- Syllabus for Physics (B.Stat) -

Physics-I

Classical Mechanics (34 lectures)

1. **Survey of the elementary principles (2 lectures)**

   Mechanics of a particle, Mechanics of a system of particles and conservation laws, Conservative force field.

2. **Lagrange's formulation (15 lectures)**

   The basic problem with the constraint forces, Principle of virtual work, D'Alembert's Principle, Degrees of Freedom, Generalised Coordinates, Lagrange's equations of motion of the second kind, Velocity Dependent potentials and the dissipation function, Simple applications of the Lagrange's formulation.

3. **Two Body Central Force Problems (5 lectures)**

   The problem, Centre of Mass and Relative Coordinates; reduced Mass**,** The Equations of motion**,** The equivalent one dimensional problem**,** The equation of the orbit**,** The Kepler orbits.

4. **Variational Principle and Hamiltonian Mechanics (12 lectures)**

   Some techniques of the calculus of variations, Hamilton's principle, Derivation of Lagrange's equations from Hamilton's principle, Concept of symmetry: Homogeneity and Isotropy, Conservation Theorems and Symmetry properties. Hamilton's equations for one dimensional system.

References:

1. Classical Mechanics- H. Goldstein
2. Introduction to Classical Mechanics – R. Takwale and P. Puranik

Electromagnetic Theory - I (16 lectures)

1. **Vector Analysis (4 lectures)**

   Vector Algebra, Vector calculus.

2. **Electrostatics (6 lectures)**

   The Electric Field, Divergence and Curl of electrostatic fields, Electric Potential, Work and Energy in Electrostatics, Conductors, The method of images, Polarization, The electric displacement, Linear dielectrics .

3. **Magneto-statics (6 lectures)**

   The Lorentz Force Law, The Biot-Savart Law, Divergence and Curl of B, Magnetic Vector Potential, Magnetization, The Auxiliary Field H, Magnetic susceptibility and permeability.

References:

1. Introduction to Electrodynamics- D. J. Griffiths
2. Feynman Lectures on Physics- Volume II
3. Classical Electricity and Magnetism-W.K. H. Panofsky and M. Phillips

Physics II

Thermodynamics and Statistical Mechanics (25 lectures)

1. **Thermodynamics (5 lectures)**

   Laws of thermodynamics, Maxwell's relations and thermodynamic functions, kinetic theory of ideal gases, non-ideal (Van der Waals) gas.

2 **Statistical formulation of mechanical problems (10 lectures)**

   State of a system, ensembles, postulates, Probability calculations, partition function, its properties and its connection with thermodynamic quantities, Ideal gas, non-ideal (Van der Waals) gas, Para-magnetism, System of quantum harmonic oscillators.

3. **Quantum Statistical Mechanics (10 lectures)**

   Blackbody radiation, Debye's Theory, Ideal Bose Gas, Ideal Fermi Gas, Gibbs paradox, Maxwell-Boltzmann statistics, Bose-Einstein statistics, Fermi-Dirac statistics, Classical limits, specific heat of solids (Einstein approximation).

References:

1. Thermodynamics – E. Fermi
2. Statistical Mechanics – R. K. Pathria
3. Fundamentals of Statistical and Thermal Physics – F. Reif

Electromagnetic Theory - II (25 lectures)

1. **Electrodynamics (6 lectures)**

   Electromotive Force, Electromagnetic Induction, Maxwell's equations.

2. **Conservation Laws (2 lectures)**

   Conservation of Charge and Energy, Conservation of momentum.

3. **Electromagnetic waves (12 lectures)**

   Waves in One dimension, Electromagnetic Waves in Vacuum, Electromagnetic waves in Matter, Electromagnetic waves in Conductor, Wave Guides.

4. **Potentials and Fields (5 lectures)**

   Scalar and Vector potentials, Gauge Transformations, Coulomb gauge and Lorentz Gauge.

References :

Introduction to Electrodynamics- D. J. Griffiths

Physics-III

Special Theory of Relativity (13 lectures)

1. **Principle of relativity (5 lectures)**

   Galilean Relativity, Significance of Michelson-Morley experiment, The Postulates of special Relativity, The Lorentz Transformation.

2. **Relativistic effects (6 lectures)**

   Time dilatation, Length Contraction, The relativistic velocity addition formula, Mass formula, Mass energy equations.

3. **Four vector formalism (2 lectures)**

   Minkowskian four- Dimensional Space Time, Four velocity and Four momentum and their interpretation.

Quantum Mechanics (37 lectures)

1. **Introduction to Quantum Theory (3 lectures)**

   The Photoelectric Effect, The Compton Effect, De Broglie relation, The Diffraction of matter waves, The Statistical Interpretation of matter waves, The Superposition Principle.

2. **The Mathematical Foundations of Quantum Mechanics (11 lectures)**

   Hilbert Space, Operators, Eigen value, Eigen function, Bra and Ket notation, state and Observables, Born probability Interpretation, The Heisenberg's Uncertainty

Principle, Principle of complementarity, Dynamics; The Schrodinger picture, The Heisenberg picture.

3. **The Schrodinger Equation and its application (6 lectures)**

   Stationary States, The Harmonic Oscillator, The Free particle, Particle in a Box, The finite square well, The potential barrier.

4. **Operator Formalism (12 lectures)**

   Creation and annihilation operators, Harmonic oscillators, Angular momentum. Addition of Angular Momentum, Details of Spin-1/2 system.

5. **Symmetry in Quantum Mechanics (5 lectures)**

   Symmetries, Conservation Laws, Degeneracy, Discrete Symmetries, Parity or Space Inversion.

References:

1. Special Theory of Relativity –R. Resnick
2. Modern quantum mechanics - J.J.Sakurai
3. Quantum mechanics – J.L. Powell and B. Crasemann