Parvatibai Chowgule College of Arts & Science
(Autonomous)
Margao – Goa

MINUTES OF MEETING OF THE BOARD OF STUDIES IN PHYSICS
HELD ON 29th October 2022 AT 11:00 am

Vide Chowgule College notice (F.133(C)/1107 dated 14th October, 2022) an online meeting of this BoS was convened on 29th October, 2022 at 11:00 am. Since the members present represented the Quorum, the BoS began its proceedings.

Minutes are presented in the format.

Members present:

1. Dr. Ashish M. Desai (Chairman)
2. Dr. Ananya Das
3. Mrs. Malati Dessai
4. Mr. Yatin P. Desai (Member Secretary)
5. Mr. Mohanlal Mali
6. Ms. Valencia Fernandes
7. Dr. Bholanath Pahari (Academic Council Nominee)
8. Dr. Sudhir Cherukulappurath (Vice-Chancellor Nominee)

Members Absent:

1. Dr. Tarun Kumar Jha (Academic Council Nominee)
2. Mr. Mangrish Salelkar (Industry Representative)
3. Mr. Harison Cota (Postgraduate Alumni)

Proceedings

The Chairperson welcomed the members of BoS and explained the agenda of the meeting. The board transacted the following business:

Agenda Items:

1. To review and revise the Course Outcomes (CO) as per the suggestions given in the Governing Body meeting.
2. To approve the additional list of external examiners for Third Year Project Evaluation
3. Introduction of new Courses under NEP 2020, if any.
4. Any Other Business (A.O.B.)

PART A: Resolutions

1. The Course Learning Outcomes for some of the Odd Semester courses were revised. The revised course learning outcomes are presented in Annexure I and the syllabus of the undergraduate course in Physics, for the odd semesters, with the revised course outcomes is presented in Annexure II.
2. During the meeting, additional Faculty members were identified as external examiners for Third Year B. Sc. Project. The updated list of external examiners for the Third Year B. Sc. Project is given in Annexure III.
3. In view of NEP 2020, in the meeting it was proposed that the Department of Physics in collaboration with one of the Departments of Life sciences and the Department of Geology may design a course on Introduction to Biophysics and Introduction to Geophysics respectively.
4. Under A.O.B, student feedback about the Generic elective courses (Elementary Physics and Physics for Life sciences) was discussed. It was suggested that the syllabus of the Generic Elective courses may be modified.
5. All the above recommended changes may be implemented from academic year 2023-24 onwards.

PART B: Resolutions/Recommendations of BoS that require consideration / approval of Academic Council:

1. Revised course learning outcomes presented in Annexure I.
2. The updated list of external examiners for the Third Year B. Sc. Project presented in Annexure III.

The Chairman thanked the members of Board of Studies in Physics for their valuable contribution and active participation. The meeting ended at 1:00 pm.
The foregoing minutes of the meeting are circulated by the Chairman on 5th November 2022.

Mr. Yatin P. Desai	Dr. Ashish M. Desai
Member Secretary	Chairman
BoS (Physics)	BoS (Physics)

Date: 5th November 2022

PART C: The remarks of the Dean of the Faculty:-

a. The minutes are in order

b. The minutes may be placed before the Academic Council with remark, if any.

c. Important points of the minutes which need clear policy decision of the Academic council to be recorded.

Date:

Signature of the Dean: ________________________
(Faculty of Science) (Dr. Meghana Devli)

Annexure I

Revised Course Learning Outcomes (Odd Semesters):

Sr. No.	Course Code	Course Title	Course Outcomes At the end of this course students will be able to:
1	**PHY-I.C-1**	**Introduction to Mathematical Physics**	**CLO1:** Understand vector analysis and its application in physics. **CLO2:** Have a good grasp on various tests used to test the convergence and divergence of different kinds of series and learn how to expand a function in power series. **CLO3:** Understand the basics of complex numbers. **CLO4:** Understand matrix operations and properties of matrices. **CLO5:** Learn basics of partial differentiation and its application in physics. **CLO6:** Solve ordinary first and second order differential equations important in the physical sciences, **CLO7:** Familiarize with spherical and cylindrical coordinate systems. **CLO8:** Use mathematical techniques to solve several problems in physics and enhance problem solving skills.
2	**PHY-I.C-2**	**Mechanics I**	**CLO1**: Develop understanding of Newtonian mechanics in one and two dimensions and solve the Newton equations for simple configurations. **CLO2**: Understand the Law of Conservation of Linear Momentum and Angular Momentum and apply these laws to understand elastic and inelastic collision. **CLO3**: Apply the knowledge of work and energy theorems in kinematics through examples. **CLO4**: Understand the Principle of Conservation of Mechanical Energy (for conservative forces) and apply this law to problems of objects moving under the influence of conservative forces.

			CLO5: Understand ideas of Newton's Law of gravity, gravitational field and potential energy by solving various problems.
3	**PHY-E1**	**Optics**	**CLO1**: Understand and apply cardinal points technique and aberration to study the image formation in optical systems and solve numerical problems based on aberration and cardinal points. **CLO2**: Apply division by wave front and division by amplitude techniques to study interference patterns and solve numerical problems based on interference in thin films. **CLO3**: Derive conditions for Fresnel class diffraction and Fraunhofer class diffraction, and solve numerical problems based on diffraction grating, resolving power of telescope and prism. **CLO4**: Apply Huygen's theory of double refraction to study the types of crystal. **CLO5**: Analyze the types of polarized light with help of Nicol Prism and retardation plate. **CLO6**: Determine optical rotation of sugar solution using Polarimeters.
4	**PHY-E2**	**Modern Physics**	**CLO1:** Understand constituents of an atom and atomic structure. **CLO2:** Understand and interpret experiments that reveal the particle properties of waves and wavelike properties of particle. **CLO3:** Apply uncertainty principle to solve numerical problems related to subatomic physics **CLO4:** Understand the working of mass spectrographs and accelerators **CLO5:** Understand the basic operating principle of the laser and the optical fibre.
5	**PHY-E17**	**Introduction to Astronomy and Astrophysics**	**CLO1:** Understand the various Extra-galactic objects. **CLO2:** Understand the construction, working and mounting of modern telescopes. **CLO3:** Understand co-ordinate system of Celestial Objects.

			CLO4: Understand different spectral classes of stars, galaxies and the very early universe. **CLO5:** Locate objects in the sky using coordinate systems.
6	**PHY-II.C-7**	**Electromagnetic Theory – II**	**CLO1:** Calculate magnetic field induction using Biot-Savart's law and Ampere's law. **CLO2:** Interpret bound currents and calculate magnetic fields in matter. **CLO3:** Comprehend microscopic theory magnetism. **CLO4:** Relate electrostatics and magnetostatics using Maxwell's equations. **CLO5:** Develop and solve the wave equation for propagation of electromagnetic waves through material media and vacuum at different angles of incidence.
7	**PHY-E9**	**Solid State Physics**	**CLO1:** Identify bonding types in crystalline solids and correlate the nature of bonding of solid to some of the physical properties associated with it. **CLO2:** Identify different crystal systems and determine structural parameters like unit cell of crystal lattices, translation vectors, atomic packing, crystal planes and directions with help of Miller Indices. **CLO3:** Derive and apply Bragg's law to determine crystal structure. **CLO4:** Derive and apply classical free electron theory of metals to study electrical conductivity **CLO5:** Derive and apply density of energy states to estimate density of free electrons, Fermi energy and mean energy of electron gas at absolute zero **CLO6:** Derive and apply Fermi Free electron gas model in 3 dimensions to study electrical properties of metals. **CLO7:** Understand Bloch's theorem, Kronig-Penney Model and interpret energy band structures in solids, effective mass and energy-wavevector relationship. **CLO8:** Distinguish materials with respect to their magnetic properties.

			CLO9: Apply the knowledge gained to solve problems in solid state physics using relevant mathematical tools.
8	**PHY-E10**	**Thermodynamics and Statistical Mechanics**	**CLO1:** Understand basics of kinetic theory of gases. **CLO2:** Comprehend concepts of thermodynamic potentials and their physical interpretation. **CLO3:** Understand Maxwell-Boltzmann distribution law and its application to classical gas. **CLO4:** Learn Bose-Einstein statistics and derive classical radiation laws of black body radiation. **CLO5:** Comprehend Fermi-Dirac statistics and its application to the electrons in metals **CLO6:** Understand the concept of Fermi energy and electronic contribution to specific heat of metals.
9	**PHY-E12**	**Mathematical Physics**	**CLO1:** Comprehend the functions of complex variables. **CLO2:** Apply mathematical techniques such as: calculus of residues to evaluate definite integrals. **CLO3:** Apply solutions of Legendre, Bessel and Hermite equations in solving various Physics problems. **CLO4:** Apply Fourier transforms of different functions in solving various Physics problems. **CLO5:** Able to solve higher order problems in Physics**.**
10	**PHY-E6**	**Solid State Devices**	**CLO1:** Comprehend the p-n junction theory and analyse the effect of heat and light on the performance of the semiconductor devices. **CLO2:** Understand different types of special diodes and their uses in various electronics applications. **CLO3:** Understand different types of optoelectronic devices and their uses in various electronics applications.

			CLO4: Design, construct and working of the circuits based on breakdown devices. **CLO5**: Understand basic construction of FET, principle of operation of different types of FETs, and its applications.
11	**PHY-GEC-1**	**Elementary Physics**	**CLO1:** Develop understanding of Newtonian mechanics in one and two dimensions and solve the Newton equations for simple configurations. **CLO2:** Comprehend the phenomenon of elasticity, surface tension and their application. **CLO3**: Understand different types of crystal systems and determine structural parameters like unit cell of crystal lattices. **CLO4:** Derive and apply Bragg's law to determine crystal structure. **CLO5:** Discuss and interpret experiments that reveal the particle properties of waves and wavelike properties of matter. **CLO6:** Understand the uncertainty principle and its applications. **CLO7:** Understand different types of temperature scales and relationship between different scales of temperature. **CLO8:** comprehend the first law of thermodynamics to represent the relationship between heat and mechanical work. **CLO9:** comprehend the second law of thermodynamics to depict the manner in which thermodynamic changes take place. **CLO10:** Understand the basic properties of the nucleus and explain the process of radioactivity. **CLO11:** Gain knowledge on basic concept of nuclear force and Meson theory of nuclear force.
12	**PHY-GEC-2**	**Physics for Life Sciences**	**CLO1:** Comprehend the first law of thermodynamics to represent the relationship between heat and mechanical work. **CLO2:** Comprehend the second law of thermodynamics to depict the manner in which thermodynamic changes take place.

			CLO3: Comprehend the phenomenon of surface tension, viscosity and their application. **CLO4:** Understand the dependence of velocity of sound waves on various factors like temperature, pressure, density and humidity. **CLO5:** Understand the production and detection techniques of ultrasonic waves and its applications. **CLO6:** Apply the principles of electrostatics to solve problems relating to electric field and electric potential. **CLO7:** Apply the principles of magnetostatics to solve problems relating to magnetic field. **CLO8:** Comprehend the basic phenomenon of radioactivity. **CLO9:** Understand laws of reflection and refraction, and learn different types of optical eyepiece.

Annexure II

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)
DEPARTMENT OF PHYSICS
COURSE STRUCTURE
THREE YEARS B.Sc. DEGREE COURSE IN PHYSICS

SEMESTER	CORE		ELECTIVE					SEC
I	PHY-I.C-1 Introduction to Mathematical Physics	PHY-I.C-2 Mechanics-I	-------	-------	-------	-------	-------	
II	PHY-II.C-3 Heat and Thermodynamics	PHY-II.C-4 Electricity and Magnetism	-------	-------	-------	-------	-------	
III	PHY-III.C-5 Electromagnetic Theory-I	-------	PHY-E1 *Optics	PHY-E2 Modern Physics	PHY-E3 Oscillations, Waves and Sound	PHY-E17 Introduction to Astronomy and Astrophysics	---------	PHY-SEC.1 Basics of Visualization and Scientific word processing
IV	PHY-IV.C-6 Quantum Mechanics	-------	PHY-E5 *Electronics-I	PHY-E18 Introduction to Error Analysis	PHY-E4 Properties of Matter and Acoustics	PHY-E7 Computational Physics	-------	PHY-SEC.2 Instrumentation
V	PHY-V.C-7 Electromagnetic Theory-II	-------	PHY-E9 *Solid State Physics	PHY-E10 Thermodynamics and Statistical Mechanics	PHY-E11 Electronics-II	PHY-E12 Mathematical Physics	PHY-E6 Solid State Devices	
VI	PHY-VI.C-8 Atomic and Molecular Physics	-------	PHY-E13 *Mechanics II	PHY-E14 Nuclear and Elementary Particle Physics	PHY-E15 Introduction to Special Theory of Relativity	PHY-E16 Introduction to Material Science		

* BoS Physics recommends these elective courses to be taken by students as a prerequisite to the M.Sc. (Physics) Program.

Course to be offered as Generic Elective Course

Sr. No.	Course Code	Course Title
1	PHY-GEC-1	Elementary Physics
2	PHY-GEC-2	Physics for Life Sciences
3	PHY-GEC-3	Introduction to Astronomy

SEMESTER-I

Course Title **: Introduction to Mathematical Physics**

Course Code **: PHY-I.C-1**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Course Objectives **:** To develop basic competence in certain areas of mathematics required for understanding several important topics in physics.

Course Learning Outcomes: At the end of this course students will be able to:

CLO1: Understand vector analysis and its application in physics.

CLO2: Have a good grasp on various tests used to test the convergence and divergence of different kinds of series and learn how to expand a function in power series.

CLO3: Understand the basics of complex numbers.

CLO4: Understand matrix operations and properties of matrices.

CLO5: Learn basics of partial differentiation and its application in physics.

CLO6: Solve ordinary first and second order differential equations important in the physical sciences,

CLO7: Familiarize with spherical and cylindrical coordinate systems.

CLO8: Use mathematical techniques to solve several problems in physics and enhance problem solving skills.

