs and Parallax, parallax measurement	2	4
5.	Applications and limitation of Aerial Photography	3	
6.	CRP- Data acquisition, methods of acquisition, Post Processing, Trimming, Control Points	4	6
7.	Photogrammetric DEM generation, Terrain Analysis, Topographic Analysis, Viewshed Analysis	4	6
8.	Applications of CRP	2	
	Total	25	25

Reference Books:

1. Campbell, J.B. (2002). Introduction to remote sensing, 3rd ed., The Guilford Press. ISBN 1-57230-640-8.
2. Joseph, George (2007) Fundamentals of Remote Sensing Universities Press India
3. Lillesand, T.M.; R.W. Kiefer, and J.W. Chipman (2007). Remote sensing and image interpretation, 5th ed., Wiley. ISBN 0-471-15227-7.
4. Sabins Floyd F Remote Sensing: Principles and Interpretation New York: WH Freeman and Company
5. Professor Thomas Luhmann, Dr. Stuart Robson, Dr. Stephen Kyle and Professor Ian Harley (2006). Close Range Photogrammetry, Whittles Publishing, ISBN 1-870325-50-8
6. K. B. Atkinson, Close Range Photogrammetry and Machin Vision, Whittles Publishing

ELECTIVE
Course Title: BASICS OF GEO-STATISTICS
Course Code: GO 103
Marks: 100 (50 Theory+50 Practical)
Credits: 4

Course outline

The course is designed to develop the skills required to understand, organize, interpolate, analyze and interpret the geospatial information and to develop the firm foundation to apply it in various fields.

Details of course contents and allotted time

No.	Topic	Allotted time (hours)	
		L	P
1	Introduction, the concept of spatially related statistics, integrated approach, advantages and disadvantages	2	
2	Graphical and Tabular, Descriptive Techniques, Art and Science of Graphical Presentations	2	2
3	Data Collection and Sampling	4	5
4	Random Variables and Discrete and Probability Distributions	4	3
5	Continuous Probability Distributions and Introduction to Estimation	3	3
6	Introduction to Hypothesis Testing	2	2
7	Prediction and interpolation :spatial interpolation, spatial classification, Kriging types and application, prediction and validation, normalization	2	3
8	Inference About A Population and Inference About Comparing Two Populations	2	5
9	Modeling the variogram, experimental variogram and nested sampling	2	2
10	Applications of Geostatistics	2	
	Total	25	25

Reference Books:

1 Simon W. Houlding, (2000) Practical Geostatistics: Modeling and Spatial Analysis, Springer, Berlin
2 Richard Webstar and Margaret A. Oliver : Geostatistics for Environmental Scientists, Statistics in Practice (2nd ed) J. Wiley
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 Roy, P.S. (2006). Geoinformatics for Tropical Ecosystems Bishen Singh Mahendra Pal Singh, Dehradun

SEMESTER II

CORE

Course Title: ADVANCED REMOTE SENSING AND GIS

Course Code: GC 201

Marks: 100 (50 Theory+50 Practical)

Credits: 4

Course outline

The course will provide latest state of art in remote sensing and GIS technology. It will provide an opportunity to understand and work with latest developments remote sensing data base and GIS technology.

Details of course contents and allotted time

No.	Topic	Allotted time (hours)	
		L	P
1	Microwave Remote Sensing (SAR, SLAR, Radar, INSAR, SRTM and interpretations & applications)	4	2
2	Thermal Remote Sensing Concept, Thermal Image Interpretation	2	
3	Thermal Remote Sensing Applications, LST, SST		4
4	LiDAR: introduction and applications, IceSAT Data processing	2	2
5	Hyperspectral Remote Sensing: interpretation, processing and classification, Hyperion Data Processing	4	5
6	ISRO/ESO Missions	1	
7	Current Trends and advancement in GIS-smart city, cloud computing	2	
8	Decision support system- Multi-criteria and Multi-attribute	4	5
9	WebGIS, Internet Mapping, ArcGIS Server	3	3
10	GIS servers, Intermediate softwares and Distributed GIS systems	3	4
	Total	25	25

Reference Books:

1. Asrar Ghassem (2004) Theory and applications of optical remote sensing New York: John Wiley and Sons
2. Lillesand, T.M.; R.W. Kiefer, and J.W. Chipman (2003). Remote sensing and image interpretation, 5th ed., Wiley. ISBN 0-471-15227-7.
3. Mitchel, Tyler (2005): WebMapping Illustrated, O'Reilly, Sebastopol, 350 pages, ISBN 0-569-00865-1. This book discusses various Open Source WebMapping projects and provides hints and tricks as well as examples.
4. Ott, T. and Swiaczny, F. (2001) Time-integrative GIS. Management and analysis of spatio-temporal data, Berlin / Heidelberg / New York: Springer.
5. Peterson, Michael P. (ed.) (2003): Maps and the Internet, Elsevier, ISBN 0-08-044201-3.
6. Skolnik, Merrill I. (2001). Introduction to Radar Systems, McGraw-Hill (1st ed., 1962; 2nd ed., 1980; 3rd ed.), ISBN 0-07-066572-9.
7. 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.
8. Worboys, Michael, and Matt Duckham. (2004) GIS: a computing perspective. Boca Raton: CRC Press.

CORE
Course Title: SPATIAL ANALYSIS AND MODELING
Course Code: GC 202
Marks: 100 (50 Theory+50 Practical)
Credits: 4

Course outline

The course covers fundamental aspects of spatial data modeling specifically on the aspect of three-dimensional (3D) modeling, structuring, raster and vector analysis etc. It also looks into integration of non-spatial data and its application.

Details of course contents and allotted time

No.	Topic	Allotted time (hours)	
		L	P
1.	Introduction to analysis- Significance of spatial analysis, overview of tools for analysis	4	4
2.	Spatial analysis Vector Based- Overlay operations: point in polygon, line polygon, polygon in polygon, Single layer operations, features identification, extraction, classification and manipulation, Multilayer operations: union, Intersection, difference	3	4
3.	Spatial analysis raster based- Map algebra, grid based operations, local, focal, zonal and global functions, cost surface analysis, optimal path and proximity search	3	3
4.	Network Analysis- Concept of network analysis, Types of network analysis, Evaluation of network complexity using Alpha, Gama indices, Network data model	4	4
5.	Point pattern analysis -Method for evaluating point patterns, Clustered and random distribution	3	4
6.	Surface Analysis- Interpolation method, DEM, TIN, variance filter, slope and aspect, relief and hill shading	4	3
7.	Spatial modeling-Role of spatial model, explanative, predictive and normative models, Handling complex spatial query, case studies.	4	3
	Total	25	25

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.

ELECTIVE
Course Title: FUNDAMENTALS OF GPS AND APPLICATIONS
Course Code: GO 201
Marks: 100 (50 Theory+50 Practical)
Credits: 4

Course outline
This course will provide fundamental information on the global positioning system (GPS). Topics to be introduced include the history and development of navigation and GPS, an overview of the technological requirements for the system, a review on how the system works, and a discussion of various applications that can incorporate a GPS.

No.	Topic	Allotted time (hours)	
		L	P
1	Introduction to GPS, History of Positioning System GPS System Description,	2	
2	Satellite Constellation, GPS systems,	2	
3	GPS Signals, Bias, Error Sources	2	
4	Positioning modes, Differential positioning, Selective Ability	4	
5	Handheld GPS models, Features and Accuracy, Collecting points, Data import, Layout generation.	3	10
6	Introduction to DGPS and Total Station, GPS Performance	4	
7	DGPS Assembly, Static Survey, Kinematic Survey, GCPs, Applications	4	10
8	Post Processing and Enhancing Accuracy	1	2
9	GPS applications in Transportation, Navigation, Aviation, Mining, Forestry and Precision Agriculture	3	3
	Total	25	25

Reference Books:

1 Pratap Mishra, Per Enge. Global Positioning System: Signals, Measurements, and Performance (Revised Second Edition)
2 Bolstad, P. (2005) GIS Fundamentals: A first text on Geographic Information Systems, Second Edition. White Bear Lake, MN: Eider Press, 543 pp.
3 Campbell, J.B. (2002). Introduction to remote sensing, 3rd ed., The Guilford Press. ISBN 1-57230-640-8.
4 Chang, K. (2007) Introduction to Geographic Information System, 4th Edition. McGraw Hill.
5 Jan Van Sickle, GPS for Land Surveyors, Third Edition
6 Hojmann Wellenhodf, H Collins. Global Positioning System, Theory and Practice

ELECTIVE
Course Title: DIGITAL IMAGE PROCESSING
Course Code: GO 202
Marks: 100 (50 Theory+50 Practical)
Credits: 4

Course outline

This course will introduce fundamental technologies of digital image processing i.e. compression, information extraction and analysis. Students will also gain understanding of algorithm, analytical tools, and practical implementations of various digital image applications.

Details of course contents and allotted time

No.	Topic	Allotted time (hours)	
		L	P
1.	Introduction to Digital Image, Processing & Information Extraction Visual perception	2	
2.	Digital Data Formats Image sampling. Basic relationship between pixels – linear and non-linear operations, Image statistics	3	
3.	Development, scope and fundamental steps involved in Digital Image Processing, components of Image Processing	3	
4.	Image Rectification- Geometric Correction, rectification of photo and images	3	5
5.	Radiometric and Atmospheric Correction, Noise Reduction, Haze Reduction	2	5
6.	Image enhancement Techniques, Contrast Stretch, Spatial Filtering, Convolution, Fourier Transform, Noise removal	2	5
7.	Multispectral Image Processing: Colour Image processing, slicing, Image compression, dilation, Segmentation, Spectral rationing, density slicing and image fusion	5	5
8.	Image Classification,feature extraction, accuracy, assessment, change detection and integration with GIS	5	5
	Total	25	25

Reference Books:

1. Burger, Wilhelm; Mark J. Burge (2007). Digital Image Processing: An Algorithmic Approach Using Java. Springer. ISBN 1846283795.
2. Campbell, J.B. (2002). Introduction to remote sensing, 3rd ed., The Guilford Press. ISBN 1-57230-640-8.
3. Jensen John R (2007). Introductory Digital Image processing: Remote Sensing Perspective New Jersey: Prentice Hall
4. Joseph, George (2007). Fundamentals of Remote Sensing Universities Press India
5. Lillesand, T.M.; R.W. Kiefer, and J.W. Chipman (2007). Remote sensing and image interpretation, 5th ed., Wiley. ISBN 0-471-15227-7.
6. Romeny, Bart M. (2003). Front-End Vision and Multi-Scale Image Analysis. ISBN1-4020-1507-0.
7. Umbaugh, Scott E (2005). Computer Imaging: Digital Image Analysis and Processing. ISBN 0-84-932919-1.

