Annexure VII

B.Sc. - Semester VI Annexure VII

PHYSICS

MATHEMATICAL METHODS AND NUMERICAL TECHNIQUES

(4 CREDITS) **PAPER – I** **(48 LECTURES)**

Unit-1

Complex numbers and their polar form, Properties of moduli and arguments, Regions in the complex plane, Continuity and differentiability of complex functions, Analytic (Regular) functions, The Cauchy - Reimann equations and its polar form, Laplace equation, Harmonic functions.

Unit-2

Initial and boundary value problems, Partial differential equation and variable separable method, Legendre's relation, Bessel function, Recurrence relations, Taylor and Laurent's series, Cauchy Integral formula.

Unit-3

Mean value theorem, physical application, Partial derivatives, Maxima and minima, Diffusion equation of heat flow- 1D, 2D, 3D, Fourier series, Convolution- Physical application, Fourier transform.

Unit-4

Numerical methods for solution of differential, partial differential and integral equations, Euler's method, Runge - Kutta method, Numerical Integration, Differentiation, Simpson's rule -1/3, 1/8, Newton Raphson method, Gauss quadratic formula.

Suggested books:

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
2. Fourier Analysis: M.R. Spiegel, 2004, Tata McGraw-Hill.
3. Mathematics for Physicists: Susan M. Lea, 2004, Thomson Brooks/Cole.
4. An Introduction to Ordinary Differential Equations: E.A Coddington, 1961, PHI Learning
5. Differential Equations: George F. Simmons, 2006, Tata McGraw-Hill.
6. Essential Mathematical Methods: K.F. Riley and M.P. Hobson, 2011, Cambridge University Press
7. Introduction to Numerical Analysis: S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.

18

17/5/19 17.5.19 17/5

8 • Numerical Recipes in C++: The Art of Scientific Computing, W.H. Press et.al., 2nd Edn., 2013, Cambridge University Press.

9 • A first course in Numerical Methods: U.M. Ascher & C. Greif, 2012, PHI Learning.

10 • An Introduction to computational Physics:T.Pang,2nd Edn., 2006,CambridgeUniv. Press

B. Sc. - Semester VI
PHYSICS
ELEMENTS OF RELATIVISTIC AND CLASSICAL MECHANICS

(4 CREDITS) **PAPER-II** **(48 LECTURES)**

Unit - I

Michelson-Morley experiment and its consequences. Notion of relativity of electric and magnetic effects and rejection of absolute motion, Einstein's postulates of special theory of relativity. Lorentz transformations; their orthogonality and homogeneity. Relativity of simultaneity, Lorentz contraction, Time dilation. Resolution of Twin Paradox, Relativistic Doppler effect, Relativistic addition of velocities and rapidities. Motion under a constant force. Variation of mass with velocity, zero rest mass particle.

Unit - II

Spacetime diagrams for frames in relative motion. Light cones. Four-interval, Time-like, space-like and light-like intervals. Invariance under Lorentz transformations, Difference between invariant and conserved quantities, Mass energy equivalence, Relation between energy and momentum, Four-momentum and its conservation. Basics of general theory of relativity. Equivalence principle. Basic concept of Schwarzschild metric, gravitational redshift, bending of light, gravitational waves.

Unit - III

Holonomic and non-holonomic constraints. Principle of virtual work, Lagrange's equations from D'Alembert's principle, Degrees of freedom, Generalized coordinates. Hamilton's principle and its role in Lagrangian formulation, Lagrangian of a relativistic free particle. Generalized momentum. Cyclic coordinates. Conservation laws and spacetime symmetries. Calculus of variation and its applications, brachistochrone problem. Hamiltonian formulation and Hamilton's equations of motion.

Unit - IV

Two-body central force problem. Reduced mass from Lagrangian, Derivation of orbits from first integrals of equations of motion, and from Hamilton-Jacobi equation, Classification of orbits—closed, open, bounded, unbounded motion. Importance of inverse square law force. Planetary orbits as circular hodographs, Isochronous potentials, Kepler's problem in velocity space, Inadequacy of Classical Mechanics, Virial theorem and its applications. Action-angle variables for one-dimensional periodic motion.