Theory:

Unit I: **[15 h]**

1. **Infinite Series and Power Series** **[10 h]**
   Geometric Series and other infinite series. Convergent and Divergent Series. Testing series for convergence. Power series. Expanding functions in power series. Techniques for obtaining power series expansion.
   [Boas 1.1-1.7, 1.10-1.13]
2. **Complex Numbers** **[5 h]**
   Real and imaginary Parts of a complex number. Complex plane. Complex algebra. Euler's formula. Powers and roots of complex numbers. Exponential and trigonometric functions.
   [Boas 2.1-2.5, 2.9-2.11]

Unit II: **[15 h]**

1. **Vector Algebra** **[5 h]**
   Scalars and vectors. Basis vectors and components. Multiplication of Vectors. Equation of lines and planes. Using vectors to find distances.
   [Boas 3.4-3.5]

2. **Coordinate Systems** **[3 h]**
   Plane polar coordinates. Cylindrical and Spherical polar coordinates.
   [Harper 1.6.6, Riley 8.9]

3. **Matrices** **[7 h]**
   Matrix Analysis and Notation, Matrix Operations, Properties of matrices. Transpose matrix. Complex Conjugate Matrix, Hermitian Matrix, Unit matrix, Diagonal matrix, Adjoint and self-adjoint matrix, symmetric matrix, anti-symmetric matrix, unitary matrix, orthogonal matrix, trace of a matrix, inverse matrix. Solution of a system of linear equations. The eigenvalue problem.
   [Harper 2.3-2.8]

Unit III: **[15 h]**

1. **Partial Differentiation** **[6 h]**
   Definition of the partial derivative. Total differentials. Exact and inexact differentials. Theorems of partial differentiation. Chain rule. Thermodynamic relations. Differentiation of Integrals.
   [Riley 4.1-4.5, 4.10-4.11]

2. **Ordinary Differential Equation** **[9 h]**
   Introduction. Linear differential equation of the first order. Homogenous and inhomogeneous linear differential equation of the second order.
   [Boas 8.1-8.6 and Harper 5.1-5.2]

Experiments: (Minimum Six)

1. Introduction Error Analysis: Propagation of Errors
2. Statistical Analysis of Random measurement
3. Simulation of Radioactive Decay using Rolling of Dice
4. Plotting of various algebraic and trigonometric functions using Excel.
5. Curve fitting using Excel.
6. Interpretation of graphs.
7. Solving Integration, Ordinary Differential Equation and Matrices using Mathematica.
8. Tutorial on vector algebra

9. Tutorial on infinite series
10. Tutorial on differential equations
11. Tutorial on matrices and partial differentiation

References:

1. Riley K. F., Hobson M. P., Bence S. J., 1998, *Mathematical Methods for Physics and Engineering*, Cambridge University Press, UK
2. Mary L. Boas, *Mathematical Methods in Physical Sciences* 3rd Edition, John Wiley and Sons, USA
3. Charlie Harper, *Introduction to Mathematical Physics*, Prentice Hall of India, New Delhi

Additional References:

1. B. D. Gupta, 2004. *Mathematical Physics*, Vikas Publishing House, New Delhi
2. M. Spiegel, S. Lipschutz, D. Spellman, 2009, *Schaum's Outline of Vector Analysis,* Mc-Graw Hill Education

Web References:

1. https://ocw.mit.edu/resources/res-18-007-calculus-revisited-multivariable-calculus-fall-2011/
2. https://nptel.ac.in/courses/111108081/
3. https://www.math.upenn.edu/~deturck/m104/notes/week6.pdf
4. http://tutorial.math.lamar.edu/Classes/CalcIII/CalcIII.aspx
5. http://home.iitk.ac.in/~peeyush/102A/Lecture-notes.pdf
6. http://www.jimahoffman.com/MathB30/Matrices/Matrix1.pdf

Course Title : Mechanics I

Course Code : PHY-I.C-2

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Course Objectives : This course provides an introduction to topics in mechanics, which are essential for advanced work in physics. An objective of this course is to train students to think about some of the physical phenomenon in mathematical terms.
Course Learning Outcomes: At the end of this course students will be able to:

CLO1: Develop understanding of Newtonian mechanics in one and two dimensions and solve the Newton equations for simple configurations.
CLO2: Understand the Law of Conservation of Linear Momentum and Angular Momentum and apply these laws to understand elastic and inelastic collision.
CLO3: Apply the knowledge of work and energy theorems in kinematics through examples.
CLO4: Understand the Principle of Conservation of Mechanical Energy (for conservative forces) and apply this law to problems of objects moving under the influence of conservative forces.
CLO5: Understand ideas of Newton's Law of gravity, gravitational field and potential energy by solving various problems.

Theory:

Unit I: **Elements of Newtonian Mechanics, Motion of Particle in one dimension [15 h]**
1. **Elements of Newtonian Mechanics [7 h]**
Mechanics an exact science, Brief description of classical view of Space and Time. Kinematics, the description of motion. Dynamics, the concept of Mass and Force. Newton's First and Second Laws; Inertial frames. Equations of motion. Interpretation of Newton's third Law as Conservation of Momentum. Units and dimensions, Some elementary problems in Mechanics (Applications of Newton's Laws) - Atwood Machine, Forces acting on a brick sliding down an inclined plane.
[Symon 1.1, 1.2, 1.3, 1.4, 1.6, 1.7, Taylor 1.1-1.7, Kleppner 2.4]

2. **Motion of Particle in one dimension [8 h]**
Momentum and Energy theorems, Discussion of the general problem of one dimensional motion, Applied force dependent on time, Damping force dependant on the velocity. Conservative force depending on position. Potential Energy, Falling bodies.
[Symon 2.1, 2.2, 2.3, 2.4, 2.5, 2.6]

Unit II: **Motion of a particle in two dimensions [15 h]**
1. Motion of a particle in two dimensions **[15 h]**
Vector algebra, Applications to set of forces acting on a particle, differentiation and integration of vectors, kinematics in a plane, momentum and energy theorems, plane and vector angular momentum theorems, The harmonic oscillator in two dimensions, projectiles, potential energy.
[Symon 3.1, 3.2, 3.3, 3.4, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12]

Unit III: Motion of system of particles, Gravitation **[15 h]**

1. Motion of system of particles **[8 h]**

Conservation of linear momentum, conservation of angular momentum,conservation of energy.
[Symon 4.1, 4.2, 4.3]

2. Gravitation **[7 h]**

Centres of gravity for extended bodies, Gravitational field and gravitational potential, Gravitational field equations
[Symon 6.1, 6.2, 6.3]

Experiments: (Minimum Six)

1. Dimensions of different solid body
2. Moment of Inertia of a flywheel
3. Atwood Machine
4. Verification of Newton's Second Law using Air Track
5. Conservation of linear momentum using Air Track
6. Spring Mass System: Determining the Spring Constant
7. Simple Pendulum
8. Determining "g" using time of flight method using Python

References:

1. Symon Keith, 2016, Mechanics, Pearson Education
2. Taylor J. R., 2005, Classical Mechanics, University Science Books, USA
3. Kleppner, Kolenkow, 2013, Introduction to Mechanics, Cambridge University Press, UK

Additional References:

1. Kittle, Knight, 2011, Mechanics, Berkeley Physics Course, Vol. 1, McGraw Hill Education,
2. .Mathur D. S, 2005, Mechanics, S. Chand & Co., New Delhi
3. Takwale R. G., and Puranik P. S., 1997, Introduction to Classical Mechanics, Tata Mc-Graw Hill, New Delhi
4. Javier E. Hasbun, 2010, Classical Mechanics, Jones and Bartlett India Pvt. Ltd.
5. Atam Arya, 1997, Introduction to Newtonian Mechanics, Addison-Wesley
5. Symon K. R., 1971, Mechanics, Addison Wesley, New York
6. Brij Lal and N. Subramanyam, 2005, Mechanics and Electrodynamics, S. Chand and Company Ltd., New Delhi

Web References:

1. https://nptel.ac.in/courses/122106027/
2. https://ocw.mit.edu/courses/physics/8-01sc-classical-mechanics-fall-2016/
3. https://www.khanacademy.org/science/ap-physics-1/
4. https://www.feynmanlectures.caltech.edu/I_13.html
5. http://hep.physics.wayne.edu/~harr/courses/5200/f07/lecture06.htm

SEMESTER-III

Course Title : Electromagnetic Theory – I

Course Code : PHY-III.C-5

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Pre-requisite : Electricity and Magnetism (PHY-II.C-4) and Introduction to Mathematical Physics (PHY-I.C-1)

Course Objectives : To acquaint students with fundamental principles of Electrostatics part of the Electromagnetic Theory.

Course Learning Outcomes: At the end of this course students will be able to:
CLO1: Apply vector calculus to understand concepts in electrostatics.
CLO2: Comprehend the interaction between charges in vacuum as well as in medium.
CLO3: Calculate the electric field and electrical potential for discrete charges and continuous distribution of charge.
CLO4: Apply suitable techniques to solve various electrostatic problems.
CLO5: Understand how ferroelectric materials can be used as memory devices.

Theory:

UNIT I: Vector Analysis [10 h]

1. **Vector Analysis [10 h]**

   Review of Vector Operations and Vector Algebra

   Position, Displacement and Separation Vectors, Differential Calculus: Ordinary Derivatives, Gradient, The Operator $\vec{\nabla}$, The Divergence and Curl, Product Rules, Second Derivatives, Integral Calculus: Line, Surface and Volume Integrals, The fundamental Theorem for Divergences, The fundamental Theorem for Curls, Different Co-ordinate Systems: Cartesian Co-ordinate System, Cylindrical Co- ordinate System, Spherical Co-ordinate System, Some Useful Vector Identities with Proofs.

   [Griffiths pp. 1 – 8, 13 – 22, 28] [Harper pp. 20, 26 30-31, 36]

UNIT II: Electrostatics and Techniques to Solve Electrostatic Problems [20 h]

1. **Electrostatics [12 h]**

   The Electric Field: Coulomb's Law, The Electric Field, Continuous Charge Distributions, Divergence and Curl of Electrostatic Fields: Field Lines, Flux and Gauss's Law, The Divergence of E, Applications of Gauss's Law, The Curl of E, Electric Potential: Introduction to Potential, Poisson's Equation and Laplace's Equation, Potential of a Localized Charged Distribution, Summary: Electrostatic Boundary Condition, Work and Energy in Electrostatics: Work Done to Move a Charge, The Energy of a Point Charge Distribution, The Energy of a Continuous Charge Distribution, Comments on Electrostatic Energy, Conductors: Basic Properties of Conductor, Induced Charges, Surface Charge and the Force on a Conductor, Capacitors.

   [Griffiths, pp. 58 – 103]

2. **Techniques to Solve Electrostatic Problems [8 h]**

   Poisson's Equation, Laplace's Equation: Laplace's Equation in One Dimension, Laplace's Equation in Two Dimensions, Laplace's Equation in Rectangular Co-ordinates, Solution to Laplace's Equation in Spherical Co-ordinates (Zonal Harmonics), Conducting Sphere in Uniform Electric Field, Electrostatic Images: Point Charge and Conducting Sphere, Line Charge and Line Images.

   [Griffiths, pp. 51 – 67]

UNIT III: Electrostatic Field in Matter and Microscopic Theory of Dielectrics [15 h]

1. **Electrostatic Field in Matter [8 h]**

   Polarization, Gauss's Law in a Dielectric, Electric Displacement Vector, Electric Susceptibility and Dielectric Constant, Boundary Conditions on the Field Vectors, Boundary Value Problems Involving Dielectric, Dielectric Sphere in a Uniform Electric Field

   [Reitz, pp. 75 – 93]

2. **Microscopic Theory of Dielectrics [7 h]**

   Molecular field in a dielectric: Clausius Mossotti Relation, Polar and Non-Polar Molecules, Induced Dipoles, Langevin's Debye Formula, Permanent Polarization, Ferroelectricity.

   [Reitz, pp. 101 – 109]

Experiments: (Minimum Six)

1. Van-de-graff Generator. [Demonstration]
2. Measurement of dielectric constant and susceptibility of liquid using parallel metal plates.
3. Measurement of dielectric constant and susceptibility of liquid using coaxial metal tubes.
4. Measurement and Study of variation of dielectric constant of BaTiO3 ferroelectric and determination of its Curie temperature.
5. E and D measurement for a parallel plate capacitor and calculation of dielectric constant.
6. Law of Capacitance using Dielectric Constant Measurement Kit.
7. Absolute capacity by ballistic galvanometer.
8. C1/C2 by De-Sauty's method using ballistic galvanometer.
9. Dipole Moment and Polarizability of Benzene.

References:

1. Griffiths D. J., 2011, *Introduction to Electrodynamics*, 3rd Ed., Prentice Hall of India, New Delhi
2. Harper Charlie, 1993, *Introduction to Mathematical Physics*, Prentice Hall of India, New Delhi
3. Reitz J. R., Milford F. J., Christy R. W., 1979, *Foundations of Electromagnetic Theory*, 3rd Ed. Addison-Wesley Publishing Company

Additional Reference:

1. Mukherji U., 2008, *Electromagnetic Field Theory and Wave Propagation*, Narosa Publishing House.

Web References:

1. https://nptel.ac.in/courses/115101005/
2. https://swayam.gov.in/nd1_noc19_ph08/preview
3. https://ocw.mit.edu/courses/physics/8-07-electromagnetism-ii-fall-2012/lecture-notes/
4. https://www.feynmanlectures.caltech.edu/II_10.html
5. https://www.iiserkol.ac.in/~ph324/ExptManuals/DielectricConstant.pdf

Course Title : **Optics**

Course Code : **PHY-E1**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Pre-requisite :**Nil**.

Course Objective: The course aims to enable the students to develop an understanding towards the properties of light, its nature, its propagation and the different phenomena exhibited by light. The whole branch is divided into: (1) Geometrical Optics involving geometrical consideration of image –formation based on the rectilinear propagation of light and (2) Physical Optics considering the wave nature of light, then explaining the optical phenomena such as Interference, Diffraction and Polarization exhibited by light using suitable theories. The primary aim of this course is to emphasize the different fundamental principles and the techniques used for different optical phenomena.