ELECTIVE
Course Title: GIS PROGRAMING
Course Code: GO 203
Marks: 100 (50 Theory+50 Practical)
Credits: 4

Course outline

The course is designed to develop programming skills using a spatial data to automate the analysis process. This includes the programming workflow in spatial domain, visual basic for application and various scripting languages.

Details of course contents and allotted time

No.	Topic	Allotted time (hours)	
		L	P
1	Introduction to GIS programming, Customization	1	
2	Object oriented programming languages	2	
3	Introduction to ArcObjects, Map Objects, Object Libraries	4	
4	Object, Class, Interface, Inheritance	2	1
5	VBA for ArcGIS, Excel, MS Access	2	5
6	Working with Layers and Symbololy	4	2
7	VBA for GIS Analysis	4	5
8	Introduction to Python	1	5
9	Working with Geoprocessing scripts, Automation	2	5
10	GIS Modeling Automation	2	2
11	Applications	1	
	Total	25	25

Reference Books:

1 Kang-Tsung Chang, Programming ArcObjects with VBA: a task-oriented approach, 2, illustrated, CRC Press, 2007, ISBN 0849392837, 9780849392832
2 Robert Burke (2003) ,Getting to know ArcObjects, programming ArcGIS with VBA, Esri Pr,ISBN-10: 158948018X,ISBN-13: 9781589480186
3 Rick Leinecker, Vanessa L. Williams,Visual Studio 2008 All-In-One Desk ,For Dummies 2008, ISBN0 470191082, 9780470191088
4 Bruce Ralston,Developing GIS Solutions With MapObjects and Visual Basic, OnWord Press; 1 edition (October 31, 2001), ISBN-10: 0766854388 ,ISBN-13: 978-766854383
5 Swaroop CH, A Byte of Python
6 John Walkenbach, Excel VBA Programming or Dummies
7 John Zelle (2010), Python Programming
8 Michael Dawson (2010), Python Programming for the Absolute Beginner, 3rd Edition
9 Zhi Jun Lio, David Percy, Larry V Stanislawski. GIS Programming: Concepts and Applications

SEMESTER III

CORE

Course Title: GIS FOR ENVIRONMENTAL MANAGEMENT

Course Code: GC 301

Marks: 100 (50 Theory+50 Practical)

Credits: 4

Course Outline:

The course designed to understand the fundamentals of environment and the application of GIS in the monitoring, assessment and planning.

Details of course contents and allotted time

No.	Topic	Allotted time (hours)	
		L	P
1	Introduction to the Field of Natural resources management	2	
2	Biodiversity- Ecological systems, conservation protection and management of natural resources and environments.	4	4
5	Water resources- Watershed Planning and Management	2	4
6	Coastal Management :Introduction, Coastal and Marine environment, Coastal Processes, Satellite Oceanography, Chlorophyll detection, Hazard mapping, PFZ mapping	3	4
7	Soil- Land evaluation, physiographic soil mapping , soil type identification, soil moisture mapping	2	
8	Atmospheric and marine sciences	2	1
9	Geomorphology- Concept geomorphology land form analysis Arial and satellite data, interpretation, drainage basin, morphometry and solpe mapping,integrated, Approch for landslide hazard zonation mapping	4	4
10	Disaster management	2	4
11	Site evaluation and planning	2	4
12	Geology- lineament, fault, fracture, ground movement Geological mapping, Subsurface structure mapping, interpretation	2	
	Total	25	25

Reference Books:

1. Jensen, J.R. (2000). Remote sensing of the environment: an Earth resource perspective. Prentice Hall. ISBN 0-13-489733-1.
2. Kondratyev K Ya, Buznitov AA and Pokrovoky OM (2000). Global Change and Remote Sensing: John Wiley and Sons.
3. Roy, P.S. Geoinformatics for Tropical Ecosystems Bishen Singh Mahendra Pal Singh, Dehradun
4. P. Castro and M.E. Huber, Marine Biology,McGraw-Hill
5. Richard A Geyer ,Marine Environmental Pollution, , Elsevier Oceanography Series

CORE
Course Title: GIS FOR URBAN AND REGIONAL PLANNING
Course Code: GC 302
Marks: 100 (50 Theory+50 Practical)
Credits: 4

Course outline

The course is aimed to introduce the concept of urban and regional planning and applications of GIS in it. It consists of collection, processing, analysis and development of solution from urban and regional problems.

Details of course contents and allotted time

No.	Topic	Allotted time (hours) L	P
1	Basics concepts of geo-technologies and recent developments	2	
2	Data classification methods and data exploration , Sources of Urban data, Mapping database, Attribute data and relational database management systems	2	4
3	Methods of spatial data analysis, System analysis of the urban planning process, Planning and urban design	2	4
4	Data acquisition in an urban environment, Quality control and multisource updating of urban databases, Design methodologies for information system,	3	3
5	Facility management and urban infrastructure development	3	4
6	Groupware in urban planning, web sites for urban planning	2	1
7	Smart city- concept and planning	2	1
8	Real time information systems for urban environment and risk monitoring	3	1
9	Urban network – road, electricity, water, drainage and cable	3	3
10	Site selection for urban development	3	4
	Total	25	25

Reference Book

1. Ayse Pamuk (2008) Mapping Global Cities, GIS Methods In Urban Analysis. ESRI Press. New York
2. Frederick R Steiner and Kent Butter (ed) (2007) Planning and Urban Design Standards, John Wiley and Sons New Jersey, Canada.
3. Juliana Maantay and John Ziegler ( ) GIS for Urban Environment
4. Lidia Diappia (2004): Evolving Cities Geocomputation in Territorial Planning, Urban and Regional Planning and Developmental Series, Ashgate Publishing Company, USA
5. Robert Laurini (2001) Information System for Urban Planning: A Hyper Media Cooperative Approach(Geographical Information System Workshop)Taylor & Francis, London
6. Saroj K. Pal: Statistical Techniques-A basic approach to Geography, Tata Mc Graw-Hall Publishing Company Limited, New Delhi 110 002.

ELECTIVE
Course Title: GIS FOR BUSINESS AND SERVICE PLANNING
Course Code: GO 301
Marks: 100 (50 Theory+50 Practical)
Credits: 4

Course outline

The course is designed to develop the skills required to develop the data base for business and service planning. It also highlights the various applications of Geoinformatics in business decision making process.

Details of course contents and allotted time

No.	Topic	Allotted time (hours)	
		L	P
1	GIS for Business, Services, Planning and management, Developments and prospects	2	
2	Population data sources, availability, measurement and modeling	2	
3	Human resources management	2	
5	Market spatial analysis, service area analysis, spatial decision support systems, business geography	4	5
6	Business censuses and the modeling of customer targeting,	3	5
7	Manipulation and merging business application databases	2	
8	Customized versus proprietary solutions to business application	2	5
9	Databases consultancy applications of GIS, Enterprise resource planning	2	5
10	Internet platform for GIS Customer facing GIS : web , eCommerce and mobile solutions, Online mapping	2	3
11	Applications Supporting business decision, Enterprise applications, Customized spatial decision support systems	2	2
12	Ethical Legal and Security issues of spatial technology	2	
	Total	25	25

Reference Book

1. James B. Pick (2008) Geo-Business in the Digital Organization, John Wiley and Sons, New York
2. Ravi Kalakota et al.: Electronic Commerce: A Managers Guide Pearsons Education 2004

ELECTIVE
Course Title: GIS FOR PRECISION AGRICULTURE AND RURAL PLANNING
Course Code: GO 302
Marks: 100 (50 Theory+50 Practical)
Credits: 4

Course outline
The course designed to understand the fundamentals of Rural Development and the application of GIS in the monitoring, assessment and planning for precision agriculture.

Details of course contents and allotted time

No.	Topic	Allotted time (hours)	
		L	P
1	Rural Development and Planning	2	
2	Components of Rural Development	2	
3	Data Collection (Social, Economic, Cultural, Facilities), Methods, Formats, Pre-processing	4	6
4	GPS applications in Rural Planning	3	2
5	GPS applications in Precision Agriculture	3	2
6	Facility Management- Medical, Educational, Banking, Water Supply, Garbage Disposal	3	3
7	Participatory GIS for Rural Planning	4	2
8	Geoinformatics for precision farming, Crop monitoring and Assessment	2	5
9	Agro-market Analysis	2	5
	Total	25	25

Reference Books:

1. C.P.Lo and AKW Young- Concepts and Techniques in GIS.
2. Anji Reddy-RS and GIS.
3. Majid Hussain- Systematic Agriculture Geography.
4. The proceedings of the first National Conference on Agro- Informatics (NCAI), INSAIT, Dharwad.
5. Ancha Srinivasan : Handbook of Precision Agriculture- Principles and Applications, Food Products Press, NY
6. Terry Brase 2006, Precision Agriculture
7. Jasbir singh- Agricultural Geography, concept publishing co. Delhi.

ELECTIVE
Course Title: GIS FOR RESOURCE MANAGEMENT
Course Code: GO 303
Marks: 100 (50 Theory+50 Practical)
Credits: 4

Course outline

The course is aimed to introduce the concept of land management, Taxation and to learn how GIS can be applied in resource management sector.

