32. PHYSICS

Preface

The Four Years UG Physics syllabus under NEP-2020 has been framed to enhance the knowledge acquired at the +2 level and to motivate and inspire the students to create deep interest in Physics.

Programme Outcomes

Upon successful completion of these courses, the students will be able to understand basic laws of Physics and their applications in solving most of the microscopic and macroscopic dimensional problems in nature.

PHY-100: MATHEMATICAL PHYSICS, PROPERTIES OF MATTER AND WAVES

(Contact Hours: 75, Credits: 4)

Course Objectives:Mathematical physics serves as a tool to understand physics. Mechanics helps the students to understand the basic laws of physics in day-to-day life and Waves and Vibrations help to understand different types of wave motion in physical systems. Practical will help students to determine and verify physical quantities related to mechanics and waves.

Learning Outcomes:Upon successful completion of this course, the students will be able to understand how to solve various problems of physics using mathematical tools; various laws of motion and properties of matter using mechanics; waves and oscillation in different physical media. These principles are basic requirements for higher studies of physics. The practical performed by the students will help them to measure some of the important physical quantities related to mechanics and waves for better understanding of the topics.

Unit I: Mathematical Physics-I **(15 hours)**

Vector Calculus: Scalar and vector field, Definitions and significance of Gradient, Divergence and Curl, Gauss's divergence theorem, Stoke's Theorem, Green's Theorem (without proofs) in Cartesian coordinates.

Coordinate systems: Polar, Spherical and Cylindrical co-ordinates.

Differential Equations: Ordinary differential equation, 1st order homogeneous linear differential equations and 2nd order homogeneous linear differential equations with constant coefficients.

Unit II: Mechanics and Properties of Matter (15 hours)

Newton's Laws of Motion, Free body diagram and applications.

System of particles and rigid body motion: Center of Mass (CM) and Laboratory frames, motion of the center of mass. Linear and angular momentum of a system of particles. Moment of inertia of sphere, disc and cylinder.

Frames of reference: Inertial and non-inertial frames, uniformly rotating frame of references, Centrifugal and Coriolis force and their applications.

Elasticity: Hooke's Law, Elastic constants and their relations, Poisson ratio, torsional cylinder, bending of beam, cantilever (weightless) loaded at the free end.

Fluid Dynamics: Equation of continuity, Bernoulli's theorem and its applications, Surface tension and surface energy, Capillarity and formation of droplets, Streamline and turbulent flow, Viscosity, Terminal velocity, Stoke's Law, Poiseulle's equation.

Unit III: **Waves and Oscillations (15 hours)**

Simple harmonic motion (SHM): Differential equation of simple harmonic motion and its solution. Superposition of two simple harmonic oscillations. Lissajous figures and their uses.

Damped and forced oscillations: Damped SHM, energy of damped SHM, Q-value of damped oscillations. Forced vibrations, Transients and steady state oscillations of forced vibrations, and condition of resonance.

Wave motion: Representation of plane progressive wave, Classical wave equation of a plane progressive wave and its general solution. Energy and energy density of a plane progressive wave. Qualitative idea of spherical waves. Phase velocity and group velocity.

Unit IV: **Experimental Physics-I (30 hours)**

1. Determination of the value of acceleration due to gravity (g) using Bar Pendulum.
2. Determination of the acceleration of gravity (g) using Kater's Pendulum.
3. Determination of the moment of inertia of a regular solid about an axis passing through its centre of gravity using torsional pendulum.
4. Determination of the rigidity modulus of a cylindrical body by static torsion apparatus.
5. Determination of co-efficient of viscosity of liquid by capillary tube method.
6. Determination of the surface tension of a liquid by Jaeger's method

7. Determination of the frequency of a tuning fork by Melde's method.
8. Determination of Young Modulus of a wire by Searle's Method.

Suggested readings: (All latest edition)

1. Essential of Mathematical methods K. F. Riley and M. P. Hobson, Cambridge University (2011).
2. An Introduction to Mechanics: Daniel Kleppner and Robert Kolenkow, Cambridge University Press (2011).
3. A Treatise on General Properties of Matter: Chatterjee and Sengupta, New Central book Agency, Kolkata (2011).
4. Mechanics: J. C. Upadyaya, Himalaya Publishing House, Agra (1999).
5. The Physics of Waves and Oscillations, N. Bajaj, McGraw Hill Education, Europe (2017).
6. Schaum's Outline of Mathematics for Physics Students (Schaum's Outline Series) (2011).
7. Mechanics: D. S. Mathur, S. Chand & Co., New Delhi (2000).
6. Acoustics, Waves and Oscillations: S. N. Sen, New Age International (1990).
7. Waves and Oscillation: R. N. Choudhuri, New Age International (2010).
8. B. Sc. Practical Physics, C. L. Arora, S. Chand & Co. (2005).
9. A Text Book of Practical Physics, S. K. Ghosh, New Central Book Agency, Kolkata (2004).
10. A Text Book on Practical Physics, K. G. Majumdar& B. Ghosh, Sreedhar Publishers, Calcutta

PHY-150: ELECTRICITY AND MAGNETISM, OPTICS AND ELECTRONICS

(Contact Hours: 75, Credits: 4)

Course Objectives:The course on Electromagnetism will help the students to understand the effect of charge at rest and in motion and dielectric properties of the matter. Study of geometrical optics will help the students to picturize image formation. The basics of electronics are required to understand the different functions of electronic devices. The practical will help the students to determine physical properties of electrical and electronic components and also help them to understand the optics related topics.