Reference books:

1. Introduction to Special Relativity : R. Resnick (Wiley-Eastern).
2. Spacetime Physics : E. Taylor and J. Wheeler (Freeman 1992).
3. Special Relativity: A.P. French (W W Norton).
4. Introducing Einstein's Relativity: Ray D'Inverno (Oxford 1992).
5. An introduction to Relativity: J.V.Narlikar (Cambridge Univ press)
6. Spacetime and Geometry: S. Carroll (Pearson 2018).
7. Classical Mechanics : H.Goldstein et al, (Prentice Hall/Narosa).
8. Introduction to Classical Mechanics (with problems and solutions): D.J. Morrin (Cambridge Univ Press, 2008).
9. Mechanics: L. D. Landau and E.M. Lifshitz (Elsevier)
10. Classical Mechanics : N. C. Rana and P.S. Joag (McGraw Hill, 2017).

21

17/5/19

17/5/18

17.5.18

B.Sc. Semester VI

PHYSICS

SOLID STATE PHYSICS

(4 CREDITS) **PAPER-III** **(48 LECTURES)**

Unit –I

Crystal Structure: Lattice Translation Vectors and Lattice, Basis and Crystal Structure, Primitive and Unit Cells, Two and Three dimensional lattice types, Symmetry operations, Points groups and space groups, Miller indices, Simple crystal structures, NaCl, CsCl, Diamond, Cubic, ZnS and Hexagonal, Glasses.

Crystal Diffraction and Reciprocal Lattice: Incident Beam, Bragg's Law, Experimental Diffraction Method, Laue Method, Rotating-Crystal Method, Powder Method, Derivation of Scattered Wave Amplitude, Fourier Analysis, Reciprocal Lattice Vectors, Diffraction Conditions, Ewald Method, Brillouin Zones, Reciprocal Lattice to SC, BCC and FCC lattices, Fourier Analysis of the Basis and Atomic Form Factor.

Unit – II

Crystal Bindings: Crystal of Inert Gases, Van der Walls-London Interaction Repulsive Interaction, Equilibrium Lattice Constants, Cohesive Energy, Compressibility and Bulk Modulus of Ionic Crystal, Madelung Energy and Evaluation of Madelung Constant, Covalent Crystals, Metallic Bond, Hydrogen-Bonded Crystals, Atomic Radii.

Elementary Lattice Dynamics: Lattice Vibrations and Phonons, Linear Mono-and Diatomic Chains, Acoustic and Optical Phonons (Qualitative treatment only), Qualitative Description of Phonon in Solids, Dulong and Petit's Law, Einstein Theory of Specific Heat of solids.

Unit III

Electrical Properties of Materials: Free Electron Theory, Fermi Energy, Density of States, Heat Capacity of Electron Gas, Paramagnetic Susceptibility of Conduction Electrons, Hall Effect in Metals. Origin of Band Theory, Qualitative Idea of Bloch Theorem, Kronig-Penney Model, Number of Orbitals in a Band, Effective Mass of Electron, Concept of Holes, Band Gap, Energy Band Diagram and Classification of Solids.

Band Structure in Semiconductors, Direct and Indirect Band Gap, Intrinsic and Extrinsic Semiconductors, p and n-type Semiconductors, Conductivity and Hall Effect in Semi-Conductors (Qualitative Discussion Only).

Unit IV

Magnetic Properties of Matter: Origin of Magnetism, Dia-Para-Ferri-and Ferromagnetic materials, Classical Langvein theory of Dia-and paramagnetism, Curies's Law, Weiss theory of paramagnetism, Qualitative discussion of B-H Curve; Hysteresis and Energy Loss, Soft and Hard magnetic materials (06 Lectures).

Dielectric Properties of Materials: Classification of dielectrics, Electric Polarization, Local electric field at an atom, Depolarization field, Dielectric Constant, Electric Susceptibility, Polarizability, Langvin theory of polarization, Polar Solids, Ferroelectricity (Qualitative discussion only)

Referece Books:

1. Introduction to Solid State Physics: Charles Kittel
2. Solid State Physics: Adrianus J. Dekker
3. Solid State Physics: Ashcroft and Mermin
4. Introduction to Solids: Lenoid V. Azaroff