Details of course contents and allotted time

No.	Topic	Allotted time (hours) L	Allotted time (hours) P
1	Land Resources- Concept of Land, Land units & Resources- Land evaluation. Measurement Units, Land Information Management (LIM)	5	
2	Cadastral Mapping, Land Registration Workflow, Parcel management, Land Parcel Data Model, data capture, data management and processing	5	8
3	Land Capability Mapping and Limitations, Public Access, Land classifications, Land use planning, Taxation	5	5
4	Water Resources- Watershed Management, Flood management and Damage Assessment, Zone Mapping, Groundwater recharge mapping, Water Quality, Watershed Erosion Modeling	5	8
5	Coastal Zone management, Fisheries, Coral Reefs, Navigation, data storage and access, analysis	5	4
	Total	15	25

Reference Books:

1 Peter Wyatt, GIS in Land and Property Management, Taylor & Francis, 2003
2 Van Dijk, A., Bos, M.G., GIS and Remote Sensing Techniques in Land and Water management, Springer, 2001, ISBN 978-94-010-6492-7
3 Ian Williamson, Stig Enemark, Jude Wallace, Abbas Rajabifard (2009). Land Administration for Sustainable Development, ESRI press, ISBN: 978158948041
4 Nancy von Meyer (2004), GIS and Land Records, ESRI press
5 Laura Lang (2004), Managing Natural Resources with GIS, ESRI Press, ISBN 1-879102-53-6
6 Roger Tomlinson (2007), Thinking about GIS, ESRI Press
7 Michael G. Wing, Pete Bettinger (2008),Geographic Information Systems: Applications in Natural Resource Management, Oxford University Press, USA
8 David R Maidment, Scott Morehouse (2002). Arc Hydro: GIS for Water Resources, ISBN-13: 978-1589480346
9 Gil Strassberg, Norman L. Jones, David R Maidment (2011), Arc Hydro Groundwater: GIS for Hydrogeology
10 John G. Lyon (2002). GIS for Water Resource and Watershed Management, Taylor & Francis
11 B.E. Vieux (2005). Distributed Hydrologic Modeling Using GIS, ISBN-13: 978-0792370024

Parvatibai Chowgule College of Arts & Science
(Autonomous)
Margao – Goa

MINUTES OF MEETING OF THE BOARD OF STUDIES IN GEOGRAPHY

HELD ON 21st FEBRUARY 2019 AT 9.00AM.

PART B: Resolutions/ recommendations of BoS that require consideration / approval of Academic Council:

1. The summary of changes incorporated in the syllabi is attached in **Annexure A.**
2. The syllabus of M.Sc.GIS Semester I & II as presented in the Table no. 1.1 and attached in **Annexure 1.1.**
3. The syllabus of P.G.D.G.I.S. Semester I & II as presented in the Table 1.2 and attached in **Annexure 1.2**

Table No. 1.1

Sr. No.	CORE COURSE	Nature of Course	PG Level at which offered
1	PG.MGIS.C1: Basics of GIS and GPS	Compulsory	MSc Part I Semester I
2	PG.MGIS.C2: Basic of RS and Photogrammery	Compulsory	MSc Part I Semester I
3	PG.MGIS.C3: Geostatistics	Compulsory	MSc Part I Semester I
4	PG.MGIS.E1: Digital Cartography	Elective	MSc Part I Semester I
5	PG.MGIS.E2: Principles of Computer and Programming	Elective	MSc Part I Semester I
6	PG.MGIS.C4: Spatial Analysis & Modeling	Compulsory	MSc Part I Semester II
7	PG.MGIS.C5: Advanced Remote Sensing and GIS	Compulsory	MSc Part I Semester II
8	PG.MGIS.E3: Digital Image Processing	Elective	MSc Part I Semester II
9	PG.MGIS.E4: Programming & Customization	Elective	MSc Part I Semester II
10	PG.MGIS.E5: Field Techniques Report writing	Elective	MSc Part I Semester II
11	PG.MGIS.C6: GIS for Environmental Management	Compulsory	MSc Part II Semester III
12	PG.MGIS.C7: GIS for Urban and Regional Planning	Compulsory	MSc Part II Semester III
13	PG.MGIS.E6: Web GIS and its Applications in GIS	Elective	MSc Part II Semester III
14	PG.MGIS.E7: Research and Methodology	Elective	MSc Part II Semester III
15	PG.MGIS.E8: GIS for Resource Management	Elective	MSc Part II Semester III
16	PG.MGIS.C8: Project Work	Compulsory	MSc Part II Semester IV

Table No. 1.2

Sr. No.	CORE COURSE	Nature of Course	PG Level at which offered
1	PG.DGIS.C: Basics of GIS and GPS	Compulsory	PGDGIS Semester I
2	PG.DGIS.C2: Geostatistics	Compulsory	PGDGIS Semester I
3	PG.DGIS.C3: Basic of RS and Photogrammetry	Compulsory	PGDGIS Semester I
4	PG.DGIS.E1: Digital Cartography	Elective	PGDGIS Semester I
5	PG.DGIS.E3: Principles of Computer and Programming	Elective	PGDGIS Semester I
6	PG.DGIS.C4: Spatial Analysis and modeling	Compulsory	PGDGIS Semester II
7	PG.DGIS.C5: Advanced Remote Sensing and GIS	Elective	PGDGIS Semester II
8	PG.DGIS.E4: Digital Image Processing	Elective	PGDGIS Semester II
9	PG.DGIS.E5: GIS for Environmental Management	Elective	PGDGIS Semester II
10	PG.DGIS.E6: Pilot Project, Field Work and Tour	Elective	PGDGIS Semester II

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
MARGAO – GOA 403601

POSTGRADUATE DEPARTMENT OF GEOGRAPHY

MASTER OF SCIENCE IN GEOINFORMATICS

Course Structure

Course Code	Course Title	Marks Theory and Practical 50+50	Credits (2+2=4)
SEMESTER I			
PG.MGIS.C1	Basics of GIS and GPS	100	4
PG.MGIS.C2	Basic of RS and Photogrammetry	100	4
PG.MGIS.C3	Geostatistics	100	4
PG.MGIS.E1	Digital Cartography	100	4
PG.MGIS.E2	Principles of Computer and Programming	100	4
SEMESTER II			
PG.MGIS.C4	Spatial Analysis & Modeling	100	4
PG.MGIS.C5	Advanced Remote Sensing and GIS	100	4
PG.MGIS.E3	Digital Image Processing	100	4
PG.MGIS.E4	Programming & Customization	100	4
PG.MGIS.E5	Field techniques Report writing	100	4
SEMESTER III			
PG.MGIS.C6	GIS for Environmental Management	100	4
PG.MGIS.C7	GIS for Urban and Regional Planning	100	4
PG.MGIS.E6	WEB GIS and its Applications in GIS	100	4
PG.MGIS.E7	Research and methodology	100	4
PG.MGIS.E8	GIS for Resource Management	100	4
SEMESTER IV			
PG.MGIS.C8	Project Work	500	20

Note:
1) Duration – 1 lecture of One hour each and One practical/ Laboratory session is equivalent to one contact hour in class room.
2) Each paper will have four instructional contact hours consisting three theory and one practical
3) Total Marks: 2000 (entire course is divided into 15 papers consisting 100 marks each for first 3 semester and a 500 marks project work in 4th semester. Each semester will consist of 20 credits (1 credit = 25 marks) 2 credits for theory and 2credits for practical.
4) Project is the part of paper PG.GIS.C8. Fourth semester is fully devoted to project work.

- C- Core Subject Compulsory

- E- Elective Subject Optional

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M.Sc in Geoinformatics

SEMESTER I
CORE
Course Title: Basics of GIS and GPS
Course Code: PG.MGIS.C1
Credits: 04
Marks:100

Course objective

The course focuses on the fundamentals Geographical Information System, and Global Positioning System by introducing the concept, techniques, hardware and software used in collection, processing and analysis of geospatial data.

Course Outcome

Students will demonstrate proficiency and conceptual understanding in using software and automated techniques to carry out thematic maps and analysis through a series of laboratory exercises and creation of reports

Details of course contents and allotted credits

No	Topic	L	P
I	Introduction to GIS • History and development. • Components and Applications trends of GIS. • Data models: vector and raster • Data type, structure, Spatial and attribute, point, line, polygon- arc, nodes, vertices, and topology. Attribute data. • Data processing systems, input and output devices, editing and attributing and linking	1	1
II	Spatial data inputs • Digitization • Error identification • Types and sources of error • Correction editing and topology building	1	1
III	Introduction to GPS • History of Positioning System GPS System Description, Error Sources & Receiver • Introduction to DGPS and Total Station, GPS Performance and Policy Applications • Introduction to open source GIS		

Reference Books:

1. Bolstad, P. (2005) GIS Fundamentals: A first text on Geographic Information Systems, Second Edition. White Bear Lake, MN: Eider Press, 543 pp.
2. Burrough, P.A. and McDonnell, R.A. (1998) Principles of geographical information systems. Oxford University Press, Oxford, 327 pp.
3. Campbell, J.B. (2002). Introduction to remote sensing, 3rd ed., The Guilford Press. ISBN 1-57230-640-8.
4. Chang, K. (2007) Introduction to Geographic Information System, 4th Edition. McGraw Hill.
5. Curran Paul J Principles of Remote Sensing UK: ELBS,
6. Elangovan,K (2006) GIS: Fundamentals, Applications and Implementations. New India Publishing Agency, New Delhi"208 pp.

7. Heywood, I., Cornelius, S., and Carver, S. (2006) An Introduction to Geographical Information Systems. Prentice Hall. 3rd edition.
8. Jensen, J.R. (2000). *Remote sensing of the environment: an Earth resource perspective*. Prentice Hall. ISBN 0-13-489733-1.
9. Joseph, George Fundamentals of Remote Sensing Universities Press India
10. Lillesand, T.M.; R.W. Kiefer, and J.W. Chipman (2003). Remote sensing and image interpretation, 5th ed., Wiley. ISBN 0-471-15227-7.
11. Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W. (2005) Geographic Information Systems and Science. Chichester: Wiley. 2nd edition.
12. Maguire, D.J., Goodchild M.F., Rhind D.W. (1997) Geographic Information Systems: principles, and applications. Longman Scientific and Technical, Harlow.
13. Muralikrishna V Geographical Information Systems and Remote Sensing Applications Allied Publsihers Private Limited
14. Nag P and Kudrat M Digital Remote sensing New Delhi: Concept Publishing
15. Richards, J.A.; and X. Jia (2006). Remote sensing digital image analysis: an introduction, 4th ed., Springer. ISBN 3-540-25128-6.
16. Sabins Floyd F Remote Sensing: Principles and Interpretation New York: WH Freeman and Company
17. 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.
18. Wise, S. (2002) GIS Basics. London: Taylor & Francis.

CORE
Course Title: Basic of Remote Sensing and Photogrammetry
Course Code: PG.MGIS.C2
Credits: 04
Marks:100

Course objective

Give foundational knowledge about remote sensing and its types and different sensors used for remote sensing which will focus on comprehension of the physical, computational, and perceptual basis for remote sensing. Gain familiarity with a variety of physical, biological, and human geographic applications of remote sensing. Gain basic experience in the hands-on application of remote sensing data through visual interpretation and digital image processing exercises.

Course outcome

Students will be able to understand the concept of remote sensing and EMR apart from this basic level of fundamental physical principles of remote sensing, including the electromagnetic spectrum; the emission, scattering, reflection, and absorption of electromagnetic (EM) radiation; how EM radiation interactions vary across a limited number of substances, geometries, and temperatures; and geometric properties of photographs and imagery.