Learning Outcomes:Upon successful completion of this course, the students will be able to understand the basic laws of electricity and magnetism, the formation of optical images, concepts of both analog and digital electronics. The practical will help the students in handling the multimeter, potentiometer and function generators, whereas the experiments performed on optics will help to measure different parameters of lenses.

Unit I: Electricity and Magnetism (15 hours)

Coulomb's law and Electric field, Electrostatic potential, Gauss' law in electrostatics (both differential and integral forms) and its application due to a linearly charged rod and a solid sphere, Polarization and displacement vector, Gauss' law in dielectric media.

Biot and Savart's Law and its application due to a straight conductor and solenoid, Ampere's law and its applications, Law of magnetostatics in differential forms.

Integral and Differential form of Faraday's laws, Modification of Ampere's law, Maxwell's equation in free space and in dielectric medium.

Circuits, Kirchhoff's Laws, Series and Parallel resistances, Capacitances, Parallel plate capacitor. Use of complex numbers to find impedance and voltage in series and parallel LCR circuits, Power dissipation, Quality factor and Resonance.

Unit II: Theory of image formation and matrix optics (15 hours)

Fermat's Principle and its applications to reflection and refraction at plane and curved boundaries.

General theory of image formation: Cardinal points of an optical system, Refraction through a thick lens, Relation between the distances of cardinal points, Combination of thin lenses separated by a distance.

Matrix optics: Reflection, refraction and translation matrices, Lens maker formula by matrix method, System matrix of thin and thick lens, Equation of image plane.

Unit III: Electronics-I (15 hours)

Binary system, Binary to decimal and decimal to binary conversion, Binary arithmetic-addition and subtraction, Signed binary numbers, two's complement scheme.

Logic gates: OR, AND, NOT gates and their realization with diodes and transistors, NOR and NAND as universal gates.

Boolean algebra: De' Morgan's theorems, Boolean expression, Simplification of Boolean expression and their representation with basic logic gates.

Diodes and their applications, Bipolar junction transistor (BJT): Different current components and characteristics of a BJT, CB and CE configurations and related characteristics, active, cut-off and saturation regions, current amplification factors in CB and CE configuration.

Unit IV: Experimental Physics-II (30 hours)

1. Determination of the value of an unknown low resistance using potentiometer.

2. Determination of the value of EMF of a Cell using potentiometer.
3. Determination of the resistance per unit length of the meter bridge wire by Carey-Foster method.
4. Determination of the value of unknown capacitance using De-Sauty's method.
5. Determination of the focal length of two thin lenses in contact using displacement method and verification of the result by measuring the focal length of individual lenses.
6. Determination of refractive index of the materials of a prism by measuring angle of prism and minimum deviation using spectrometer.
7. To find the frequency response of series LCR circuit.
8. To find the frequency response of parallel LCR circuit.
9. Construction and verification of AND and OR gates using diodes and resistors.
10. Study the characteristics of a transistor (CE/CB mode).

Suggested readings: (All latest edition)

1. Foundations of Electromagnetic Theory, John R. Reitz, Frederick J. Milford, and Robert W. Christy, Pearson (2008).
2. Electricity and Magnetism: D. C. Tayal, Himalayan Publisher (2019).
3. Electricity and Magnetism: K. K. Tewari, S. Chand & Co., New Delhi (2012).
4. Electricity and Magnetism: Edward M. Purcell, Mc-Graw Hill Education (2013).
5. A textbook of Optics: D. N. Subrahmanyam, BrijLal and M. N. Avadhanulu, S. Chand & Co., New Delhi (2012).
6. Physical Optics: A. K. Ghatak, Tata Mc-Graw Hill India (1997).
7. Modern Optics: A. B. Gupta, Books and Allied (P) Ltd. (2006).
8. Basic Electronics: D. C. Tayal, Himalayan Publisher (2010).
9. Basic Electronics: Devices, Circuits and its Fundamentals: S. Kal, Prentice Hall India, New Delhi (2002).
10. Principles of Electronics: V. K. Mehta and R. Mehta, S. Chand & Co., New Delhi (2005).
11. B. Sc. Practical Physics, C. L. Arora, S. Chand & Co. (2005).
12. A textbook of Practical Physics, S. Ghosh, New Central Book Agency, Kolkata (2004).
13. A textbook of Practical Physics, K. G. Mazumdar, Syndicate Press (2006).
14. B. Sc. Practical Physics, Harnam Singh, P. S. Hemne, S. Chand & Co., New Delhi (2011).