Course Learning Outcomes: On completion of this course, the students will be able to:
CLO1: Understand and apply cardinal points technique and aberration to study the image formation in optical systems and solve numerical problems based on aberration and cardinal points.
CLO2: Apply division by wave front and division by amplitude techniques to study interference patterns and solve numerical problems based on interference in thin films.
CLO3: Derive conditions for Fresnel class diffraction and Fraunhofer class diffraction, and solve numerical problems based on diffraction grating, resolving power of telescope and prism.
CLO4: Apply Huygen's theory of double refraction to study the types of crystal.
CLO5: Analyze the types of polarized light with help of Nicol Prism and retardation plate.
CLO6: Determine optical rotation of sugar solution using Polarimeters.

Theory:

Unit I: Geometrical Optics [15 h]

1. **Fundamentals of Reflection and Refraction** **[6 h]**
   Refractive index and optical path, Fermat's Principle of least time, Derivation of the laws of reflection and refraction using Fermat's Principle.
   Lenses: thin and thick lenses, Lens equation, Lens maker's formula, Cardinal points of an optical system, Combination of coaxially placed two thin lenses (equivalent lenses) (including derivation for focal length and cardinal points).
   [Subramanyam; Chapter.1: 1.6, 1.7; Sing; Chapter.1: 1.2, 1.3, 1.4; Subramanyam; Chapter.4: 4.8, 4.9, 4.10, 4.11, 4.12, 4.15, 4.17; Chapter.5: 5.2, 5.2.1, 5.2.2, 5.2.3, 5.3, 5.10, Chapter.6: 6.1, 6.2]

2. **Lens Aberrations** **[5 h]**

Introduction, Types of aberrations: monochromatic and chromatic aberration, Monochromatic aberration and its reduction: Spherical aberration, Types of chromatic aberration: Achromatism (lenses in contact and separated by finite distance).

[Subramanyam; Chapter.9: 9.1, 9.2, 9.5, 9.5.1, 9.10, 9.11, 9.12, 9.13]

3. **Optical Instruments[4 h]**

Objective and Eyepiece, Huygen's eyepiece, Ramsden's eyepiece, Telescopes, Refracting and Reflecting type of telescopes and Spectrometer.

[Subramanyam; Chapter.10: 10.8, 10.10, 10.10.1, 10.11, 10.11.1,10.12, 10.15, 10.15.1, 10.16, 10.16.1,10.17]

Unit II: Interference and Diffraction [20 h]

1. **Introduction to Interference and Interference in Thin Films** **[6 h]**

Superposition of waves, Interference, Coherence, Conditions for Interference, Techniques of obtaining Interference, Young's Double Slit Experiment, Phase Change on reflection: Stoke's law.

[Subramanyam: Chapter.14: 14.3, 14.4, 14.4.2, 14.4.4, 14.6, 14.7, 14.8 and Singh Ref.2: Chapter6: 6.3]

Thin Film, Interference due to reflected and transmitted lights in thin films: Plane Parallel Film, Wedge-shaped Film, Newton's Rings, Types of fringes.

[Subramanyam: Chapter.15: 15.1, 15.2, 15.2.1 - 15.2.5, 15.3, 15.4, 15.5, 15.5.1 - 15.5.4, 15.6, 15.6.1 - 15.6.9]

2. **Interferometry** **[3 h]**

Michelson's Interferometer: Principle, Construction, Working, Circular Fringes, Localised Fringes, White Light Fringes, Application of Michelson's Interferometer: Measurement of Wavelength and Determination of the difference in the wavelength of two waves.

[Subramanyam; Chapter.15: 15.7, 15.7.1 - 15.7.5, 15.8, 15.8.1, 15.8.2]

3. **Introduction to Diffraction and Fresnel Class Diffraction** **[5 h]**

Difference between Interference and Diffraction, Types of diffraction: Fresnel Class and Fraunhoffer Class.

[Subramanyam; Chapter.17: 17.6, 17.7 and Sing: Chapter7: 7.5, 7.6]

Diffraction of Light (Fresnel Class): Division of cylindrical wave-front into Fresnel's half period strips, Diffraction at straight edge, Diffraction at a narrow wire.

[Singh: Chapter.7: 7.9, 7.10, 7.11]

4. **Fraunhoffer Class Diffraction and Resolving Power of optical Instruments [6 h]**
   Diffraction at a single slit (Central maximum, Secondary maxima and Secondary minima), Diffraction at double slit, Distinction between single slit and double slit diffraction patterns, Missing orders in a double slit diffraction pattern, Diffraction at N slits(only conceptual), Determination of wavelength of a spectral line using Plane Transmission Grating. Resolving Power, Rayleigh's criterion, Resolving power of telescope and Resolving Power of Prism.
   [Subramanyam: Chapter.18: 18.2, 18.2.1, pg.431 to 433, 18.4, 18.4.1, 18.4.2, 18.4.3, 18.7, 18.7.1, 18.7.2, 18.7.6 and Chapter.19: 19.1, 19.2, 19.6, 19.7, 19.11]

Unit III: Polarization [10 h]

1. **Production and Analysis of Polarized lights [7 h]**
   Polarized Light, Natural Light, Production of Linearly Polarised Light, Anisotropic Crystal, Calcite Crystal, Huygens Theory of Double Refraction in Uniaxial crystal, Nicol prism- its fabrication, working and use, Types of Polarized Light, Retardation plates - Quarter wave plate and Half wave plate, Production of Elliptically and Circularly Polarized Lights, Detection of plane, circularly, elliptically polarized lights, Analysis of polarized light.
2. **Polarimeter [3 h]**
   Optical activity, Specific rotation, Simple Polarimeter, Laurent's Half-Shade Polarimeter.
   [Subramanyam: Chapter.20: 20.3, 20.4, 20.5, 20.5.1 to 20.5.5, 20.7, 20.8, 20.8.1 to 20.8.3, 20.9, 20.9.1, 20.9.2, 20.6.1, 20.6.3, 20.15, 20.17.1, 20.17.2, 20.18, 20.18.1, 20.19, 20.19.1, 20.20, 20.24, 20.24.1, 20.25, 20.26]

Experiments: (Minimum six)

1. Cardinals points of Two lenses
2. Prism Spectrometer: Optical levelling, Angle of Prism
3. Dispersive power of prism
4. Newton's Rings
5. Wedge shaped air film
6. Single Slit Diffraction using LASER/Sodium source.
7. Diffraction Grating using LASER/Sodium source.
8. Malus's Law using LASER source.
9. Brewster's Law using LASER source.
10. Polarimeter (Demonstration)
11. Lloyd's Mirror/Biprism (Demonstration)
12. Cylindrical Obstacle (Demonstration)

References:

1. Subramanyam N., Lal Brij, Avadhanulu M. N., 2006, *A Text book of Optics*, First multicolour Edition, S. Chand & Company Ltd., New Delhi
2. Singh S. P., Agarwal J. P., 2001, *Optics*, 8th Edition, Pragati Prakashan, Meerut

Additional References:

1. Mathur B. K., *Principles of Optics*, New Global Printing Press, Kanpur.
2. GhatakA., 1977, *Optics*, Tata McGraw-Hill Publishing Company Ltd., New Delhi
3. Jenkins F. A., White H. E., 1981, *Fundamentals of Optics*, Tata McGraw-Hill Publishing Company Ltd., New Delhi.

Web References:

1. https://ocw.mit.edu/courses/mechanical-engineering/2-71-optics-spring-2009/video-lectures/
2. https://www.youtube.com/playlist?list=PLkzOLGQfSuu0L7NRVSxXrMd73NDc48ILb
3. https://www.youtube.com/playlist?list=PL9jo2wQj1WCP2eeRb8UacmKJy850Y9DYQ
4. https://www.youtube.com/playlist?list=PLX2gX-ftPVXWA5TjEhVQSQQzZ-5_5Nui8
5. https://www.youtube.com/watch?v=htSPI7YHnP4&list=PLD707C7AF1A0BC358
6. https://www.youtube.com/watch?v=v1U38n52h9A&list=PLA435953DF9CC6BB9

Course Title **: Modern Physics**

Course Code **: PHY-E2**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Pre-requisite **:Nil**.

Course Objectives:

Modern Physics involves the study of radiation and matter at atomic levels and velocities close to the speed of light. This course will focus on the early development of the theory of atomic structure, wave particle duality, mass spectrographs, accelerators and Lasers. Lectures will help you clarify concepts of modern physics through various conceptual questions and problems.

Course Learning Outcomes: At the end of this course students will be able to:

CLO1: Understand constituents of an atom and atomic structure.
CLO2: Understand and interpret experiments that reveal the particle properties of waves and wavelike properties of particle.
CLO3: Apply uncertainty principle to solve numerical problems related to subatomic physics
CLO4: Understand the working of mass spectrographs and accelerators
CLO5: Understand the basic operating principle of the laser and the optical fibre.

Theory:

Unit I: **[15 h]**

1. **Electrons, Nucleus and Atoms:** **[4 h]**
   Determination of e/m for cathode rays. Thomson's model of the atom and qualitative discussion of alpha scattering experiment. Rutherford's model of the atom. Determining upper limit to nuclear dimension. Electron orbits. Failure of Classical Physics.
   [Rajam: Pages 33-36, 44-50, Beiser: 5.1, 5.3, 5.5-5.7]

2. **Brief review of Atomic models:** **[6 h]**
   Atomic Spectra. Frank-Hertz experiment. The Bohr Atom: Quantization of energy. Bohr-Sommerfeld model. Nuclear motion and reduced mass. Bohr's Correspondence Principle.
   [**Beiser: 6.1, 6.3-6.8]**

3. **Particle Properties of waves:** **[5h]**
   Concepts of Blackbody radiation. The Photoelectric effect. Compton Effect. Experimental verification of the Photoelectric effect.
   [Singh: 1.1-1.3, Beiser: 3.1,3.2, 3.5, Muregeshan: 8.5]

Unit II: **[15 h]**

1. **De Broglie's Postulate - Wavelike properties of Particles:** **[9 h]**
    a. **Dual nature of matter:** Experiments with bullets, waves and electrons. The interference of electron waves. Watching the electrons.
    [Feynman: 1.1-1.6]
    b. **Matter Waves**: De Broglie's postulate. Davisson and Germer experiment. Electron diffraction experiment of G. P. Thomson. Review of the Bohr's postulate about stationary states in the light of De Broglie's concepts.
    [Eisberg: 3.1], [Singh: 2.8]
    c. **Properties of Matter waves:** Wave and group velocities. Relation between the group velocity and phase velocity. Velocity of De Broglie wave. Wave packet and its motion in one dimension.
    [Singh: 2.3-2.5, 2.9]

2. **Heisenberg's Uncertainty Principle:** **[6 h]**
    Uncertainty principle. Elementary proof of Heisenberg's uncertainty relation between position and momentum. Elementary proof of Heisenberg's uncertainty relation between energy and time. Illustration of Heisenberg's uncertainty principle with thought-experiments. Consequences of the uncertainty relation.

    [Singh: 3.1-3.5]

Unit III: **[15 h]**

1. **Measurement of Mass and accelerators** **[6 h]**
    Measurement of Mass: Thomson's positive ray analysis, Dempster's Mass spectrometer, Bainbridge Mass spectrograph.
    Linear accelerator and Cyclotron.
    [**Rajam: pg. 227-233, 240-244, Muregeshan: 30.3, 30.4]**

2. **Lasers:** **[9 h]**
    Attenuation of light in an optical media. Thermal Equilibrium. Interaction of light with matter. Einstein's A and B coefficients and their relations. Population inversion. Principal pumping schemes. Ruby Laser, He-Ne Laser and Semiconductor laser. Applications of Laser.
    Optical fibres: Optical fibre, Total internal reflection, Propagation of light through optical fibre, Losses in optical fibre.
    [Subrahmanyam: 22.1-22.11,22.15, 22.16.1, 22.16.3, 22.7, 24.1-24.4, 24.15]

Experiments: (Minimum Six)

1. Determination of e/m of electrons using Thomson's method.
2. Measurement of k/e.
3. Measurement of diameter of Lycopodium powder.
4. To determine wavelength of Laser source by diffraction of single slit.
5. To determine wavelength of Laser source by diffraction of double slit.
6. Frank Hertz Experiment.
7. Photoelectric effect.
8. IV Characteristics of LASER
9. Optical fibre: Numerical aperture
10. Bending loss in optical fibre

References:

1. Beiser, A. 1969, *Perspectives of Modern Physics*, McGraw-Hill Book Company, Singapore.
2. Feynman, R. 2012, *Feynman Lectures on Physics: Quantum Mechanics (Volume - 3)*, Pearson Education, India.
3. Murugeshan, R 2009, *Modern Physics*, S. Chand and Company limited, New Delhi.
4. Rajam, J. 2000, *Atomic Physics*, S. Chand and Company limited, New Delhi.
5. Subramanyam, N., Lal, B. and Avadhanulu, M. 2004, *A Textbook of Optics*, S. Chand and Company limited, New Delhi.
6. Singh, K. And Singh, S. 2013, *Elements of Quantum Mechanics*, S. Chand, New Delhi.

Additional References:

1. Ghatak 2012, *Optics*,McGraw Hill Education, India.
2. Richtmyer, F., Kennard, E., Cooper, J. 2001, *Introduction to Modern Physics*, 6th ed. McGraw-Hill Book Company, New Delhi.
3. Tipler, P. 2012, *Modern Physics*, WH Freeman, New York.

Web References:

1. https://hcverma.in/QuantumMechanics
2. https://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-solid-state-chemistry-fall-2010/
3. https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2016/
4. https://www.youtube.com/watch?v=VLU4dntonhE&list=PLLUpvzaZLf3LeHh3JgGDSfkLQX02BsDK1
5. https://phet.colorado.edu/en/simulations/category/physics

Course Title : **Oscillations, Waves and Sound**

Course Code : **PHY-E3**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Prerequisite : **Nil**

Course Objectives : Simple harmonic motion is one of the fundamental types of motion that exists in nature. The objective of this course is to cover the fundamental physical concepts of Simple harmonic motion, waves and sound.