Details of course contents and allotted credits

No	Topic	L	P
I	Fundamental of Remote Sensing • Introduction, History, development, • stages of remote sensing, EMR & EMR spectrum, EMR Quantities, Energy sources and radiation principles, • Theories of EMR, Concept of Energy interactions in the atmosphere, energy Black body, atmospheric windows • types of remote sensing interactions with the earth surface features, Spectral reflectance of vegetation, Soil and water,	1	1
II	Platform, Orbit and sensor • Platform: Ground based, air-borne, space-borne, • Orbit: Geostationary satellite and polar orbiting satellite, Sensor: • Types of sensor and cameras, processes of sensor & its characteristics, Whiskbroom and Push broom cameras		
III	Techniques of interpretation • Aerial photo interpretation, satellite image interpretation, • Recognition elements: Tone, Color, Texture, Pattern, Shape, Size and associated features	1	1
IV	Aerial photography • Types, Geometry, Scale, Height and Process of Aerial Photograph, • basic requirement of Aerial Photograph, planning & execution of photographic flight, aerial cameras, relief displacement, • stereo vision, stereo model & stereoscope, parallax & parallax measurement		

References books

1. Campbell, J.B. (2002). *Introduction to remote sensing*, 3rd ed., The Guilford Press. ISBN 1-57230-640-8.
2. Curran Paul, J. (1984) Principles of Remote Sensing UK: ELBS.
3. Joseph, George (2007) Fundamentals of Remote Sensing Universities Press India
4. Lillesand, T.M.; R.W. Kiefer, and J.W. Chipman (2007). *Remote sensing and image interpretation*, 5th ed., Wiley. ISBN 0-471-15227-7.
5. Moffitt, F. H. (1980). Photogrammetry. 3rd Ed, Harper & Row, NY.
6. Sabins Floyd F Remote Sensing: Principles and Interpretation New York: WH Freeman and Company
7. Wolf, P. R. (1983). Elements of Photgrammetry. McGraw-Hill, NY.
8. Zorn, H. C. (1980). Introductory Course in Photogrammetry. 6th Ed. ITC, Netherlands.

CORE
Course Title: Geostatistics
Course Code: PG.MGIS.C3
Credits: 04
Marks:100

Course objective
The course is designed to process geospatial data and use of statistics in the field of GIS. The course focuses on the development of the skills using statistical techniques in understanding, organizing, interpolation, analyzing and interpretation of geostatistical data and to develop the firm foundation to apply it in various fields.

Course Outcome
After completion of the course students will understand various types of datasets and applying different statistical techniques to different data sets. This will systematically access, analyze and evaluate information and ideas from multiple sources in order to identify underlying assumptions, and formulate conclusions. The course will enhance skills like solving quantitative problems and statistical queries.

Details of course contents and allotted credits

No	Topic	L	P
I	Introduction to Statistics • Statistical and Graphical foundation, data classification • Integrated approach, advantages and disadvantages. • Data type and structure. • 3D grid data geometry and association	1	1
II	Basic statistics • Measurement and summary, distribution, covariance and correlation, transformations, data analysis, display and sampling. • Prediction and interpolation : spatial interpolation, • Spectral analysis: linear sequences, Gilgai transect, power spectra and Caragabal transact(bandwidth and confidence interval)	1	1
III	Geostatistical uncertainty, probability and reliability • Data management for Geostatistics • Applications of Geostatistics		

Reference Books:

1 Simon W. Houlding, (2000) Practical Geostatistics: Modeling and Spatial Analysis, Springer, Berlin
2 Ricardo A. Olea (1999) Geostatistics for Engineers and Earth Scientist, Kluwer Academic Publishers, Boston
3 Richard Webstar and Margaret A. Oliver : Geostatistics for Environmental Scientists, Statistics in Practice (2^{nd} ed) J. Wiley
4 Ott, T. and Swiaczny, F. (2001). Time-integrative GIS. Management and analysis of spatio-temporal data. Berlin / Heidelberg / New York: Springer.
5 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.
6 Roy, P.S. (2006). Geoinformatics for Tropical Ecosystems Bishen Singh Mahendra Pal Singh, Dehradun

ELECTIVE
Course Title: Digital Cartography
Course Code: PG.MGIS.E1
Credits: 04
Marks:100

Course objective

The course gives emphasis on the art, science, and technologies of cartography and Photogrammetry. It develops the user's ability to understand how maps are created traditionally and digitally. Representation and communicate spatial phenomena and their relationships through photogrammetric perspective which emphasis on skills like making of map, map reading signs and symbols etc..

Course outcome

Students will understand different types of projections and datum used in various locations. Proficiency and conceptual understanding in using Manual and computer techniques to carry out thematic maps and special purpose maps. Remote sensing, image processing and analysis through a series of laboratory exercises and reports

Details of course contents and allotted credits

No	Topic	L	P
I	Introduction to Cartography • Basics of Map • Fundamentals of direction, scale, types, sources • Elementary geodesy- Datum and Projection • Projection coordinates • WGS 84	1	1
II	Thematic Cartography Characteristics of geographical phenomena • Principles of colour perception • Colour scheme for Univariate choropleth and Isorithmic maps, proportional symbol mapping • Interpolation methods for smooth continuous phenomena symbolizing smooth continuous phenomena. Dot and asymmetric mapping		
III	Geographic representation • Map and mapping, map design, symbolization, conventional signs • map layout, map referencing and indexing, scale of maps and map contents • Field work techniques, socio – economic survey and attribute data.	1	1

Reference Books:

1. ESRI. 2004. ESRI Cartography: Capabilities and Trends. Redlands, CA. White Paper
2. Imus, D. and Dunlavey, P. 2002. Back to the Drawing Board: Cartography vs the Digital Workflow. MT. Hood, Oregon.
3. Kraak, Menno-Jan and Allan Brown (2001): Web Cartography – Developments and prospects, Taylor & Francis, New York, ISBN 0-7484-0869-X.
4. MacEachren, A.M. (1994). Some Truth with Maps: A Primer on Symbolization & Design. University Park: The Pennsylvania State University. ISBN.
5. Monmonier, Mark (1991). How to Lie with Maps. Chicago: University of Chicago Press. ISBN 0-226-53421-9.

6. Monmonier, Mark (1993). Mapping It Out. Chicago: University of Chicago Press. ISBN.
7. Pickles, John (2003). A History of Spaces: Cartographic Reason, Mapping, and the Geo-Coded World. Taylor & Francis. ISBN 0-415-14497-3
8. Sircar, D.C.C. (January 1990). Studies in the Geography of Ancient and Medieval India. Motilal Banarsidass Publishers. ISBN 8120806905.
9. Slocum, T. (2003). Thematic Cartography and Geographic Visualization. Upper Saddle River, New Jersey: Prentice Hall. ISBN 0-130-35123-7. Wilford, John Noble (2000). The Mapmakers. Vintage Books. ISBN 0-375-70850-2.
10. Terry A. Slocum (1999): Thematic Cartography and Visualization, Prentice Hall, New Jersey
9. MJ Kraak, F Ormeling - 2003 - Cartography: visualization of geospatial data Addison-Wesley Longman Ltd
10. Burnside, C. D. (1985). Mapping from Aerial Photography. 2nd Ed, Collins.
11. Campbell, J.B. (2002). *Introduction to remote sensing*, 3rd ed., The Guilford Press. ISBN 1-57230-640-8.
12. Curran Paul, J. (1984) Principles of Remote Sensing UK: ELBS.
13. Joseph, George (2007) Fundamentals of Remote Sensing Universities Press India
14. Lillesand, T.M.; R.W. Kiefer, and J.W. Chipman (2007). *Remote sensing and image interpretation*, 5th ed., Wiley. ISBN 0-471-15227-7.
15. Moffitt, F. H. (1980). Photogrammetry. 3rd Ed, Harper & Row, NY.
16. Sabins Floyd F Remote Sensing: Principles and Interpretation New York: WH Freeman and Company
17. Wolf, P. R. (1983). Elements of Photgrammetry. McGraw-Hill, NY.
18. Zorn, H. C. (1980). Introductory Course in Photogrammetry. 6th Ed. ITC, Netherlands.

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ELECTIVE
Course Title: Principles of Computer and Programming
Course Code: PG.MGIS.E2
Credits: 04
Marks: 100

Course objective

The course will explore the Application of computer in the field of GIS, DBMS and programming for GIS customization. The main focus is on introduction to computers-DBMS, basics of programming languages.

Course outcome

Students will demonstrate proficiency and conceptual understanding in data creation and storage, languages or manuscripts techniques to carry out geographical data for developing and designing application and use of Programming in GIS.

Details of course contents and allotted time

<table>
<tr><td>No</td><td>Topic</td><td>L</td><td>P</td></tr>
<tr><td>I</td><td>Introduction to Computers
• Hardware and Software, System requirement, configuration and operating systems and Computer Applications
• Algorithms and Programming in Computers
• MS ACCESS and applications</td><td>1</td><td>1</td></tr>
<tr><td>II</td><td>Introduction to simple programming in C
• Developing programming techniques and solutions for spatial algorithms and problem-solving using VB
• Getting started with HTML, flash</td><td rowspan="2">1</td><td rowspan="2">1</td></tr>
<tr><td>III</td><td>Introduction to Python</td></tr>
</table>

Reference Books:

1. Benjamin C. Pierce (2002). Types and Programming Languages, The MIT Press.
2. Bruce J. MacLennan (1999). Principles of Programming Languages: Design, Evaluation, and Implementation, Oxford University Press.
3. Daniel P. Friedman and Mitchell Wand (2001). Christopher Thomas Haynes: Essentials of Programming Languages, The MIT Press.
4. David Gelernter and Suresh Jagannathan (1990). Programming Linguistics, The MIT Press.
5. Goldschlager, L. (1998). A Lister Computer Science - a modern Introduction Prentice Hall, 1988.
6. John C. Mitchell (2002). Concepts in Programming Languages, Cambridge University Press.
7. Michael L. Scott (2005). Programming Language Pragmatics, Morgan Kaufmann Publishers.
8. Ravi Sethi (1996). Programming Languages: Concepts and Constructs, 2nd ed., Addison-Wesley.
9. James S. McKeown (2010), Programming in Visual Basic 2010: The Very Beginner's Guide
10. Richard Mansfield (2003), Visual Basic .NET All in One Desk Reference for Dummies

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SEMESTER II
CORE
Course Title: Spatial Analysis and Modeling
Course Code: PG.MGIS.C4
Credits: 04
Marks:100

Course objective
The course focuses on fundamental aspects of spatial data modeling specifically on the aspect of two dimensional and three-dimensional (3D) modeling, structuring of raster and vector analysis and its types. It also looks into integration of non-spatial data and its application.

Course outcome
Student will able to apply spatial tool and techniques in spatial datasets for carry out Surface and 3d analysis. Students will demonstrate proficiency and conceptual understanding spatial model making process.

Details of course contents and allotted credits

<table>
<tr><td>No</td><td>Topic</td><td>L</td><td>P</td></tr>
<tr><td>I</td><td>Introduction to analysis.
• Significance of spatial analysis, overview of tools for analysis
Spatial analysis of Vector Base
• Overlay operations: point in polygon, line polygon, polygon in polygon, Single layer operations, features identification, extraction, classification and manipulation, Multilayer operations: union, Intersection, difference
Spatial analysis of raster base
• Map algebra, grid based operations, local, focal, zonal and global functions, cost surface analysis, optimal path and proximity search.</td><td>1</td><td>1</td></tr>
<tr><td>II</td><td>Analysis
• Network Analysis- Concept of network analysis, Types of network analysis, Evaluation of network complexity using Alpha, Gama indices, Network data model
• Point pattern- Method for evaluating point patterns, Clustered and random distribution
• Surface analysis- Interpolation method, DEM, TIN, variance filter, slope and aspect, relief and hill shading</td><td rowspan="2">1</td><td rowspan="2">1</td></tr>
<tr><td>III</td><td>Spatial modeling
• Role of spatial model, explanative, predictive and normative models, handling complex spatial query, case studies.</td></tr>
</table>

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 Multi-criteria Decision Analysis. New York: John Wiley and Sons
7. GIS and Multi-criteria Analysis by Makrewski Jacek, USA, 1999.
8. Principals of GIS by Burrough P.A. MacDonneli R.A. published by Oxford University Press, 2000.
9. Geographical Information Science, vol. I by Roy P.S. Published by IIRS, 2000.
10. Fundamentals of Geographic Information Systems, 2nd Edition by Demers M.N. published by John Wiley & Sons 2000

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CORE
Course Title: Advanced Remote Sensing and GIS
Course Code: PG.MGIS.C5
Credits: 04
Marks:100

Course objective

The course will provide latest state of art in remote sensing and GIS technology. It will provide an opportunity to understand and work with latest developments remote sensing data base and GIS technology.

Course outcome

Students will be able to apply mathematical relationships (at a pre-calculus level) describing fundamental physical, geometric, and computational principles relevant to remote sensing and GIS. They will create Remote sensing application

Details of course contents and allotted credits

No	Topic	L	P
I	Advanced Remote Sensing • Microwave Remote Sensing • Thermal Remote Sensing • Hyper spectral Remote Sensing • LiDAR & Drone	1	1
II	Advancement in GIS • Participatory GIS and Mobile GIS • WebGIS (ArcIMS, MapServer, Geomedia, MapGuide • GIS servers, Intermediate software and Distributed GIS systems	1	1
III	Multi-criteria decision making analysis – • Ranking • Rating • Pair wise comparison Fuzzy logic		

Reference Books:

1. Asrar Ghassem (2004) Theory and applications of optical remote sensing NewYork: John Wiley
2. Berry, J.K. (1993) Beyond Mapping: Concepts, Algorithms and Issues in GIS. Fort Collins, CO: GIS World Books.
3. Lillesand, T.M.; R.W. Kiefer, and J.W. Chipman (2003). Remote sensing and image interpretation, 5th ed., Wiley. ISBN 0-471-15227-7.
4. Malczewski, J. (*1999).* GIS and Multicriteria Decision Analysis. New York: John Wiley and Sons
5. Mitchel, Tyler (2005): WebMapping Illustrated, O'Reilly, Sebastopol, 350 pages, ISBN 0-569-00865-1. This book discusses various Open Source WebMapping projects and provides hints and tricks as well as examples.
6. Ott, T. and Swiaczny, F. (2001) Time-integrative GIS. Management and analysis of spatio-temporal data, Berlin / Heidelberg / New York: Springer.
7. Peterson, Michael P. (ed.) (2003): Maps and the Internet, Elsevier, ISBN 0-08-044201-3.
8. Skolnik, Merrill I. (2001). Introduction to Radar Systems, McGraw-Hill (1st ed., 1962; 2nd ed., 1980; 3rd ed.), ISBN 0-07-066572-9.
9. 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.
10. Worboys, Michael, & Matt Duckham (2004) GIS: a computing perspective. Boca Raton: CRC Press.

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ELECTIVE
Course Title: Digital Image Processing
Course Code: PG.MGIS.E3
Credits: 04
Marks:100

Course objective

This course will introduce fundamental technologies of digital image processing i.e. compression, information extraction and analysis. Students will also gain understanding of algorithm, analytical tools, and practical implementations of various digital image applications.

Course outcome

Students will demonstrate proficiency and conceptual understanding in using software or manual techniques which will prove how digital technology has come over traditional technology to carry out remote sensing image processing and analysis through a series of laboratory exercises and reports

Details of course contents and allotted credits

No	Topic	L	P
I	Introduction to Digital Image Processing • Visual perception, Image sensing and acquisition, • Digital Data Formats Image sampling and Quantization • Basic relationship between pixels. • Development, scope and fundamental steps involved in Digital Image Processing, components of Image Processing	1	1
II	Image Rectification • Radiometric and Atmospheric Correction • Geometric Correction, Ortho-rectification, calibration and rectification of photo and images, • Image enhancement in spatial domain and frequency domain, Filtering, Fourier Transform, Noise removal	1	1
III	Multispectral Image Processing • Colour Image processing, slicing, Image compression, dilation, Segmentation, Spectral rationing, density slicing and image fusion • Object recognition, classification, object recognition, feature extraction, accuracy, assessment, change detection Accuracy Assessment and integration with GIS		

Reference Books:

1. Burger, Wilhelm; Mark J. Burge (2007). Digital Image Processing: An Algorithmic Approach Using Java. Springer. ISBN 1846283795.
2. Campbell, J.B. (2002). Introduction to remote sensing, 3rd ed., The Guilford Press. ISBN 1-57230-640-8.
3. Damen MCJ, Sicco Smith G and Kerstappen(Ed) (). Remote Sensing for Resources Development and Environmental Management 3rd.volume Set Netherlands: Balkema
4. Gonzalez, Rafael C.; Richard E. Woods (1992). Digital Image Processing. ISBN 0-201-50803-6.
5. Jensen John R (2007). Introductory Digital Image processing: Remote Sensing Perspective New Jersey: Prentice Hall
6. Joseph, George (2007). Fundamentals of Remote Sensing Universities Press India
7. Lillesand, T.M.; R.W. Kiefer, and J.W. Chipman (2007). Remote sensing and image interpretation, 5th ed., Wiley. ISBN 0-471-15227-7.
8. Pratt, William K. (1978). Digital Image Processing. ISBN 0-471-01888-0.
9. Romeny, Bart M. (2003). Front-End Vision and Multi-Scale Image Analysis. ISBN1-4020-1507-0.
10. Umbaugh, Scott E (2005). Computer Imaging: Digital Image Analysis and Processing. ISBN 0-84-932919-1

ELECTIVE
Course Title: Programming and Customization
Course Code: PG.MGIS.E4
Credits: 04
Marks:100

Course objective
The course is designed to develop programming skills using a spatial data to automate the analysis process. This includes the programming workflow in spatial domain, python for application and various scripting languages.

Course outcome
Student will develop new tools and software also customizes open source software. They design and built web base platform for geospatial database.

Details of course contents and allotted credits

No	Topic	L	P
	Using raster data Generating cell size obtaining with width and height of raster Counting raster band and swapping raster bands querying ,creating ,raster based analysis	1	1
I.	Dynamic maps Map canvas, map units, iterating over layers, graduated layer symbol renderer ,map, book mark SVG for layer symbol, map layer transparency ,mouse coordinate tracking tool, composing static map analysis data using algorithm		

Reference Books:

1 Kang-Tsung Chang, Programming ArcObjects with VBA: a task-oriented approach, 2, illustrated, CRC Press, 2007, ISBN 0849392837, 9780849392832
2 Robert Burke (2003) ,Getting to know ArcObjects, programming ArcGIS with VBA, Esri Pr,ISBN-10: 158948018X,ISBN-13: 9781589480186
3 Rick Leinecker, Vanessa L. Williams,Visual Studio 2008 All-In-One Desk ,For Dummies 2008, ISBN0 470191082, 9780470191088
4 Bruce Ralston,Developing GIS Solutions With MapObjects and Visual Basic, OnWord Press; 1 edition (October 31, 2001), ISBN-10: 0766854388 ,ISBN-13: 978-766854383
5 Swaroop CH, A Byte of Python
6 John Walkenbach, Excel VBA Programming or Dummies
7 John Zelle (2010), Python Programming
8 Michael Dawson (2010), Python Programming for the Absolute Beginner, 3rd Edition
9 Zhi Jun Lio, David Percy, Larry V Stanislawski. GIS Programming: Concepts and Applications

ELECTIVE
Course Title: Field Techniques and Report Writing
Course Code: PG.MGIS.E5
Credits: 04
Marks:100

Course objective
The course is designed to develop field and Survey techniques using different survey instruments and Interpretation of toposheets and maps. This includes field techniques and importance of field survey in GIS.

Course outcome
Students will describe a survey method and different instruments and it's assemble and summarize relevant survey for relevant work which will skill development in using different instruments. Report writing and Interpretation of Maps will focus on writing skills.

Details of course contents and allotted time

No.	Topic	L	P
I	Introduction to Field Survey • Importance of field instrument survey - scope and purpose, principles and application of selected survey instruments.	1	1
II	Chain and Plane Table Survey • Chain survey: use of tapes-open traverse, triangulation survey; Plane table; plan preparation, • resection -one point and two point problem; three • Point problem; tracing paper method.		
III	Dumpy level, Auto level and Theodolite Survey • Dumpy level: traverse survey, contour plan preparation. Theodolite - horizontal, land vertical (height) measures, accessible and inaccessible method.	1	1
IV	Village Survey and Report writing • Fundamentals of Village survey, prerequisites of village survey, preparation of questionnaires, data entry, basic analysis in Microsoft excel • Interpretation of surveyed maps and Report writing.		