Course Learning Outcomes: After successful completion of this course, students will be able to:
CLO1: Set up an equation of motion for simple harmonic motion and obtain its solution.
CLO2: Explain how superposition of waves leads to different Lissajous figures.
CLO3: Set and solve the equation of motion for damped and driven damped harmonic oscillators and analyse the nature of oscillations.
CLO4: Understand the dependence of velocity of sound waves on various factors like temperature, pressure, density, humidity.
CLO5: Solve problems for different cases of Doppler effect.

Theory:

Unit I: Undamped free oscillation **[15 h]**

1. **Undamped free oscillation** **[15 h]**
   Different type of equilibria (Stable, unstable and neutral equilibrium). Periodic oscillations and potential well.
   [Mathur: 5.9]
   Differential equation for simple harmonic oscillator and its solutions. Energy of the harmonic oscillator.
   [Taylor: 5.1-5.2]
   Examples of simple harmonic oscillations: spring and mass system, simple and compound pendulum, torsional pendulum, bifilar oscillations, Helmholtz resonator.
   [Mathur: 7.7.1-7.7.5]
   Superposition of two simple harmonic motions of the same frequency along the same line. Superposition of two mutually perpendicular simple harmonic vibrations of the same frequency. Superposition of two mutually perpendicular simple harmonic vibrations and having time periods in the ratio 1:2. Uses of Lissajous' figures.
   [Subrahmanyam: 2.1, 2.2, 2.4, 2.6, 2.9]

Unit II: Damped Oscillations and Driven Damped Oscillations [15 h]

1. **Damped Oscillations** **[5 h]**
   Introduction. Differential equation of damped harmonic oscillator and its solution, discussion of different cases (Strong, weak and Critical damping).Logarithmic decrement. Energy equation of damped oscillations. Power dissipation. Quality factor.
   [Taylor: 5.4 and Mathur: 8.2-8.4]

2. **Driven Damped Oscillations** **[5 h]**
   Introduction, Differential equation of forced oscillation and its solution (transient and steady state). Resonance. Width of the resonance; the Q factor. The phase at resonance. Velocity resonance.
   [Taylor: 5.5-5.6 and Mathur: 8.9]

3. **Coupled Oscillations [5 h]**
   Coupled oscillations. Normal Coordinates. Energy of coupled oscillations.

Unit III: Waves and Sound and Doppler Effect [15 h]

1. **Waves and Sound** **[10 h]**
   Transverse vibrations in strings. Velocity of longitudinal waves in gases. Newton's formula for velocity of sound. Velocity in a homogeneous medium. Laplace's correction. Kundt's tube-determination of velocity of sound in a gas and in solids. Intensity level and Bel and Decibel.
   Production and detection of Ultrasonic waves and its applications
   [Khanna 4.2, 5.3-5.5, 11.1, 11.3, 12.1-12.4, 19.6 and Subrah.: 11.23 11.25,11.27]

2. **Doppler Effect:** **[5 h]**
   Explanation of Doppler effect in sound. Observer in rest and source in motion. Source at rest and observer in motion. When both source and observer are in motion. Effect of wind velocity. Doppler effect in light. Applications of Doppler effect.
   [Subrahmanyam: 8.1-8.6]

Experiments: (Minimum Six)

1. To determine the equivalent length of the Kater's pendulum and the acceleration due to gravity using a resonance pendulum.
2. To determine the damping constant using Damped harmonic oscillator
3. To determine the velocity of Sound using Helmholtz resonator
4. To determine the value of acceleration due to gravity using a bar pendulum.
5. To determine the frequency of AC mains using Sonometer.
6. Bifilar suspension: Dependence of the time period on the geometry of non-parallel bifilar suspension.

7. Log Decrement.
8. Velocity of Sound using CRO.
9. Lissajous Figures (Demonstration).

References:

1. Khanna, D., Bedi, R. 1992, *A Textbook of Sound*, Atma Ram and sons, Delhi.
2. Mathur, D. 2012, *Mechanics*, S. Chand, New Delhi.
3. Taylor, J. 2005, *Classical Mechanics*, University Science Books, USA
4. Subrahmanyam, N. and Lal, B. 1994, Waves and Oscillation, Vikas Publishing House, Noida

Additional References:

1. French, AP 2003, Vibration and Waves, CBS Publisher, India.
2. Halliday, D., Resnick, R. and Walker, J. 2003, Fundamentals of Physics, 6^{th} edition, John Wiley and Sons, USA.
3. Pain, J. 2005, *The Physics of Vibration and Waves*, 6^{th} Edition, Wiley.

Web References:

1. https://nptel.ac.in/courses/115/106/115106119/
2. https://nptel.ac.in/courses/115/106/115106090/
3. https://ocw.mit.edu/courses/physics/8-03sc-physics-iii-vibrations-and-waves-fall-2016/part-i-mechanical-vibrations-and-waves/
4. http://galileo.phys.virginia.edu/classes/152.mf1i.spring02/OscWavesIndex.htm
5. http://www.qrg.northwestern.edu/projects/vss/docs/communications/3-what-is-the-doppler-effect.html

Course Title: Introduction to Astronomy and Astrophysics

Course Code: PHY-E17

Marks: 75 (Theory) + 25 (Practical)

Credits: 3 (Theory) + 1 (Practical)

Prerequisites: Classical Mechanics, Optics, Modern Physics, Quantum Mechanics, Electromagnetic Theory - I

Course Objectives: The course aims to introduce the students to the Exciting World of Extragalactic Universe.

Course Learning Outcomes: At the end of the course, students will be able:

CLO1: Understand the various Extra-galactic objects.

CLO2: Understand the construction, working and mounting of modern telescopes.

CLO3: Understand co-ordinate system of Celestial Objects.

CLO4: Understand different spectral classes of stars, galaxies and the very early universe.

CLO5: Locate objects in the sky using coordinate systems.

Theory:

UNIT I: FUNDAMENTALS OF ASTRONOMY [15 h]

1. The Celestial Sphere and Mechanics: [7 h]

The Greek tradition: The geocentric universe; The Copernican revolution: Bringing Order to the Planets; Positions on the Celestial Sphere: The Altitude- Azimuth Coordinate system, The Equatorial Coordinate System, Precession, Measurement of time

Elliptical orbits: Kepler's Laws of Planetary Motion, Geometry of Elliptical Motion

[**Carroll & Ostlie: Chapter 1: 1.1-1.3; Chapter 2: 2.1]**

2. Continuous Spectrum of Light [8 h]

Stellar Parallax; The Magnitude Scale: Apparent Magnitude, Flux, Luminosity and Inverse Square Law, Absolute Magnitude, Distance Modulus; Blackbody Radiation: Connection between color and temperature, Stefan Boltzmann Equation; Planck function and Astrophysics; Color Index: UBV Wavelength filters, Color indices and the Bolometric Correction, The Color-Color diagram; Interaction of Light and Matter: Spectral lines, Kirchoff's laws, Applications of Stellar Spectra Data, Spectrographs

[**Carroll & Ostlie: Chapter 3: 3.1-3.2, 3.4-3.6; Chapter 5: 5.1]**

UNIT II: ASTRONOMICAL TOOLS, THE SOLAR SYSTEM AND THE NATURE OF STARS [15 h]

1. Astronomical Instruments: [4 h]

Optical telescopes: Refracting and reflecting telescopes, Telescope mounts, Large Aperture telescopes, Adaptive optics, Space based observatories, Electronic detectors; Radio telescopes: Spectral flux density, Improving resolution – Large apertures and Interferometry

[**Carroll & Ostlie: Chapter 6: 6.2-6.3]**

2. The Solar Sytem: [6 h]

Brief survey: General characteristics of the planets, Moons of the planets, Asteroid belt, Comets and Kuiper belt objects, Meteorites, Solar system formation – a brief overview; Tidal forces: Physics of tides, Effects of tides, Synchronous rotation, Additional tidal effects from the sun, Roche limit

[**Carroll & Ostlie: Chapter 19: 19.1-19.2]**

3. Classification of Stellar Spectra: [5 h]

Formation of spectral lines: Spectral types of stars, The Maxwell Boltzmann velocity distribution, The Boltzmann equation, Saha equation; The Hertzsprung Russell Diagram: An enormous range in stellar radii

[**Carroll & Ostlie: Chapter 8: 8.1-8.2]**

UNIT III: STAR FORMATION, GALAXIES AND THE UNIVERSE [15 h]

1. Star formation [6 h]

Formation of protostars- Jeans criterion; Pre-Main Sequence- Formation of Brown Dwarfs, The Zero Age Main Sequence (ZAMS); Evolution of the Main Sequence- Schönberg-Chandrsekhar limit; Late Stages of Stellar Evolution- Subgiant branch, Red Giant branch, Horizontal branch; Stellar Clusters- Globular and Galactic clusters

[**Carroll & Ostlie: Chapter 12: 12.2-12.3, Chapter 13: 13.1-13.3]**

2. The Milky Way and the Nature of Galaxies **[5 h]**

Morphology of the Milky Way Galaxy; Galactic Center; The Hubble Sequence: Classification of galaxies

[**Carroll & Ostlie: Chapter 24: 24.2, 24.4, Chapter 25: 25.1]**

3. The Early Universe **[4 h]**

Fundamental particles, Hot and Cold Dark matter, Planck's limits on time, mass and length, Unification and spontaneous symmetry breaking, Problems with the standard theory of the Big Bang, Inflation

[**Carroll & Ostlie: Chapter 30: 30.1]**

Experiments: (Minimum six)

1. Resolving power of telescope
2. Study of scattering of light (Diameter of Lycopodium powder)
3. To find radius of curvature of a convex lens using optical lever
4. Measurement of the solar constant
5. Draw constellation map of a) Orion b) Auriga c) Taurus d) Ursa Major (Big Dipper) marking of pole star.
6. To determine the elements in sun using Frauhoffer spectra
7. To estimate Astronomical Unit using Venus transit data by parallax method
8. Determine the period of revolution of sun using virtual laboratory
9. To become familiar with the astronomical objects visible to naked eye in the night sky using the software Stellarium
10. To become familiar with the Constellations in the night sky using the software Stellarium
11. To identify the retrograde motion of Mars with respect to the Background stars using Stellarium
12. To identify some of the prominent spectral lines in the spectrum of our sun
13. To get familiar with the spectra of different stars using Stellarium
14. To extract coordinates of a star assuming a telescope in equatorial mount using Stellarium
15. To measure astronomical distances using Cepheid variables using Stellarium
16. To measure the Proper Motion of Barnard's Star using Stellarium
17. To identify a Circumpolar Star using Stellarium
18. To determine the distance and age of cluster using Colour Magnitude Diagram using Stellarium
19. To determine orbital inclination of the planet Mars using Stellarium
20. To measure planetary distances using Stellarium
21. To measure distance to Moon using Stellarium

22. To determine observer’s location by means of the stars using Stellarium

References:

1. Freedman, R. A. & Kaufmann III, W. J., 2008. *Universe*, Eighth Edition. New York: Clancy Marshall
2. Shu, F. H., 1982. *The Physical Universe An Introduction to Astronomy*. Sausalito, California: University Science Books.
3. Kutner, M. L., First published in 2003. *Astronomy A Physical Perspective*. Second ed. New York: Cambridge University Press.
1. Carroll, B. W. & Ostlie, D. A., n.d. *An Introduction to Modern Astrophysics*. Second ed. San Francisco: Addison Wesley.

Additional References:

1. Roy A.E., Clarke D., 1989, *Astronomy structure of the Universe*, Adam Hilger Pub.
2. Glasstone S., 1965, *Source book on the Space Sciences*, Van Nostrand Reinhold Inc., U.S
3. Bhatia V. B., 2001, *Textbook of Astronomy and Astrophysics* with Elements of Cosmology, Narosa Publishers, New Delhi.
4. Narlikar J.V., 1976, *Structure of the Universe*, Oxford Paperbacks.
5. Badyanath and Basu, 2010, *An Introduction to Astrophysics*, 2nd Edition, Prentice Hall India Learning Private Limited
1. Abhyankar K.D., 2001, *Astrophysics - Stars and Galaxies*, Tata McGraw Hill, New Delhi
2. Sule, A., 2013. *A Problem Book in Astronomy and Astrophysics.* [Online]
3. Palen, S. E., 2002. *Schaum's Outline Series, Astronomy*. United States of America: McGraw Hill.

Web References:

1. https://youtu.be/QJjT9QPlnJs
2. https://youtu.be/vDv3iSMdYyc
3. https://youtu.be/Upy-jNpQW_0
4. https://youtu.be/nzmFc2gjUo4
5. https://youtu.be/0b7-4tfx3J4
6. https://ocw.mit.edu/courses/physics/8-282j-introduction-to-astronomy-spring-2006/
7. https://ocw.mit.edu/courses/physics/8-901-astrophysics-i-spring-2006/
8. https://ocw.mit.edu/courses/physics/8-902-astrophysics-ii-fall-2004/

Course Title **: Basics of Visualization and Scientific word processing**

Course Code **: PHY-SEC.1**

Marks **: 100**

Credits **: 4**

Course Objectives **:** To develop basic competence in Linux environment, Data visualization, scientific word processing and Crystal visualization.

Course Outcomes **:** At the end of this course students will be able to:

CLO1: Familiarize with the Linux environment

CLO2: Design crystal structures using crystal visualizers

CLO3: Understand basic mechanisms of Latex and prepare high quality type setting.

CLO4: Plot and visualize data to explore data sets graphically or create high quality graphs for presentation and publication purpose.

Unit I **[20 h]**

Introduction to Linux Environment:

- Installation of Virtual Box.
- Navigation: Current working directory, Listing the Contents of a Directory. Changing the Current Working Directory.
- Exploring the system: Determining A File's Type With file. Viewing File Contents With less.
- Manipulating files and directories: Creating, deleting, copying and moving of directories and files.
- Filters: grep, head/tail, tee, awk, sed, more, less.
- Vi Editor: Appending text. Deleting text. Cutting, Copying, And Pasting Text. Saving work.
- Simple bash scripting: Introduction and executable permissions, if-then-else, do-while and for loops.