References:
1. Clendinning , J. Principles and use of Surveying Instruments. 2nd edition, Blockie. A 1958.
2. Clendinning ,J Principles of surveying 2nd edition 1960.
3. Hotine, Major M. The re-triangulation of Great Britain. Empire survey review 1935.
4. Mitra,R.P. and Ramesh A : Fundamentals of Cartography Revised Edition, Concept Publication, New Delhi.
5. Monkhouse - Maps and diagrams Methuen 1971.
6. Negi, Balbir Singh. Practical Geography Third revised Ed. Kedar Nath and Ram Nath, Meerut &Delhi, 1994-95.
7. Sandover,J.A. Plane Surveying. Arnold 1961.
8. Singh & Karanjta - Map work and Practical Geography Central Book Dept Allahabad 1972.
9. Singh, R.L.and Dutt, P.K. Elements of Practical Geography, Students Friends, Allahabad.1968.

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
MARGAO – GOA 403601

POSTGRADUATE DEPARTMENT OF GEOGRAPHY

MASTER OF SCIENCE IN GEOINFORMATICS

Course Structure

Course Code	Course Title	Marks Theory and Practical 50+50	Credits (2+2=4)
SEMESTER I			
PG.MGIS.C1	Basics of GIS and GPS	100	4
PG.MGIS.C2	Basic of RS and Photogrammetry	100	4
PG.MGIS.C3	Geostatistics	100	4
PG.MGIS.E1	Digital Cartography	100	4
PG.MGIS.E2	Principles of Computer and Programming	100	4
SEMESTER II			
PG.MGIS.C4	Spatial Analysis & Modeling	100	4
PG.MGIS.C5	Advanced Remote Sensing and GIS	100	4
PG.MGIS.E3	Digital Image Processing	100	4
PG.MGIS.E4	Programming & Customization	100	4
PG.MGIS.E5	Field techniques and Report writing	100	4
SEMESTER III			
PG.MGIS.C6	Application of GIS in Disaster management	100	4
PG.MGIS.C7	Applications of GIS in Urban and Regional Planning	100	4
PG.MGIS.E6	WEB GIS and development of WEB Application	100	4
PG.MGIS.E7	Research methodology	100	4
PG.MGIS.E8	Applications of GIS in Resource Management	100	4
PG.MGIS.E9	Applications of GIS in Agriculture and Soil	100	4
SEMESTER IV			
PG.MGIS.C8	Project Work	500	20

Note:
1) Each course will have six instructional contact hours consisting of two hours of theory and four hours of practical
3) Total Marks: 2000 (entire programme is divided into 15 courses consisting 100 marks each for first 3 semester and a 500 marks project work in 4th semester. Each semester will consist of 20 credits (1 credit = 25 marks) 2 credits for theory and 2 credits for practical.
4) Fourth semester is fully devoted to project work (PG.MGIS.C8)

- C- Core Subject Compulsory
- E- Elective Subject Optional

Semester -III

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE

M.Sc in Geoinformatics

SEMESTER III
CORE
Course Title: APPLICATION OF GIS IN FOR DISASTER MANAGEMENT
Course Code: PG.MGIS.C6
Credits: 04
Marks: 100

Prerequisite courses: NIL

Course objectives:

- Provide students with the state-of-art technical skills to build disaster and hazard applications.
- This course helpful in mitigation strategies and preparedness plans. Real time geographic data can improve the allocation of resources for response. A GIS technology is much useful in modeling of disaster risks and human adaptations to hazards.

Course outcome:

After completion of this course, students will be able to:

1. Be equipped with practical skills and the ability to apply their theoretical concept to design, perform experiments, analyze and interpret data and thus develop proficiency in lab management.
2. It is provides decision support system in disaster management and making model reduce risk and Hazard. Students will handle different disaster project like Flood, landslideing, fire and drought.
3. To be able use these skills to identify and analyzed Disaster and preparing them for a successful career in geospatial industry and research institute.
4. Acquire of fundamental and advanced knowledge of the different aspect in Geoinformatics with the means ability to specialize in a specific field.

Details of course contents and allotted time

No.	**Topic**	**Credits**	
		L 24	**P 48**
1	• Disaster management , types of hazard and disaster, risk and vulnerability assessment	1	1
2	• Disaster management measures –Structural and Non-structuraldisaster,prevention,mitigation,preparedness,response,recovery and rehabilitation		
3	• Disaster zonation of world –climatic, geological &Geomorphologic hazard	1	1
4	• Strategies of risk reduction –disaster preparedness, support system, organization ,awareness programs,diaster policy and planning in India • Case study –landslide,flood,cyclone and drought		

Reference Books

Mandatory

1. Alexander, D. (1993). Natural disasters. UCL Press Ltd., University College London. 632.

Supplementary

1. Adler, R.F. and A.J. Negri, 1988. A satellite infrared technique to estimate tropical convective and stratiform rainfall. J. Appl. Meteorol., 27: 30-51.
2. Anagnostou, E.N., A.J. Negri and R.F. Adler, 1999. A satellite infrared technique for diurnal rainfall variability studies. J. Geophy. Res., 104: 31477-31488.
3. Barrett, E.C., (1996) The storm project: using remote sensing for improved monitoring and prediction of heavy rainfall and related events. Remote Sensing Reviews, vol 14, 282 pp.
4. Van Westen, C.J. (1993) Application of Geographic Information Systems to Landslide Hazard Zonation. ITC-Publication Number 15, ITC, Enschede, The Netherlands, 245 pp.
5. Pelling, M. (2003). The Vulnerability of Cities: Natural Disaster and Social Resilience, Earthscan, London.
6. Pike, R.J., (2000). Geomorphometry - diversity in quantitative surface analysis. Progress in Physical Geography 24 (1), 1-20.

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1) https://www.nrsc.gov.in/
2) https://www.iirs.gov.in/
3) http://www.undp.org/popin/wdtrends/wdtrends.htm
4) https://www.isprs.org/proceedings/xxxiii/congress/part7/1609_XXXIII-part7.pdf
5) http://www.tric.u-tokai.ac.jp/ISPRScom8/TC8/TC8_CD/headline/JAXA_Special_Session%20-%206/JTS64_20100608144600.pdf
6) https://www.semanticscholar.org/paper/Role-of-Remote-Sensing-in-Disaster-Management-Nirupama-Simonovic/da84562b2057ca5866d933d47ee8815a06f0229c

CORE
Course Title: APPLICATION OF GIS IN URBAN AND REGIONAL PLANNING
Course Code: PG.MGIS.C7
Credits: 04
Marks: 100

Prerequisite courses: NIL

Course objective:

- The course is aimed to introduce the concept of urban and regional planning and applications of GIS in it. It consists of collection, processing, analysis and development of solution from urban and regional problems.

Course outcome:

After completion of this course, students will be able to:

1. Students will describe a remote sensing data and assemble and summarize relevant literature in a written assignment, case study and development of models in various urban environmental activities.
2. Develop urban application in Geospatial technology
3. To be able use these skills to identify and analyzed Urban and Regional problem and preparing them for a successful career in geospatial industry and research institute.
4. Be able to demonstrate proficiency in quantitative reasoning and analytical skills.

Details of course contents and allotted time

No.	Topic	Credits	
		L 24	**P 48**
1	• Define urban, Urban area in India, purpose of urban planning, classification of urban settlement, geospatial application urban planning and innovative technology urban planning, National urban information system • Urban land use inventory, urban sprawl growth and trends, network analysis, urban environment analysis and suitability analysis	1	1
2	• Data visualization and mapping design, Visualization for displaying and accessing urban information Groupware in urban planning, web sites for urban planning		
3	• Region, characterization of region, Need for region planning dataset of region planning • Urban landscape changing model	1	1
4	• Real time information systems for urban environment and risk monitoring		
	Total	2	2

Reference Books

Mandatory

1. AysePamuk (2008) Mapping Global Cities, GIS Methods In Urban Analysis. ESRI Press. New York

Supplementary

1. Bhat, L.S. et al: Micro-Level Planning: A Case Study of Karnal Area, Haryana, K. B. Publications, New Delhi, 1976.
2. Bhat, L.S.: Regional Planning in India, Statistical Publishing Society, Calcutta, 1973.
3. Chorley, R.J. and Haggett, P. (ed): Network Analysis in Geography, Arnold, 1969.
4. Edward J Kaiser, David R. Godschalk,(1998) hypothetical City Workbook, Exercise, Spreadsheets, and GIS Data to Accompany Urban Land Use Planning (4th ed) Board of Trustees of University of Illinois, USA
5. Frederick R Steiner and Kent Butter (ed) (2007) Planning and Urban Design Standards, John Wiley and Sons New Jersey, Canada.
6. Juliana Maantay and John Ziegler ( ) GIS for Urban Environment
7. Kuklinski, A.R. (ed.): Growth Poles and Growth Centres in Regional Planning, Mouton, The Hague. 19

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2. https://www.iirs.gov.in/
3. https://www.sciencedirect.com/science/article/pii/019897159290022J
4. https://www.tandfonline.com/doi/abs/10.1080/13658810051030487
5. https://www.sciencedirect.com/science/article/pii/S0198971501000217
6. https://www.sciencedirect.com/science/article/pii/S1364815203001051

Elective
Course Title: **WEB GIS AND DEVELOPMENT OF WEB APPLICATION**
Course Code: PG.MGIS.E6
Credits: 04
Marks: 100

Prerequisite courses: Passing of Competency test is mandatory (Min. 40%)

Course Objective:

- Provide students with a comprehensive and up-to-date overview of Web GIS, including the basic concepts, principles, related fields (e.g. mobile GIS) and frontiers.
- Provide students with the state-of-art technical skills to build Web GIS applications and the knowledge needed to choose from various Web GIS development options.

Course Outcome:

Upon successful completion of the course, students will be able to:

1. Critically assess the organizational benefits and challenges of developing Web GIS applications
2. Explain the difference between Web GIS, geospatial web services, mashups, mobile GIS solutions, geoportals, and how these are applicable to e-business and e-government;
3. Evaluate current technologies or architectures that support Web GIS;
4. Design and implement an independent Web GIS application.

Details of course contents and allotted time

No	Topic	Credits	
		L-24	P-48
1	**Web Based Architecture and Scripting Environments** Roles of Clients & Servers, Basics of web GIS, Architecture, geospatial web services, OGC, Open source and proprietary web-based scripting and mapping environments, KML, GeoJSON, and other formats for drawing vector data in the browser,	1	1
2	Application Programming Interfaces (APIs), GeoServer, NSDI, Census GIS, BHUVAN, Crowd Sourcing.		
3	**Mobile GIS and Open Data Kit** Architecture of Mobile GIS, Operating systems for Mobile GIS, Wireless web, customization of Mobile GIS, softwares, Libraries, SDK packages and advantages,	1	1
4	Introduction to Open Data Kit (ODK), Web based databases: OpenStreet Map, Overpass turbo, Kepler.gl, Mapbox.		

Reference Books:

Mandatory

1. DuVander A 2010. Map Scripting 101: An Example-Driven Guide to Building Interactive Maps with Bing, Yahoo!, and Google Maps

Supplementary

1. Pinde Fu,(2018) Getting to Know Web GIS,(3rd Ed),Esri Press, Redlands, CA.
2. Markus Neteler And Helena Mitasova (2007): Open Source GIS: A GRASS approach, Springer-Verlag Berlin, Heidelberg
3. Andrew Cutts, Anita Graser (2018): Learn QGIS ,

Web references

1. https://www.packtpub.com/applicationdevelopment/learn-qgis-fourth-edition
2. ArcGIS Resource Center Web APIs, http://resources.arcgis.com/content/web/web-apis
3. ArcGIS JavaScript APIs, http://help.arcgis.com/en/webapi/javascript/arcgis/
4. ArcGIS JavaScript API Samples, https://developers.arcgis.com/en/javascript/jssamples
5. https://mangomap.com/web-gis

Elective
Course Title: RESEARCH METHODOLOGY
Course Code: PG.MGIS.E6
Credits: 04
Marks: 100

Prerequisite Courses: NIL

Course Objectives:

- The course aims to introduce the students to various research designs and techniques and to identify the sources of information for data collection and literature review.

Course outcome:

At the end of this course, student will be able to:

1. Understand the importance of review of literature in research
2. Develop skills of writing review of literature
3. Understand and use different referencing skills
4. Create hypothesis/formulate
5. Critically assess literature review/research paper

Unit	Topic	Credits L-24	P-48
1	**Introduction to Research:** Research and its types, Research process and steps, Essential components of Literature Review, definition of problem, Objectives & strategies of research **Methods of Data Collection :**Types of data collection and classification, designing questionnaires and schedules, digital organization of data, preprocessing	**1**	
2	**Sampling Methods:** Probability sampling, random sampling, systematic sampling, stratified sampling and cluster sampling Non-probability sampling, quota sampling **Data Analysis:** Statistical measures and their significance: Central tendencies, variation, skewness, Kurtosis, time series analysis, correlation and regression, Testing of Hypotheses: Chi Square, ANOVA	**1**	**1**
3	**Multivariate Analysis:** Multiple Regression, Factor Analysis, Multi-Criteria Analysis		**1**
4	**Report writing:** Pre writing considerations, Format of report writing, Abstract Writing, Synopsis Writing, Thesis writing, Chapterization, Format of publications in research journals.		
	Total	**2**	**2**

References

Mandatory

1. Kothari C.K. (2004), 2/e, Research Methodology- Methods and Techniques (New Age International, New Delhi)

Supplementary

1 Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments, (Wiley India)
2 Montgomery, Douglas C. &Runger, George C. (2007), 3/e, Applied Statistics &Probability for Engineers (Wiley India)
3 Krishnaswamy, K.N., Sivakumar, Appalyer and Mathiranjan M. (2006), Management Research Methodology; Integration of Principles, Methods and Techniques (Pearson Education, New Delhi)
4 Hira, D.S. System Simulation, S. Chand & Co., New Delh.

5 B.E. Vieux (2005). Distributed Hydrologic Modeling Using GIS, ISBN-13: 978-0792370024
6 Proctor, T. (2003) "Essentials of Marketing Research", 3rd edition, Prentice Hall

Web references

1. https://www.scribbr.com/dissertation/methodology/
2. https://www.researchgate.net/publication/270956555_CHAPTER_3_-_RESEARCH_METHODOLOGY_Data_collection_method_and_Research_tools
3. https://research-methodology.net/research-methodology/
4. Adapted from: Miles &Huberman (1994, p. 40). Qualitative Data Analysis, available at http://wilderdom.com/research/QualitativeVersusQuantitativeResearch.html

Elective

Course Title: APPLICATIONS OF GIS IN RESOURCE MANAGEMENT
Course Code: PG.MGIS.E8
Credits: 04
Marks: 100

Prerequisite courses: NIL

Course objectives:

- The course is aimed to introduce the concept of land, water and coastal management, taxation and to learn how GIS can be applied in resource management sector.

Course outcomes:

On completion of this course, students will be able to:

1. Understand importance of nature resources and its categorizes
2. Use these skills to identify and analyzed real world problem and preparing them for a successful career in geospatial industry and research institute
3. Acquire of fundamental and advanced knowledge of the different aspect in Geoinformatics with the means ability to specialize in a specific field.
4. Develop a tendency towards research through the compulsory internship in industry /research/ academic institutes which promote and inculcate professional ethics and code of practice among students, enabling them to work in a team with multidisciplinary approach.

Details of course contents and allotted time

No.	**Topic**	**Credits**	
		L 24	**P 48**
1	• Spatial approach in forest resource Management, Cadastral Mapping, Land Registration Workflow, Parcel management, Land Parcel Data Model, data capture, data management and processing	1	1
2	• Land Capability Mapping and Limitations, Public Access, Land classifications, Land use planning, Taxation		
3	• Water Resources- Watershed Management, Flood management and Damage Assessment, Zone Mapping, Groundwater recharge mapping, Water Quality, Watershed Erosion Modeling	1	1
4	• Coastal Zone management, Fisheries, Coral Reefs, Navigation, data storage and access, analysis		
	Total	2	2

Reference Books:

Mandatory

1. Michael G. Wing, Pete Bettinger (2008),Geographic Information Systems: Applications in Natural Resource Management, Oxford University Press, USA

Supplementary

1. Ali S.A. Resources for Future Economic Growth, Vikas Publications House, New Delhi, 1979.
2. Ress J. Natural Resources, Allocation, Economics & Policy, Rout Ledge, London, 1990.
3. Turner R.K. Sustainable Environmental Management, Belhaven Press, London, 1988.
4. Nancy von Meyer (2004), GIS and Land Records, ESRI press
5. Laura Lang (2004), Managing Natural Resources with GIS, ESRI Press, ISBN 1-879102-53-6
6. Roger Tomlinson (2007), Thinking about GIS, ESRI Press
7. John G. Lyon (2002). GIS for Water Resource and Watershed Management, Taylor & Francis

Web reference

1. https://www.geospatialworld.net/article/gis-and-remote-sensing-for-natural-resource-survey-and-management/
2. https://issuu.com/ijiras/docs/paper_11_cdac2fb1bb1686
3. https://www.geographiaias.com/blog/2018/11/24/gis-remote-sensing-in-natural-resource-management/
4. https://www.tandfonline.com/doi/abs/10.1080/01431160903376415
5. https://www.iwmi.cgiar.org/assessment/files/word/Workshops/ILRI-March/Presentations/Atsmachew.pdf
6. https://www.nrsc.gov.in/
7. https://www.iirs.gov.in/

Elective
Course Title: APPLICATION OF GIS IN AGRICULTURE &SOIL
Course Code: PG.MGIS.E9
Credits: 04
Marks: 100
Prerequisite NIL

Course objective

- The course is aimed to introduce the concept of Agriculture, Soil. Developing of models and decision support system for different Agricultural data.

Course outcome

On completion of this course, students will be able to:

1. Understanding importance of Agriculture resources and its categorization.
2. Help to identify land use and land cover problems.
3. Develop and built applications in agriculture sector.
4. Designing of models in land capability and crop yield productivity

Details of course contents and allotted time

No.	Topic	Credits	
		L -24	P-48
1	**Agriculture -**Spectral characteristic of crop, crop inventory ,crop yield modeling , crop water mangment,agro ecological zoning	1	1
2	**Land –**Crop acreage and production estimation model, Ground water potential zone, recharge and identification		
3	**Soil -**Land evaluation, physiographic soil mapping , soil type identification, soil moisture mapping	1	1
4	**Case study-** Review case studies in Geosciences, Water Resources, Agriculture, Soil		
	Total	2	2

Reference Books:

Mandatory

1. Vincent RK (2008) Fundamentals of Geological and Environmental Remote Sensing New Jersey: Prentice Hall

Supplementary

1. Cracknell A P(ed) (1998) Remote Sensing in Meteorology, Oceanography and Hydrology. Chichester: Ellis Horwood Limited
2. Damen MCJ, Sicco Smith G and Kerstappen(Ed) (1997) Remote Sensing for Resources Development and Environmental Management 3rd.volume Set Netherlands: Balkema
3. Jensen, J.R. (2000). Remote sensing of the environment: an Earth resource perspective. Prentice Hall. ISBN 0-13-489733-1.
4. Kondratyev K Ya, Buznitov AA and Pokrovoky OM (2000). Global Change and Remote Sensing: John Wiley and Sons.
5. Roy, P.S. Geoinformatics for Tropical Ecosystems Bishen Singh Mahendra Pal Singh, Dehradun
6. Skidmore Andrew (1998) Environmental Modeling with GIS and Remote Sensing Taylor and Francis
7. Steven MD and Clark JA (1998). Applications of Remote Sensing in Agriculture London Butterworths.

Web reference

1. https://www.nrsc.gov.in/
2. https://www.iirs.gov.in/
3. https://scholar.google.co.in/scholar?q=Applications+of+Remote+Sensing+in+Agriculture&hl=en&as_sdt=0&as_vis=1&oi=scholart
4. https://www.cabdirect.org/cabdirect/abstract/19710703623
5. https://www.researchgate.net/publication/323007319_APPLICATIONS_OF_REMOTE_SENSING_IN_AGRICULTURE
6. http://oar.icrisat.org/4564/1/CP_521.pdf

Semester IV

PG.MGIS.C8	**Project Work**	**500**	**20**

Guidelines

1	Problem identification and literature review	Credits 3
2	Data acquisition and collection	Credits 2
3	Field work	Credits 3
4	Data processing	Credits 3
5	Result and interpretation	Credits 3
6	Report writing	Credits3
7	Presentation	Credits3

1) Project is the part of paper PG.GIS.C8. Fourth semester is fully devoted to project work.
2) Project will cover 300 hours and 4 month durations
3) The student for the fulfillment of M.Sc- Geoinformatics must carry outIndividual dissertation work.
4) Comprehensive Viva Voce
5) Viva Voce will be conducted to the student by Department on the topic of the dissertation carried out by the student.