[Shotts: Chapter 2, 3 (pg.13-19), **4, 6** (pg. 59-66), **12** (pg. 136-147, 154-155), **24** (Pg:354-358), **27** (pg. 381-389), **29** (pg. 409-413)**, 33** (pg. 450-452)**]**

Unit II **[10 h]**

Crystalline and molecular structure visualisation

Introduction to crystal structures. Installing Vesta. designing crystal structures. Simulate XRD pattern. visualizing lattice planes and drawing lattice vectors. creating supercell.

Unit III **[20 h]**

Scientific word processing:

- **Introduction to LaTeX**: Preparing a basic LaTeX file. Input Files and File structure.
- **Typesetting Text**: The structure of text and language, Line breaking and page breaking. Readymade strings. Special characters and symbols. Titles, chapters and symbols. Cross references, Foot notes, emphasised words.
- **Environments**: Itemize, enumerate and description. Flushleft, Flushright, and Centre. Tabular
- **Typesetting mathematical formulae:** General. Grouping in math mode. Building blocks of a mathematical formula. Math spacing. Vertically aligned material.
- **Graphics and Bibliography:** EPS graphics, Bibliography and Indexing.
- **Creating Presentations:** Introduction to Beamer. Setting up a beamer document. Enhance a beamer presentation.

[Oetikar: 1.1-1.3, 2.1-2.4, 2.7-2.11, 3.1-3.5, 4.1-4.3][Binder: 11.1-11.5]

Unit IV

Data Visualization: **[10 h]**

Introduction to gnuplot. Simple plots, plotting data from a file, abbreviations and defaults. Saving commands and exporting graphs. Plotting functions and data. Math with gnuplot. multiple data sets per file. Different plot styles. Multiple axis. Plot range. Tic marks.

[Janert: 1.3, 2.1-2.2, 3.1,3.2, 4.1- 4.2, 6.1-6.3.1, 8.1-8.3.4.]

References:

1. William Shotts JR., 2013, *The Linux Command Line* 2nd Edition, No Starch Press, USA
2. Kochi Momma, Fujio Izumi, 2019, VESTA: a Three-Dimensional Visualization System for Electronic and Structural Analysis (https://jp-minerals.org/vesta/archives/VESTA_Manual.pdf)
3. Tobias Oetiker, Hubert Partl, Irnen Hyna and Elisabeth Schlegl, 2001, *The Not so Short Introduction to LateX*, Free Software Foundation, USA (https://tobi.oetiker.ch/lshort/lshort.pdf)
4. Donald Binder and Martin Erickson, 2011, *A students guide to the study practice and tools of Modern Mathematics*, CRC Press, USA

5. Phillip Janert, 2016, *Gnuplot in Action: Understanding data with graphs* 2nd Edition, Manning Publications, US

Web References:

1. https://maker.pro/linux/tutorial/basic-linux-commands-for-beginners
2. https://www.youtube.com/playlist?list=PLS1QulWo1RIb9WVQGJ_vh-RQusbZgO_As
3. https://www.youtube.com/playlist?list=PL1D4EAB31D3EBC449

4. https://www.youtube.com/playlist?list=PLAiKNYrUqmyKvRtKRYaZ6Ylwcj977r0lw
5. https://www.youtube.com/playlist?list=PLfIFNJ1DPG4nRLP5qsXn1UWTgAyysZE6-

SEMESTER-V

Course Title : **Electromagnetic Theory – II**

Course Code : **PHY-V.C-7**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Pre-requisite : **Electromagnetic Theory – I (PHY-III.C-5)**

Course Objectives **:** To acquaint students with fundamental principles of Magnetostatics part of the Electromagnetic Theory.

Course Learning Outcomes: At the end of this course, students would be able to:

CLO1: Calculate magnetic field induction using Biot-Savart's law and Ampere's law.

CLO2: Interpret bound currents and calculate magnetic fields in matter.

CLO3: Comprehend microscopic theory magnetism.

CLO4: Relate electrostatics and magnetostatics using Maxwell's equations.

CLO5: Develop and solve the wave equation for propagation of electromagnetic waves through material media and vacuum at different angles of incidence.

Theory:

Unit I: Magnetostatics **[15 h]**

1. **Magnetostatics** **[15 h]**

   Lorentz force law: Magnetic fields, Magnetic forces, Currents, Biot-Savart law: Steady currents, Magnetic fields of a steady current, Divergence and Curl of **B**: Straight-line currents, divergence and curl of **B**, applications of Ampere's law, comparison of magnetostatics and electrostatics, Magnetic vector Potential: Vector potential, magnetostatic boundary conditions, multipole expansion of the vector potential.

   [Griffiths: 5.1: 5.1.1 – 5.1.3, 5.2: 5.2.1 – 5.2.2, 5.3: 5.3.1 – 5.3.4, 5.4: 5.4.1 – 5.4.3]

Unit II: Magnetic Fiels in Matter and Microscopic Theory of Magnetism **[15 h]**

1. **Magnetic Fields in Matter** **[11 h]**

   Magnetization: Diamagnets, paramagnets and ferromagnets, torques and forces on magnetic dipoles, effect of a magnetic field on atomic orbits, magnetization, the field of a magnetized object: Bound currents, physical interpretation of bound currents, magnetic field inside matter, The auxiliary field H: Ampere's law in magnetized materials, a deceptive parallel, boundary conditions, Linear and nonlinear media: Magnetic susceptibility and permeability, Energy in magnetic fields.

   [Griffiths: 6.1: 6.1.1 – 6.1.4, 6.2: 6.2.1 – 6.2.3, 6.3: 6.3.1 – 6.3.3, 6.4: 6.4.1 – 6.4.2, 7.2.4]

2. **Microscopic Theory of Magnetism** **[4 h]**

   Molecular field inside matter, origin of diamagnetism, origin of paramagnetism, theory of ferromagnetism, ferromagnetic domains, ferrites
   [Reitz: 10.1 – 10.2]

Unit III: Maxwell's Equations and Propagation of Electromagnetic Waves **[15 h]**

1. **Maxwell's Equations** **[5 h]**

   Generalization of Ampere's law, displacement current, Maxwell's equations and their empirical basis, electromagnetic energy, Poynting theorem.
   [Reitz: 16.1 – 16.3]

2. **Propagation of Electromagnetic Waves** **[10 h]**

   The wave equation, plane monochromatic waves in non-conducting media, polarization, plane monochromatic waves in conducting media, reflection and refraction at the boundary of two non-conducting media: normal incidence and oblique incidence, Brewster's angle, critical angle.
   [Reitz: 16.4, 17.1, 17.2, 17.4, 18.1, 18.2]

Experiments: (Minimum Six)

1. Hysteresis by magnetometer.
2. B-H curve in a hard magnetic material and in a soft ferrite.
3. Core losses and copper losses in a transformer.
4. Measurement of mutual inductance using ballistic galvanometer.
5. Calibration of lock-in-amplifier and determination of mutual inductance.
6. Determination of magnetic susceptibility of $FeCl_3$ by Quincke's method.
7. M/C using ballistic galvanometer
8. Helmholtz coils.

References:

1. Griffiths D. J., 2011, *Introduction to Electrodynamics*,3rd Ed., Prentice Hall of India, New Delhi

2. Reitz J. R., Milford F. J., Christy R. W., 1979, *Foundations of Electromagnetic Theory*,3rd Ed., Addison-Wesley Publishing Company.

Additional Reference:

1. Mukherji U., 2008, *Electromagnetic Field Theory and Wave Propagation*, Narosa Publishing House.

Web References:

1. https://nptel.ac.in/courses/115101005/
2. https://swayam.gov.in/nd1_noc19_ph08/preview
3. https://ocw.mit.edu/courses/physics/8-07-electromagnetism-ii-fall-2012/lecture-notes/
4. https://www.feynmanlectures.caltech.edu/II_toc.html
5. http://galileo.phys.virginia.edu/classes/109N/more_stuff/Maxwell_Eq.html

Course Title **: Solid State Physics**

Course Code **: PHY-E9**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Pre-requisites **: Quantum Mechanics (PHY-IV.C-6)**

Course Objective: This course deals with crystalline solids and is intended to provide students with basic physical concepts and mathematical tools used to describe solids. The course broadly deals with the topics related to structural aspects and the various physical properties of crystalline solids.

Course Learning Outcomes: After completion of this course, students will be able to
CLO1: Identify bonding types in crystalline solids and correlate the nature of bonding of solid to some of the physical properties associated with it.
CLO2: Identify different crystal systems and determine structural parameters like unit cell of crystal lattices, translation vectors, atomic packing, crystal planes and directions with help of Miller Indices.
CLO3: Derive and apply Bragg's law to determine crystal structure.
CLO4: Derive and apply classical free electron theory of metals to study electrical conductivity
CLO5: Derive and apply density of energy states to estimate density of free electrons, Fermi energy and mean energy of electron gas at absolute zero
CLO6: Derive and apply Fermi Free electron gas model in 3 dimensions to study electrical properties of metals.
CLO7: Understand Bloch's theorem, Kronig-Penney Model and interpret energy band structures in solids, effective mass and energy-wavevector relationship.
CLO8: Distinguish materials with respect to their magnetic properties.
CLO9: Apply the knowledge gained to solve problems in solid state physics using relevant mathematical tools.

Theory:

Unit I: Bonding in Solids and Crystal Structures **[20 h]**

1. **Bonding in Solids** **[5h]**

   Introduction, Bonding in Solids, Cohesive energy, Ionic bonding, Calculation of Cohesive energy of ionic solids, Covalent bonding, Metallic bonding, Hydrogen bonding, Van der Waals (Molecular) bonding.
   [Pillai: Ch-3.I– 3.IX, 3.XII–3.XXIV]

2. **Crystal Structure** **[11h]**

   Introduction, Space Lattice, Unit cell, Lattice Parameter of unit cell, Bravais lattices, Crystal Symmetry, Stacking sequences in metallic crystal structure, SC, BCC, FCC and HCP structures, Crystal structures- NaCl, diamond, CsCl, ZnS, Directions in crystals, Planes in crystals- Miller indices, Distances of Separation between Successive (*hkl*) Planes.

[Pillai: Ch-4.I – 4.VIII, 4.XIV – 4.XXII]

3. **Diffraction of X-rays by Crystals** **[4 h]**

Introduction, Bragg's law, Bragg's X-ray Spectrometer, Powder Crystal method (Debye Scherrer method), Rotating Crystal method.

[Pillai: Ch-5.VII – 5.XI]

Unit II: Electrical Properties of Metals **[20 h]**

Introduction, Classical Theory of Electric Conduction, Drawbacks of Classical theory, Revision of particle in a rectangular three-dimensional box, Fermi-Dirac Statistics and Electronic distribution in Solids, Fermi distribution function, Density of energy states and Fermi energy, Mean energy of electron gas at absolute zero, Electrical conductivity from Quantum mechanical consideration, Sources of electrical resistance in metals, Thermal conductivity in metals, Joule's law, Thermionic emission, Failure of Sommerfeld's free electron model, Band theory of Solids, Bloch's Theorem, Kronig-Penny model, Brillouin Zones, Motion of electrons in one- dimensional periodic potential, Distinction between metals, insulators and semiconductors.

[Pillai: Ch-6.II – IV, 6.XIV – 6.XVIII, 6.XX – 6.XXII, 6.XXV, 6.XXIX, 6.XXXI, 6.XXXV – 6.XXXXI]

Unit III: Magnetic Materials and Magnetic Properties **[5 h]**

Introduction, Classification of magnetic materials, The quantum numbers, Origin of magnetic moment, Ferromagnetism, Ferromagnetic domains, Hysteresis, Hard and soft materials.

[Palanisamy: 8.1, 8.2, 8.3, 8.4, 8.7, 8.7.3, 8.7.5, 8.7.6]

Experiments: (Minimum Six)

1. Energy band gap of a semiconductor using a diode.
2. Energy band gap of a semiconductor using LEDs
3. Energy band gap of a thermistor.
4. To determine value of Planck's constant using LEDs of at least 4 different colours.
5. Fermi energy of Copper
6. Measurement of Hysteresis loss using CRO
7. Calculation of lattice constant by of Copper – X-ray diffraction pattern is given and

student calculates: d-spacing, miller indices and lattice constant.

8. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four-probe method (room temperature to 150 ^{o}C) and to determine its band gap
9. Investigating crystal structure using Vesta software.

References:

1. Pillai S. O., 2018, *Solid State Physics*,8th Multi Colour Edition, New Age International Publisher.
2. Palanisamy P. K., 2004, *Solid State Physics*, Scitech Publications (India) Pvt. Ltd.

Additional References:

1. Kittel C., 2004, *Introduction to Solid State Physics*, 8th Edition,John Wiley and Sons.
2. Dekker A. J., 1998, *Solid State Physics*, Macmillan India Ltd. Publisher.

Web References:

1. https://www.youtube.com/watch?v=RImqF8z91fU&list=PLtTPtV8SRcxi91n9Mni2xcQX4KhjX91xp
2. https://www.classcentral.com/course/swayam-introduction-to-solid-state-physics-13045
3. https://www.classcentral.com/course/swayam-solid-state-physics-14298
4. https://www.youtube.com/playlist?list=PLaNkJORnlhZnC6E3z1-i7WERkferhQDzq
5. https://www.youtube.com/playlist?list=PL0jxQTuSuktJd7Gbelcg9R0f3oYYeMbRs

Course Title **: Thermodynamics and Statistical Mechanics**

Course Code **: PHY-E10**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1 (Practical)**

Pre-requisite **: Heat and Thermodynamics (PHY-II.C-3)**

Course Objectives **:** This course will introduce kinetic theory, classical thermodynamics, probability and statistical methods.

Course Learning Outcomes: After completion of this course, students will be able to:
CLO1: Understand basics of kinetic theory of gases.
CLO2: Comprehend concepts of thermodynamic potentials and their physical interpretation.
CLO3: Understand Maxwell-Boltzmann distribution law and its application to classical gas.
CLO4: Learn Bose-Einstein statistics and derive classical radiation laws of black body radiation.
CLO5: Comprehend Fermi-Dirac statistics and its application to the electrons in metals
CLO6: Understand the concept of Fermi energy and electronic contribution to specific heat of metals.

Theory

Unit I: Kinetic theory of Gases and Thermodynamic Potentials. **[15 h]**

1. **Kinetic theory of Gases:** **[9 h]**
   Basic assumptions, Equation of State of an Ideal Gas, Collisions with a moving wall, the principle of equi-partition of energy, classical theory of specific heat capacity, specific heat capacity of a solid.
   [Sears and Salinger: 9.1, 9.2, 9.4 – 9.8]

2. **Thermodynamic Potentials** **[6 h]**
   The Helmholtz function and Gibbs function, Thermodynamic Potentials, Maxwell Relations.
   [Sears and Salinger: 7.1-7.3]

Unit II: Statistical Thermodynamics and Quantum Statistics **[20 h]**

1. **Statistical Thermodynamics** **[10 h]**
   Phase space, Probability of distribution, The most probable distribution, Maxwell Boltzmann Statistics. Molecular speeds: mean, most probable and r. m. s. speeds. Experimental verification of Maxwell Boltzmann statistics.
   [Beiser: 15.1 – 15.5]

2. **Quantum Statistics** **[10 h]**
   Bose Einstein statistics, Blackbody Radiation, Rayleigh Jeans formula, Plank radiation formula, Fermi Dirac statistics.
   [Beiser: 16.1 – 16.6]

Unit III: Specific Heats of Solids **[10 h]**

1. **Lattice Vibrations and Specific Heats of Solids** [10 h]
   Thermal Vibrations: Frequencies. Thermal Vibrations: Amplitudes. Normal Modes of a Lattice. Phonons. Specific Heats of Solids. The Einstein's theory. The Debye Theory. Fermi energy, Electron energy distribution.
   [Beiser: 19.1 – 19.7, Kachhava: 2.5, 2.6. 2.13]

Experiments: (Minimum Six)

1. Specific heat of Graphite
2. Study the temperature dependence of resistivity.
3. OPAMP as a bridge amplifier and its application in temperature measurement.
4. Determination of Boltzmann constant.
5. Study of Stefan's Law.
6. Determination of Stefan's constant
7. Thermal conductivity of poor conductor by LEE's method.
8. Tutorial on Maxwell Equation and Free energy
9. Tutorial on Statistical Thermodynamics
10. Tutorial on Statistical Thermodynamics

References:

1. Beiser A., 1995, *Perspectives of modern physics*, 5th edition, McGraw hill.
2. Sears F. and Salinger G., 1998, *Thermodynamics, Kinetic Theory and Statistical Thermodynamics*, 3rd Edition, Narosa.
3. Kachhava C. M., 2003, *Solid State Physics Solid State Devices and electronics*, New Age International (P) Limited.

Additional References:

1. Garg S., Bansal R.and Ghosh C., 1993, *Thermal Physics*, Tata McGraw Hill.
2. Zemansky M. and Ditman R., 1997, Heat *and Thermodynamics*, McGraw Hill.
3. Reif F., 1965, *Fundamentals of Statistical and Thermal Physics*, Mc Graw Hill

4. Brijlal, Subrahmanyam N., 2008, *Heat thermodynamics and Statistical Physics*, S Chand Company Ltd.
5. Laud B., 2003, *Introduction to Statistical Mechanics*, New Age International.
6. Saha M. and Shrivastava B., 1965, *Treatise on heat*, The Indian Press.

Web References:

1. https://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring-2008/
2. https://nptel.ac.in/courses/113106039/
3. https://www.youtube.com/watch?v=ef54OnrZBg4&list=PLclocfvsabE1j2OcBdWfVhzNJNnbQ3YM7
4. https://aptv.org/Education/khan/topic.php?topic=thermodynamics
5. https://www.youtube.com/watch?v=Th-LQz5bBJA

Course Title : Electronics-II

Course Code : PHY-E11

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Pre-requisite : Electronics-I (PHY-E5)

Course Objectives : This course aims at introducing students to analog and digital circuits.

Course Learning Outcomes: At the end of this course, students will be able to:
CLO1: Analyse AC circuits and apply the techniques in designing circuits.
CLO2: Generate different kinds of waves using OP-Amp.
CLO3: Understand the basic concepts of 555 timer.
CLO4: Apply binary operations to different digital circuits
CLO5: Understand the clocked digital electronics and its applications in different types of Counters

Theory
Unit I: [15 h]
1. **AC Models (BJT) [4 h]**
Base-Biased amplifier, Emitter-Biased amplifier, Small signal operation, analyzing an amplifier.
[Malvino: Article 9.1 to 9.7]

2. Transistor Multivibrators [4 h]
Transistor as a switch, switching times, Multivibrators – Astable, Monostable, Bistable and Schmitt Trigger.
[Mottershed: Article 18.1 to 18.5]

3. FET's and MOSFET's [7 h]
Basic structure of the JFET, Principles of operation, Characteristic curves and parameters, Common source amplifiers, Common gate amplifier, MOSFET: Depletion Mode and Enhancement mode, Dual-Gate MOSFET. FET Phase shift oscillator, FET as VVR and its applications in Attenuator, AGC and Voltmeter circuits.
[Malvino: Article 13.1 to 13.9, 14.1 to 14.5]

Unit II: [10 h]
1. OPAMP Applications [5 h]
Active diode circuits, Comparator, Window comparator, Schmitt Trigger, Waveform generator – Square wave, Triangular and Ramp Generator and monostable.
[Malvino: Article 22.7, 22.8]

2. Timers [5 h]
The 555 Timer, Basic concept, 555 block diagram, Monostable, Astable, Bistable, Schmitt Trigger and Voltage controlled oscillator (VCO) using 555 timer.
[Malvino: Article 23.7, 23.8]

[Malvino and Bates: 24.4, 24.5]

Unit III **[20 h]**

1. Digital Circuits **[10 h]**

Binary number system, Binary to Decimal and Decimal to Binary conversion, Basic logic gates, AND, OR, NOT(realization using Diodes and Transistor), NAND, NOR as universal building blocks in logic circuits, EX-OR and Ex-NOR gates. Boolean Algebra:De Morgan's Law's, Boolean Laws, NAND and NOR gates, Sum of Products methods and Product of Sum methods of representation of logical functions. Half adder and Full adder, Data Processing Circuits: Multiplexer and Demultiplexer, Encoders and decoders.
[Jain: Article 5.1 to 5.8.1, 6.1, and 6.2]

2. Sequential Circuits [10 h]

Basic RS FF, Clocked RS FF, JK FF, D-type and T-type FF, Master Slave Concept. Shift Registers:Serial-in-Serial-Out, Serial-in-Parallel-out, Parallel-in-Serial-out, Parallel-in-Parallel-out Shift registers (upto 4 bits), Counters: Applications of FF's in counters, binary ripple counter, Modulus of counter (3,5) BCD Decade Counter, Cascade BCD Decade counters.
[Jain: Article 7.1 to7.9, 8.1, 8.2, 8.4]

Experiments (Minimum Six):

1. Astable Multivibrator
2. Monostable Multivibrator
3. Bistable Multivibrator
4. Schmitt Trigger
5. F.E.T Characteristics
6. IC LM 317 Voltage Regulator
7. IC 555 Timer as Astable Multivibrator and its use as Voltage Controlled Oscillator
8. IC 555 Timer as Monostable Multivibrator
9. Digital Multiplexer
10. Verification of De Morgan’s Theorems and Boolean Identities
11. NAND and NOR Gates as Universal Building Blocks
12. Binary Addition –Half Adder and Full Adder Using Gates
13. JFET as a common source amplifier.

References :

1. Malvino A.,1996, Electronic Principles, 5th edition,Tata McGraw Hill.
2. Jain R. P. 2003, Digital Electronics, 3rd edition, Tata McGraw Hill.
3. Mottershed A. 1997, Electronics Devices and Circuits an Introduction, PHI
4. Malvino A. and Bates D.J., 2007, Electronic Principles, 7th edition, Tata McGraw Hill

Additional References:

1. Malvino A. and Leach D. 1986, Digital Principles and Applications,4th edition Tata McGraw Hill.
2. Millman J. and Halkias C., 1972, Integrated Electronics, Tata McGraw Hill.
3. Millman J. and Halkais C., 1967, Electronic Devices and Circuits, Mc Graw Hill.

4. Mehta V.K., 2003, Principles of Electronics, 8th edition, S. Chand & Company.

Web References:

1. https://nptel.ac.in/courses/117/107/117107094/
2. https://www.electronics-tutorials.ws
3. https://www.electronicshub.org/
4. https://nptel.ac.in/courses/108/105/108105132/
5. https://www.khanacademy.org/science/electrical-engineering

Course Title : **Mathematical Physics**

Course Code : **PHY-E12**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Pre-requisite : **Introduction to Mathematical Physics (PHY-I.C-1)**

Course Objectives **:** To acquaint students with mathematical skills which are required to study various concepts of Physics.

Course Learning Outcomes: At the end of this course, students will be able to:
CLO1: Comprehend the functions of complex variables.
CLO2: Apply mathematical techniques such as: calculus of residues to evaluate definite integrals.
CLO3: Apply solutions of Legendre, Bessel and Hermite equations in solving various Physics problems.
CLO4: Apply Fourier transforms of different functions in solving various Physics problems.

CLO5: Able to solve higher order problems in Physics**.**

Theory:

Unit I: Functions of a Complex Variables and Calculus of Residues **[15 h]**

1. **Functions of a Complex Variables** **[8 h]**

   Introduction, complex variables and representations: algebraic operations, Argand diagram: vector representation, complex conjugate, Euler's formula, De Moivre's theorem, the n^{th} root or power of a complex number, analytic functions of a complex variable: the derivative of f(z) and analyticity, harmonic functions, contour integrals, Cauchy's integral theorem, Cauchy's integral formula.
   [Harper: 3.1, 3.2: 3.2.1 – 3.2.6, 3.3: 3.3.1 – 3.3.5]

2. **Calculus of Residues** **[7 h]**

   Zeroes, isolated singular points, evaluation of residues: m^{th} order pole, simple pole, the Cauchy residue theorem, the Cauchy principal value, evaluation of some definite integrals.
   [Harper: 4.1 – 4.3: 4.3.1 – 4.3.2, 4.4 – 4.6: 4.6.1-4.6.4]

Unit II: Partial Differential Equations and Special Functions of Mathematical Physics

[15 h]

1. **Partial Differential Equations and Special Functions of Mathematical Physics [15h]**

   Introduction, Some important partial differential equations in physics, an illustration of the method of direct integration, method of separation of variables, the Hermite polynomials: basic equations of motion in mechanics, one-dimensional linear harmonic oscillator,

solution of Hermite's differential equation, Legendre and associate Legendre polynomials: spherical harmonics, the azimuthal equation, Legendre polynomials, Bessel function: introduction: solution of Bessel's equation, analysis of various solutions of Bessel's equation, characteristics of Bessel functions.
[Harper: 6.1 – 6.5: 6.5.1 – 6.5.3, 6.5.8]

Unit III: Fourier Series and Fourier Transforms [15 h]

1. **Fourier Series** **[7 h]**

   Introduction: The Fourier cosine and sine series, change of interval, Fourier integral, complex form of Fourier series, generalized Fourier series and Dirac-delta function, summation of the Fourier series.
   [Harper: 7.1 – 7.3]

2. **Fourier Transforms** **[8 h]**

   Introduction, theory of Fourier transforms: formal development of the complex Fourier transform, cosine and sine transforms, multiple-dimensional Fourier transforms, the transforms of derivatives, the convolution theorem, Parseval's relation, the wave packet in quantum mechanics: origin of the problem - quantization of energy, the development of a new quantum theory, a wave equation for particles - the wave packet.
   [Harper: 8.1 – 8.3]

Experiments: (Minimum Six)

1. Generating and plotting Legendre Polynomials.
2. Generating and plotting Bessel function.
3. Generating and plotting Hermite Polynomials.
4. Using spherical polar co-ordinates obtain an expression for divergence and curl of a vector function, operate gradient and Laplacean operator on a scalar function.
5. Using cylindrical co-ordinates obtain an expression for divergence and curl of a vector function, operate gradient and Laplacean operator on a scalar function.
6. Fourier series: programme to sum:$\sum_{n=1}^{\infty}(0.2)^n$, and to evaluate Fourier co-efficients of a given periodic functions.
7. Compute the n^{th} roots of unity for *n* = 2, 3, and 4.

References:

1. Harper, C., 1993, *Introduction to Mathematical Physics*, 5th Ed., Prentice Hall of India
2. Arfken G., 2005, *Mathematical Methods for Physicists*, Elsevier.
3. Spiegel, M.R., 2004, *Fourier Analysis*, Tata McGraw-Hill.

Additional References:

1. Riley K. F., Hobson M. P., Bence S. J., 1998, *Mathematical Methods for Physics and Engineering*, Cambridge University Press
2. Boas M. L., 2013, *Mathematical Methods in Physical Sciences*, 3rd Ed., John Wiley and Sons
3. Lipschutz S., 1974, *Schaum Outline of Theory and Problems of Complex Variables*, Mc Graw Hill.

Web References:

1. https://nptel.ac.in/courses/115106086/
2. https://www.maths.ed.ac.uk/~jmf/Teaching/MT3/ComplexAnalysis.pdf
3. https://www-thphys.physics.ox.ac.uk/people/FrancescoHautmann/ComplexVariable/s1_12_sl8.pdf
4. https://nptel.ac.in/courses/111/106/111106100/
5. https://nptel.ac.in/courses/115/105/115105097/

Course Title **: Solid State Devices**

Course Code **: PHY-E6**

Marks **: 75 (Theory) + 25 (Practical)**

Credits **: 3 (Theory) + 1(Practical)**

Pre-requisite **: Nil**

Course Objectives **:** The objectives are to provide a clear explanation of the operation of most commonly used solid state devices.

Course Learning Outcomes : At the end of this course, the students will be able to:

CLO1: Comprehend the p-n junction theory and analyse the effect of heat and light on the performance of the semiconductor devices.

CLO2: Understand different types of special diodes and their uses in various electronics applications.

CLO3: Understand different types of optoelectronic devices and their uses in various electronics applications.

CLO4: Design, construct and working of the circuits based on breakdown devices.

CLO5: Understand basic construction of FET, principle of operation of different types of FETs, and its applications.