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

Programme Outcome (PO) and Course Outcome (CO)

Name of the Department: **MASTER OF SCIENCE IN GEOINFORMATICS**

Program outcome	**Short Title of POs**	Description of the Programme Outcomes Graduates will be able to :
PO1	Find out problem and solution	Recognized, Identify, analyze problem and further attempt to design / develop solution that meet the specific goals
PO2	Technology characteristic	Use appropriate IT tools efficiently and effectively in daily activities of research and academic
PO3	Ethics	Recognized and understand professional ethics / human value and be responsible same
PO4	Team work and communication	Team work essential for handle big project, function effectively at various level. Communicate skillful as a responsible member of society
PO5	Research ability	Understanding general research methods and be able to analyze, interpret and resultant rational conclusion
PO6	Life Skills	Recognize the need for and have preparation and ability to engage in independent and lifelong learning in the broadest context of domain specific change

Program specific outcomes (PSO)

After successful completion of a Master degree in Geoinformatics, the student will:

Program outcome(PO)	Short Title of PSOs	Description of the program outcomes
PSO 1	Personality development	Personal effectiveness and workplace competencies are practiced through engagement in discussion boards, following course guidelines, and interactions with the instructor and other students in the class
PSO2	Technology of Geospatial aspect	Workplace competencies are strengthened as students apply the analytical and evaluative tools to GIS mapping and apps
PSO3	Development and customization of plugins	Ability to design plugins
PSO4	Analytical and problem solving skills using Geo-spatial technology	To be able use these skills to identify and analyzed real world problem and preparing them for a successful career in geospatial industry and research institute.
PSO 5	Development of research aptitude	Develop a tendency towards research through the compulsory internship in industry /research/ academic institutes which promote and inculcate professional ethics and code of practice among students, enabling them to work in a team with multidisciplinary approach.
PSO6	Advanced knowledge of Geoinformatics	Acquire of fundamental and advanced knowledge of the different aspect in Geoinformatics with the means ability to specialize in a specific field.

COURSE OUTCOMES

S.N.	Course Code	Course Title	Course Outcomes
1	PG.MGIS.C1	Basics of GIS and GPS	After successful completion of a course in student will be able CO1: Students will demonstrate proficiency and conceptual understanding in using software and automated techniques to carry out thematic maps and analysis through a series of laboratory exercises and creation of reports. CO2: Personal effectiveness and workplace competencies are practiced through engagement in discussion boards, following course guidelines, and interactions with the instructor and other students in the class CO3: To be able use these skills to identify and analyzed real world problem and preparing them for a successful career in geospatial industry and research institute CO4: Acquire of fundamental and advanced knowledge of the different aspect in Geoinformatics with the means ability to specialize in a specific field.
2	PG.MGIS.C2	Basic of Remote Sensing and Photogrammetry	After successful completion of a course in student will be able CO1: Students will be able to understand the concept of remote sensing and EMR apart from this basic level of fundamental physical principles of remote sensing, CO2: Developed basic concept including the electromagnetic spectrum; the emission, scattering, reflection, and absorption of electromagnetic (EM) radiation; how EM radiation interactions vary across a limited number of substances, geometries, and temperatures; and geometric properties of photographs and imagery. CO3: To be able use these skills to identify and analyzed earth surface problem and preparing them for a successful career in geospatial industry and research institute CO4: Be equipped with practical skills and the ability to apply their theoretical concept to design, perform experiments, analyze and interpret data and thus develop proficiency in lab management

3	PG.MGIS.C3	Geostatistics	After successful completion of a course in student will be able CO1: After completion of the course students will understand various types of datasets and applying different statistical techniques to different data sets. CO2: This will systematically access, analyze and evaluate information and ideas from multiple sources in order to identify underlying assumptions, and formulate conclusions. The course will enhance skills like solving quantitative problems and statistical queries. CO3: Develop an tendency towards academic institutes which promote and inculcate professional ethics and code of practice among students, enabling them to work in a team with multidisciplinary approach. CO4: Workplace competencies are strengthened as students apply the analytical and evaluative tools to GIS mapping and apps
4	PG.MGIS.E1	Digital Cartography	After successful completion of a course in student will be able CO1: Students will understand different types of projections and datum used in various locations. Proficiency and conceptual understanding in using Manual and computer techniques to carry out thematic maps and special purpose maps. CO2: Remote sensing, image processing and analysis through a series of laboratory exercises and report CO3: Be able to demonstrate proficiency in quantitative reasoning and analytical skills CO4: Acquire of fundamental and advanced knowledge of the different aspect in cartography with the means ability to specialize in a specific field.
5	PG.MGIS.E2	Principles of Computer and Programming	After successful completion of a course in student will be able CO1: Students will write program and understanding concept of basic computer language CO2: To be able use these skills to identify and analyzed real world problem and preparing them for a successful career in gis industry and research institute. CO3: Develop an tendency towards research through

			the compulsory internship in industry and academic institutes CO4: Workplace competencies are strengthened as students apply the analytical and evaluative tools to geospatial mapping and apps
6	PG.MGIS.C4	Spatial Analysis and Modeling	After successful completion of a course in student will be able CO1: Student will able to apply spatial tool and techniques in spatial datasets for carry out Surface and 3d analysis. CO2: Students will demonstrate proficiency and conceptual understanding spatial model making process. CO3: Be equipped with practical skills and the ability to apply their theoretical concept to design, perform experiments, analyze and interpret data and thus develop proficiency in lab management CO4: Acquire of fundamental and advanced knowledge of the different aspect in Geoinformatics with the means ability to specialize in a specific field.
7	PG.MGIS.C5	Advanced Remote Sensing and GIS	After successful completion of a course in student will be able CO1: Students will be able to apply mathematical relationships (at a pre-calculus level) describing fundamental physical, geometric, and computational principles relevant to remote sensing and GIS. CO2: They will create Remote sensing application CO3: Be equipped with practical skills and the ability to apply their theoretical concept to design, perform experiments, analyze and interpret data and thus develop proficiency in lab management CO4: Acquire of fundamental and advanced knowledge of the different aspect in Geoinformatics with the means ability to specialize in a specific field.
8	PG.MGIS.E3	Digital Image Processing	After successful completion of a course in student will be able CO1: Students will demonstrate proficiency and conceptual understanding in using software CO2: manual techniques which will prove how digital technology has come over traditional technology to carry out remote sensing image processing and analysis through a series of

			laboratory exercises and reports CO3: Acquire of fundamental and advanced knowledge of the different aspect in DIP with the means ability to specialize in a specific field. CO4: Workplace competencies are strengthened as students apply the analytical and evaluative tools to GIS mapping and apps
9	PG.MGIS.E4	Programming and Customization	After successful completion of a course in student will be able CO1: Student will develop new tools and software also customizes open source software. CO2: They design and built web base platform for geospatial database. CO3: Be able to demonstrate proficiency in quantitative reasoning and analytical skills CO4: Be equipped with practical skills and the ability to apply their theoretical concept to design, perform experiments, analyze and interpret data and thus develop proficiency in lab management
10	PG.MGIS.E5	Field Techniques and Report Writing	After successful completion of a course in student will be able CO1: Students will describe a survey method and different instruments and it's assemble and summarize relevant survey for relevant work which will skill development in using different instruments. CO2: Report writing and Interpretation of Maps will focus on writing skills. CO3: Be equipped with practical skills and the ability to apply their theoretical concept to design, perform experiments, analyze and interpret data and thus develop proficiency in lab management CO4: Acquire of fundamental and advanced knowledge of the different aspect in Geoinformatics with the means ability to specialize in a specific field.
11	PG.MGIS.C6	Application of GIS in for Disaster Management	After successful completion of a course in student will be able CO1: Be equipped with practical skills and the ability to apply their theoretical concept to design, perform experiments, analyze and interpret data and thus develop proficiency in lab management.

			CO2: It is provides decision support system in disaster management and making model reduce risk and Hazard. Students will handle different disaster project like Flood, landslide, fire and drought. CO3: To be able use these skills to identify and analyzed real world problem and preparing them for a successful career in geospatial industry and research institute. CO4: Acquire of fundamental and advanced knowledge of the different aspect in Geoinformatics with the means ability to specialize in a specific field.
12	PG.MGIS.C7	GIS for Urban and Regional Planning	After successful completion of a course in student will be able CO1: Students will describe a remote sensing application and assemble and summarize relevant literature in a written assignment, case study and development of models in various urban environmental activities. CO2: Develop a tendency towards research through the compulsory internship in industry CO3: To be able use these skills to identify and analyzed real world problem and preparing them for a successful career in geospatial industry and research institute. CO4: Be able to demonstrate proficiency in quantitative reasoning and analytical skills
13	PG.MGIS.E6	Web GIS and development Web application	After successful completion of a course in student will be able CO1: Critically assess the organizational benefits and challenges of developing Web GIS applications; CO2: Explain the difference between Web GIS, geospatial web services, mashups, mobile GIS solutions, geoportals, and how these are applicable to e-business and e-government; CO3: Evaluate current technologies or architectures that support Web GIS; CO4: Design and implement an independent Web GIS application.
14	PG.MGIS.E7	Research methodology	After successful completion of a course in student will be able CO1: Understand the importance of review of literature in research CO2: Develop skills of writing review of literature CO3: Understand and use different referencing skills

			CO4: Create hypothesis / formulate CO5: Critically assess literature review / research paper
15	PG.MGIS.E8	Application GIS for Resource Management	After successful completion of a course in student will be able CO1: Understanding importance of nature resources and its categorizes CO2: To be able use these skills to identify and analyzed real world problem and preparing them for a successful career in geospatial industry and research institute CO3: Acquire of fundamental and advanced knowledge of the different aspect in Geoinformatics with the means ability to specialize in a specific field. CO4: Develop a tendency towards research through the compulsory internship in industry / research / academic institutes which promote and inculcate professional ethics and code of practice among students, enabling them to work in a team with multidisciplinary approach.
16	PG.MGIS.E9	Application of GIS in Agriculture &Soil	After successful completion of a course in student will be able CO1: Understanding importance of Agriculture resources and its categorization. CO2: Help to identify land use and land cover problems. CO3: Develop and built applications in agriculture sector. CO4: Designing of models in land capability and crop yield productivity