Theory:

Unit I: Basic Semiconductor and pn-Junction Theory and Special Diodes **[15 h]**

1. **Basic Semiconductor and pn-Junction Theory** **[10 h]**

   The Atom, Electron Orbit and Energy Levels, Energy Bands, Conduction in Solids, Conventional Current and Electron Flow, Bonding Forces between Atoms, Classification of Solids, Intrinsic Semiconductor, Conduction of Electrons and Holes, *p*-Type and *n*-Type Semiconductors, Effect of Heat and Light, Drift Current and Diffusion Current, The *pn*-Junction, Reverse-biased Junction, Forward-biased Junction, Temperature Effect, Mobility and Conductivity, Hall Effect and Hall Coefficient.

   [Bell: Chapter 1 and Ref.2: Chapter 1: 1.8 and1.9]

2. **Special Diodes:** **[5 h]**

   Zener Diode, Use of Zener Diode as voltage regulator and as Peak Clipper, Meter Protection, Tunneling Effect, Tunnel Diode, Tunnel Diode as Oscillator, Varactor, PIN Diode, Schottky Diode, Step Recovery Diode.

   [Theraja: Chapter 15]

Unit II: Optoelectronic Devices and Industrial Devices **[20 h]**

1. **Optoelectronic Devices:** **[8 h]**

   Light Units, Photomultiplier tube, Photoconductive Cell, Photovoltaic Cell, Photodiode, Solar Cell, Phototransistor, PhotoFET, Spectral response of Human eye, Light Emitting Diode(LED), Liquid Crystal Display(LCD), Optoelectronic Couplers, Laser Diode, Light Dependent Resistor (LDR).

   [Bell: Chapter 19: 19-1 to 19-7, 19-9, 19-11, 19-12 and Theraja: 16.1 to 16.3]

2. **Industrial Devices:** **[12 h]**

   Silicon Controlled Rectifier(SCR), SCR Characteristic and Parameters, Simple applications of SCR: HWR, Battery-charging regulator and Temperature Controller, Silicon Controlled Switch (SCS), Gate Turn Off switch (GTO), Light Activated SCR (LASCR), Shockley Diode, The TRIAC and DIAC, Typical Diac-Triac Phase control circuit, The Unijunction Transistor(UJT), UJT Characteristics, UJT Parameter and Specification, UJT Relaxation Oscillator, UJT Control of SCR, Programmable Unijunction Transistor.

   [Bell: Chapter 18: 18-1, 18-2, 18-4, 18-6 to 18-11; Ref.4: Chapter 21: 21.6 to 21.10 and Mottershead: Chapter 28: 28-4]

Unit III: Field Effect Transistors [10 h]

1. **Field Effect Transistors:** **[10 h]**

   Advantage and Disadvantage of The FET, Basic Construction of JFET, Characteristics curves of The JFET, Principle of operation of The JFET, Effect of V_{DS} on Channel Conductivity, Channel Ohmic Region and Pinch-Off Region, Characteristic Parameters of The FET, Effect of Temperature on FET Parameters, The MOSFET, The Depletion MOSFET, The Enhancement MOSFET, The difference between JFETs and MOSFETs, Dual Gate MOSFET, FET used in Phase-Shift Oscillator Circuit, Applications of FET in its Channel Ohmic Region, FET as a VVR in Voltage controlled Attenuator and in an Automatic Gain Controlled Circuit, Field-Effect Diode and its use as CRD, Power MOSFETs.

[Mottershead: Chapter 21: 21-1 to 21-8, Chapter 22: 22-1 to 22-5, 22-9, 22-10;

Bell: Chapter 8: 8-9]

Experiments: **(Minimum six)**

1. Energy Gap of a Semiconductor
2. Energy Gap of a LED.
3. Zener Diode Characteristics and Voltage regulation
4. LDR Characteristics
5. LED VI Characteristics
6. Phototransistor
7. SCR characteristics and gate controlled ac half wave rectifier
8. UJT Characteristics and its use in relaxation oscillator
9. FET Characteristics
10. Solar Cell.
11. SCR, Diac, Triac Characteristics.

References:

1. Bell D. A.,2000, *Electronics Devices and Circuits*, 3rd Edition, Prentice-Hall of India Pvt. Ltd., New Delhi,
2. Singh K., Singh S. P., 2007, *Solid State Devices and Electronics*,1st Edition, S. Chand & Company Ltd., New Delhi,
3. Theraja B. L., 2005, *Basic Electronics (Solid State)*, 1stMulticolour Edition, S. Chand and Company Ltd., New Delhi,
4. Boylestad R., Nashelsky L., 2000, *Electronic Devices and Circuit Theory*, 6th Edition, Prentice-Hall of India Pvt. Ltd., New Delhi
5. Mottershead A., 2000, *Electronics Devices and Circuits An Introduction*, Prentice-Hall of India Pvt. Ltd., New Delhi

Web References:

1. https://nptel.ac.in/courses/117106091/
2. https://www.elprocus.com/types-of-diodes-and-applications/
3. https://www.electronicshub.org/types-of-diodes/
4. https://www.electronicshub.org/thyristor-basics/
5. https://gradeup.co/field-effect-transistor-study-notes-i-96d9d1d0-79ad-11e7-bf36-f08a68dca14c

Syllabi of the Generic Elective Courses

Course Title : **Elementary Physics**

Course Code : **PHY-GEC-1**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Course Objectives : To provide introduction to topics on Mechanics, Properties of Matter, Crystal Physics, Origin of Quantum Physics, Thermodynamics and Nuclear Physics which are essential allied learning components for most of the subjects of Physical, Chemical, and Earth Sciences.

Course Outcomes : At the end of this course, students will be able to:

CLO1: Develop understanding of Newtonian mechanics in one and two dimensions and solve the Newton equations for simple configurations.
CLO2: Comprehend the phenomenon of elasticity, surface tension and their application.
CLO3: Understand different types of crystal systems and determine structural parameters like unit cell of crystal lattices.
CLO4: Derive and apply Bragg's law to determine crystal structure.
CLO5: Discuss and interpret experiments that reveal the particle properties of waves and wavelike properties of matter.
CLO6: Understand the uncertainty principle and its applications.
CLO7: Understand different types of temperature scales and relationship between different scales of temperature.
CLO8: comprehend the first law of thermodynamics to represent the relationship between heat and mechanical work.
CLO9: comprehend the second law of thermodynamics to depict the manner in which thermodynamic changes take place.
CLO10: Understand the basic properties of the nucleus and explain the process of radioactivity.

CLO11: Gain knowledge on basic concept of nuclear force and Meson theory of nuclear force.

Theory:

Unit I: **[18 h]**

Elements of Newtonian Mechanics
Mechanics an exact science, Brief description of classical view of Space and Time. Kinematics, the description of motion. Dynamics, the concept of Mass and Force. Newton's First and

Second Laws; Inertial frames. Equations of motion. Interpretation of Newton's third Law as Conservation of Momentum. Units and dimensions, Some elementary problems in Mechanics (Applications of Newton's Laws) - Atwood Machine, Forces acting on a brick sliding down an inclined plane.
[Symon 1.1,1.2,1.3,1.4,1.6,1.7, Taylor 1.1-1.7, Kleppner 2.4]

Properties of Matter

i. **Elasticity**

Hooke's Law, Types of Elasticity: Young's Modulus, Bulk Modulus and Modulus of rigidity. Poisson's ratio. Determination of Young's Modulus for a wire. Torsion in a string-couple per unit twist, Torsional Pendulum.
[Mathur: Section 8.8, 8.9, 8.12, 8.13, 8.14, 8.15, 8.16, 8.18, 8.19, 8.22, 8.26, 8.30]

ii. **Surface Tension**

Brief review of molecular theory of surface tension. Relation between surface tension and surface energy. Angle of contact. Capillarity-rise of liquid in a capillary tube.
[Mathur: Section 14.1, 14.2, 14.3, 14.4 14.6, 14.8, 14.14, 14.15 and 14.17]

Crystal Physics and Crystal Diffraction

Introduction, Space Lattice, Unit cell, Lattice Parameter of unit cell, Bravais lattices, Crystal Stacking sequences in metallic crystal structure, SC, BCC, FCC and HCP structures. Introduction, Bragg's law, Bragg's X-ray Spectrometer.
[Pillai: 4.I – 4.VI, 4.XIV – 4.XV, 5.VII – 5.IX]

Unit II: [18 h]

Particle Properties of waves:
Concepts of Blackbody Radiation, The Photoelectric effect, Compton Effect.
[Beiser: 3.1,3.2, 3.5]

Wave Properties of Particles:
De Broglie's hypothesis. Davisson-Germer Experiment. Interference pattern of bullets, waves and electrons. Wave Particle duality. The Uncertainty principle and its application.
[Beiser 4.1-4.8, Feynman 1.1-1.8. Singh: 2.6, 3.1, 3.2, 3.5]

Principle of Thermometry
Review of concept of heat and temperature, Thermometry, Types of thermometers, Centigrade, Fahrenheit, Rankine Scales and relations between them, Platinum resistance thermometer, Thermocouple, Seebeck effect.
[Brij Lal: 13.1 – 13.5, 13.15, 13.17]

Laws of Thermodynamics:

Thermodynamic system, zeroth law of thermodynamics, concept of heat, Thermodynamic equilibrium, Concept of internal energy and external work done, First law of thermodynamics, reversible and irreversible processes, heat engine, Definition of efficiency, Carnot ideal heat engine, Carnot’s cycle, Second law of thermodynamics.
[Brij Lal: 4.1-4.7, 4.20-4.24, 4.28]

Unit III: **[09 h]**

Nuclear Physics:

i. **Basic Properties of the nucleus and nuclear model:**
Discovery of the nucleus, Composition of the nucleus. Particles of nuclei of atoms. Classification of nuclei. Nuclear size, Nuclear mass, Nuclear density, Nuclear spin. Nuclear magnetic dipole moment. Mass defect and packing fraction. Binding energy. Nuclear stability. Liquid drop model.
[Ilangovan: 1.3.1 – 1.8.3] [Eisberg: 15.5]

ii. **Radioactivity:**
Properties of radioactive rays, The law of radioactive Decay, Mean Life, Half-life and Decay Constant. Radioactive series, Artificial Radioactivity. Carbon dating.
[Patel: 2.2-2.3, 2.9, 2.11-2.13]

iii. **Nuclear forces:**
Main characteristics of the nuclear force. Meson theory of nuclear force, Estimation of mass of the meson using uncertainty principle, Yukawa potential.
[Patel: 8.6] [Ilangovan: 1.9]

Experiments: (Minimum Six)

1. Atwood Machine
2. Verification of Newton’s Second Law using Air Track
3. Conservation of linear momentum using Air Track
4. Spring Mass System: Determining the Spring Constant
5. Simple Pendulum
6. Photoelectric effect.
7. Cantilever: Determination of Young's modulus by vertical vibrations of a cantilever.
8. Torsional Pendulum: Determination of Rigidity Modulus of the material of a wire.
9. Bending of beams: determination of Young's modulus

10. Capillarity: determination of Surface tension
11. Rigidity Modulus of Brass.
12. Constant volume air thermometer.
13. Calculation of lattice constant by of Copper – X-ray diffraction pattern is given and student calculates: d-spacing, miller indices and lattice constant.
14. X-ray Emission (characteristic lines of copper target)- Calculation of wavelength and Energy.
15. Tutorial on Basic properties of nucleus.
16. Tutorial on Radioactivity.

References:

1. Symon Keith, 2016, Mechanics, Pearson Education
2. Kleppner, Kolenkow, 2013, Introduction to Mechanics, Cambridge University Press, UK
3. Taylor J. R., 2005, *Classical Mechanics*, University Science Books, USA
4. Mathur D. S., 2010, *Elements of Properties of Matter*, S. Chand and Company, New Delhi.
5. Pillai S. O., 2018, *Solid State Physics,* 8th Multi Colour Edition, New Age International Publisher.
6. Beiser, A. 1969, *Perspectives of Modern Physics,* McGraw-Hill Book Company, Singapore.
7. Feynman, R. 2012, *Feynman Lectures on Physics: Quantum Mechanics (Volume - 3)*, Pearson Education, India.
8. Singh, K. And Singh, S. 2013, *Elements of Quantum Mechanics,* S. Chand, New Delhi.
9. Brij Lal, Subramanyam N., Hemne P.S. 2007, *Heat Thermodynamics and Statistical Physics*, S. Chand & Company Ltd., New Delhi
10. Ilangovan, K. 2012, *Nuclear Physics*, MJP Publishers, Chennai.
11. Patel, S. 2011, *Nuclear Physics: An Introduction*, 2nd Edition. New Age International Limited, New Delhi.
12. Eisberg, R. And Resnick, R. 2010, *Quantum Physics of Atoms, Molecules, Solids, Nuclei and particles,* 2nd Edition, Wiley India Pvt Ltd.

Additional References

1. Krane, K. 1987, *Introductory Nuclear Physics,* 3rd Edition. Wiley, New Jersey.

Web references

1. https://ocw.mit.edu/courses/physics/8-01sc-classical-mechanics-fall-2016/
2. https://www.youtube.com/playlist?list=PL2ub1_oKCn7qTH_D11rqL-kAXfJv43J0-
3. https://hcverma.in/QuantumMechanics

4. http://www.zytemp.com/infrared/thermometry_history.asp
5. https://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring-2008/video-lectures/lecture-1-state-of-a-system-0th-law-equation-of-state/
6. https://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-solid-state-chemistry-fall-2010/
7. https://www.youtube.com/playlist?list=PLF15670EECA944A13

Course Title : **Physics for Life Sciences**

Course Code : **PHY-GEC-2**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Course Objectives : To provide introduction to topics on Thermodynamics, Properties of Matter, Waves and Sound, Ultrasonics, Electrostatics, Magnetostatics, Nuclear Physics and Optics which are essential allied learning components for most of the subjects of biological sciences.

Course Outcomes : At the end of this course, students will be able to:

CLO1: Comprehend the first law of thermodynamics to represent the relationship between heat and mechanical work.
CLO2: Comprehend the second law of thermodynamics to depict the manner in which thermodynamic changes take place.
CLO3: Comprehend the phenomenon of surface tension, viscosity and their application.
CLO4: Understand the dependence of velocity of sound waves on various factors like temperature, pressure, density and humidity.
CLO5: Understand the production and detection techniques of ultrasonic waves and its applications.
CLO6: Apply the principles of electrostatics to solve problems relating to electric field and electric potential.
CLO7: Apply the principles of magnetostatics to solve problems relating to magnetic field.
CLO8: Comprehend the basic phenomenon of radioactivity.
CLO9: Understand laws of reflection and refraction, and learn different types of optical eyepiece.

Theory:

Unit I: **[15 h]**

Thermodynamics
Thermodynamic system, Thermodynamic variables, Thermodynamic equilibrium, and Thermodynamic processes, Zeroth law of thermodynamics, Concept of work and internal energy, First law of thermodynamics, Isothermal and adiabatic changes, Work done in isothermal and adiabatic changes, Relation between pressure, volume and temperature in adiabatic process, Reversible and irreversible processes, Carnot Heat engine, Carnot cycle for perfect gas, efficiency, Second law of thermodynamics (Kelvin – Planck Statement, Clausius Statement).

[Brij Lal: 4.1, 4.4 – 4.7, 4.10.4, 4.11 - 4.13, 4.20 – 4.24, 4.28]

Properties of Matter

iii. Surface Tension

Brief review of molecular theory of surface tension. Relation between surface tension and surface energy. Angle of contact. Capillarity-rise of liquid in a capillary tube.
[Mathur: Section 14.1, 14.2, 14.3, 14.4 14.6, 14.8, 14.14, 14.15 and 14.17]

iv. **Viscosity**

Streamline flow, turbulent flow, Critical velocity, Coefficient of viscosity, Poiseuille's formula for flow of liquid through a capillary tube.
[Mathur: Section 12.1 - 12.12 (12.8 upto equation b)]

Unit II: [15 h]

Waves and Sound

Transverse vibrations in strings. Velocity of longitudinal waves in gases. Newton's formula for velocity of sound. Velocity in a homogeneous medium. Laplace’s correction. Kundt's tube-determination of velocity of sound in a gas and in solids. Intensity level and Bel and Decibel.

[Khanna 4.2, 5.3-5.5, 11.1, 11.3, 12.1-12.4, 19.6 and Subrah.: 11.23 11.25,11.27]

Ultrasonics

Production and detection of Ultrasonic waves. Magnetostriction method and piezo-electric generator method. Detection of velocity of ultrasonic waves. Detection and application os ultrasonic waves.
[Subrah: 11.23 11.25, 11.27]

Unit III: [15 h]

Electrostatics:

Electric charge, Coulomb’s law, Electric field, Lines of electric force, Electric potential, Electric potential due to a point charge, Relation between electric field and electric potential, Gauss’s law and its applications.
[H. C. Verma Vol. II: 29.1 – 29.8, 30.3, 30.4]

Magnetostatics:

Definition of magnetic field, Relation between electric and magnetic fields, Motion of a charged particle in a uniform magnetic field, Biot-Savart law, Magnetic field due to a current in a straight wire.

[H. C. Verma Vol. II: 34.2 – 34.4, 35.1, 35.2]

Radioactivity:
Properties of radioactive rays, The law of radioactive Decay, Mean Life, Half-life and Decay Constant. Radioactive series, Artificial Radioactivity. Carbon dating.
[Patel: 2.2-2.3, 2.9, 2.11-2.13]

Optics:
Laws of reflection and refraction. Size of an object, The simple magnifier, Objective and Eyepiece. Huygens's eyepiece. Ramsden's eyepiece.
[Subrahmanyam N.: 1.5, 10.4, 10.5, 10.8, 10.10, 10.11]

Experiments: (Minimum Six)

1. Viscosity of a liquid by Poiseuille's method
2. Capillarity: determination of Surface tension
3. To determine the velocity of Sound using Helmholtz resonator
4. Velocity of Sound using CRO.
5. To determine the frequency of AC mains using Sonometer.
6. Experiment on reflection and refraction
7. Single Slit Diffraction using LASER source.
8. Newtons rings
9. Focal length of the lens system.
10. Crystal oscillator.

References:

1. Brij Lal, Subramanyam N., Hemne P.S. 2007, *Heat Thermodynamics and Statistical Physics*, S. Chand & Company Ltd., New Delhi
2. Mathur D. S., 2010, *Elements of Properties of Matter*, S. Chand and Company, New Delhi.
3. Khanna, D., Bedi, R. 1992, *A Textbook of Sound*, Atma Ram and sons, Delhi.
4. Patel, S. 2011, *Nuclear Physics: An Introduction*, 2nd Edition. New Age International Limited, New Delhi.
5. Verma, H. C. *Concepts of Physics-Part II*. Bharati Bhawan Publisher, Noida.
6.

Web references

1. https://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring-2008/video-lectures/lecture-1-state-of-a-system-0th-law-equation-of-state/
2. https://www.youtube.com/playlist?list=PL9jo2wQj1WCPHwLSQIPlMLASX07YVBkua
3. https://ocw.mit.edu/courses/physics/8-03sc-physics-iii-vibrations-and-waves-fall-2016/part-i-mechanical-vibrations-and-waves/
4. https://www.youtube.com/watch?v=NK-BxowMIfg&list=PLD07B2225BB40E582
5. https://www.youtube.com/playlist?list=PLF15670EECA944A13
6. http://www.ilectureonline.com/lectures/subject/PHYSICS/6/70

Course Title: Introduction to Astronomy

Course Code: PHY-GEC-3

Marks: 75 (Theory) + 25 (Practical)

Credits: 3 (Theory) + 1 (Practical)

Course Objectives: This is an introductory course with the goal of giving students insights into the field of astronomy.

Course Learning Outcomes: At the end of the course, students will be able to:

CLO1: Locate objects in the sky using coordinate systems.

CLO2: Understand the working of various tools used to observe celestial bodies.

CLO3: Understand how different stellar parameters are measured

CLO4: Understand various techniques used by astronomers to determine distances to remote galaxies.

Theory:

UNIT I: INTRODUCING ASTRONOMY [15 h]

Chapter 1: Knowing the Heavens [9 h]

Introduction; The Age and Origin of the Solar System; Positional Astronomy; Constellations; Motions of the sky-Diurnal motion and Earth's rotation, Yearly motion and the Earth's orbit; The Celestial Sphere-Motions of the Celestial Sphere, the Origin of the Seasons, Motion of the Sun on the Celestial Sphere, Equinoxes and Solstices; Precession, Time and Timekeeping; Phases of the Moon; The Moon's Rotation- Synchronous rotation, Sidereal and synodic months; Eclipses and the lines of nodes; Lunar Eclipses; Solar Eclipses

[Freedman, R. A. & Kaufmann III: Chapter 1:1.2-1.4; Chapter 8:8.1-8.4; Chapter 2:2.1-2.7; Chapter 3:3.1-3.5]

Chapter 2: Gravitation and the Waltz of the Planets [6 h]

Geocentric models-the Greek Geocentric model, Ptolemaic system; Copernicus and Heliocentric models; Tycho Brahe's Observations; Kepler and the Orbits of Planets; Galileo and the Telescope-Phases of Venus, Moons of Jupiter; Newton's Law of Motion; Newton and Gravity

[Freedman, R. A. & Kaufmann III: Chapter 4: 4.1-4.7]

UNIT II: ASTRONOMICAL INSTRUMENTS [15 h]

Chapter 1: Nature of Light [5 h]

Blackbody Radiation; Wien's law and Stefan Boltzmann Law; Kirchoff's Laws; Spectral lines and the Bohr Model, Doppler Effect

[Freedman, R. A. & Kaufmann III: Chapter5: 5.3-5.4, 5.6, 5.8-5.9]

Chapter 2: Optics and Telescopes [10 h]

Refracting and Reflecting telescopes- Light gathering power, Magnification, Aberrations; Angular resolution – Limits to Angular resolution, Active and Adaptive Optics, Interferometry, Light Pollution; CCD; Spectrographs; Radio telescopes; Telescopes in Space.

[Freedman, R. A. & Kaufmann III: Chapter 6: 6.1-6.7]

UNIT III: STARS AND GALAXIES [15 h]

Chapter 1: Nature of Stars [8 h]

Thermonuclear Energy; Angular Sizes; Astronomical Distances; Stellar Distances and Parallax,; Apparent Brightness and Luminosity; The Magnitude Scale- Apparent and Absolute magnitude; Star Colors and Temperatures- UBV Photometry; Spectral Classes, Stellar Radii; The Hertzsprung-Russell Diagram- Main Sequence stars, Giants, Supergiants, White Dwarfs, Brown Dwarfs, Spectroscopic Parallax

[Freedman, R. A. & Kaufmann III: Chapter1: 1.5, 1.7; Chapter 16:16.1; Chapter 17: 17.1-17.8]

Chapter 2: Galaxies [7 h]

Distances to Galaxies; Classifying Galaxies- Spiral Galaxies, Elliptical Galaxies, Irregular Galaxies; The Distance Ladder- Standard Candles: Variable Stars and Type Ia Supernovae, Distance Determination without Standard Candles (Tully Fisher Relation), Hubble Law

[Freedman, R. A. & Kaufmann III: Chapter 24: 24.1-24.5]

Experiments: (Minimum six)

1. Resolving power of telescope.
2. Study of scattering of light (Diameter of Lycopodium powder).
3. To find radius of curvature of a convex lens using optical lever
4. Measurement of the solar constant.
5. Draw constellation map of a) Orion b) Auriga c) Taurus d) Ursa Major (Big Dipper) marking of pole star.
6. To determine the elements in sun using Frauhoffer spectra.
7. To estimate Astronomical Unit using Venus transit data by parallax method.
8. Determine the period of revolution of sun using virtual laboratory
9. To become familiar with the astronomical objects visible to naked eye in the night sky using the software Stellarium
10. To become familiar with the Constellations in the night sky using the software Stellarium
11. To identify the retrograde motion of Mars with respect to the Background stars using Stellarium
12. To identify some of the prominent spectral lines in the spectrum of our sun
13. To get familiar with the spectra of different stars using Stellarium
14. To extract coordinates of a star assuming a telescope in equatorial mount using Stellarium
15. To measure astronomical distances using Cepheid variables using Stellarium
16. To measure the Proper Motion of Barnard's Star using Stellarium
17. To identify a Circumpolar Star using Stellarium
18. To determine the distance and age of cluster using Colour Magnitude Diagram using Stellarium
19. To determine orbital inclination of the planet Mars using Stellarium
20. To measure planetary distances using Stellarium
21. To measure distance to Moon using Stellarium
22. To determine observer’s location by means of the stars using Stellarium

References:

1. Freedman, R. A. & Kaufmann III, W. J., 2008. *Universe*, Eighth Edition. New York: Clancy Marshall

2. Shu, F. H., 1982. *The Physical Universe An Introduction to Astronomy*. Sausalito, California: University Science Books.
3. Kutner, M. L., First published in 2003. *Astronomy A Physical Perspective*. Second ed. New York: Cambridge University Press.

Additional References:

1. Roy A.E., Clarke D., 1989, *Astronomy structure of the Universe*, Adam Hilger Pub.
2. Glasstone S., 1965, *Source book on the Space Sciences*, Van Nostrand Reinhold Inc., U.S
3. Narlikar J.V., 1976, *Structure of the Universe*, Oxford Paperbacks.
4. Sule, A., 2013. *A Problem Book in Astronomy and Astrophysics.* [Online]
5. Palen, S. E., 2002. *Schaum's Outline Series, Astronomy*. United States of America: McGraw Hill.

Web References:

1. https://youtu.be/QJjT9QPlnJs
2. https://youtu.be/vDv3iSMdYyc
3. https://youtu.be/Upy-jNpQW_0
4. https://youtu.be/nzmFc2gjUo4
5. https://youtu.be/0b7-4tfx3J4
6. https://ocw.mit.edu/courses/physics/8-282j-introduction-to-astronomy-spring-2006/
7. https://www.youtube.com/watch?v=nzmFc2gjUo4&list=PLA011BE74F1B54629

Annexure III

List of External Examiners for T. Y. B. Sc. Project

Sr. No.	Name	Institute
1	Dr. Ramu Murthy	Dhempe College, Miramar
2	Dr. Swati Pawar	Dhempe College, Miramar
3	Dr. Miski Naik	Dhempe College, Miramar
4	Dr. Bosco Lawrence	St. Xavier's College, Mapusa
5	Dr. Nelson Lobo	St. Xavier's College, Mapusa
6	Mr Pradeep Morajkar	St. Xavier's College, Mapusa
7	Dr.Satish Keluskar	P.E.S College, Farmagudi
8	Mrs. Mandakini Kundaikar	P.E.S College, Farmagudi
9	Mr. Narayan Bandodkar	Government College,Quepem
10	Dr. Efrem Desa	Carmel College,Nuvem
11	Dr. Manoj Kothawale	D.M.'s College Assagao
12	Dr. Jaison Joseph	Government College, Khandola
13	Mr. Prashant Chodankar	Government College, Khandola
14	Mr. Ali Aga	Government College, Sanquelim
15	Mrs. Shilpa Amonkar	Goa Engineering College, Farmagudi
16	Mr. Harison Cota	Don Bosco College of Engineering, Fatorda
17	Dr. Saidi Reddy Parne	NIT Goa
18	Dr. Girish Kundaikar	P.E.S College, Farmagudi
19	Mrs. Shilpa Amonkar	Goa Engineering College, Farmagudi
20	Dr. Manjunath Naik	Carmel College, Nuvem
21	Dr. Vaishali Gaonkar	Carmel College, Nuvem
22	Dr. Bhargav Alavani	Goa University
23	Ms. Pallavi Gaude	Goa University
24	Dr. Pranav Naik	Goa University
25	Dr. Reshma Raut Desai	Goa University
26	Dr. Elaine Gomes	Goa University
27	Mr. Irshad Shaikh	P.E.S College, Farmagudi
28	Mr. Virroy Dias	Carmel College, Nuvem
29	Dr. Benedict Soares	St. Xavier's College, Mapusa