

SYLLABUS FOR Ph.D ENTRANCE TEST- PHYSICS (2025)

Classical and Quantum Mechanics: Newton's laws, two body collisions, central force motion; special theory of relativity - Lorentz transformations, relativistic kinematics and mass energy equivalence; Generalized coordinates, Lagrangian and Hamiltonian formulations, Postulates of quantum mechanics; uncertainty principle; Schrodinger equation; one & three dimensional potential problems; particle in a box, Square well, Rectangular step potential, Rectangular barrier and Simple harmonic oscillator, hydrogen atom.

Electrodynamics: Coulomb's law, Gauss's law, Multipole expansion, Electric fields in matter, Poisson's and Laplace's equation, Induced dipoles, Polarization, Electric displacement, Linear Dielectrics. The Lorentz force law, The Biot-Savart law. Maxwell's equations and Conservation Laws; Faraday's law of induction. Poynting's theorem, Electromagnetic Waves.

Physical Methods of Analysis: Magnetic Resonance Spectroscopy: Principle, spectrometer, applications of NMR and ESR. Vacuum Technique: Production by Rotary and Diffusion Pumps, Measurement by Pirani and Penning Gauges, Optical spectroscopy– UV-Vis, FTIR, thermal techniques – TGA, DSC, Electron Microscopy, AFM, SEM & TEM.

Atomic & Molecular Physics: Many Electron Atoms: LS Coupling-Approx., Allowed Terms, Fine Structure and Relative Intensities; jj Coupling Approximation and other types of Coupling. Zeeman Effect, Stark Effect, Types of Molecules, Theory of Rotational Spectra, Vibrational Spectra & Electronic Spectra. Lasers, Criteria for Lasing and Threshold Condition, Spatial and Temporal Coherence, Types of Lasers, Applications of Lasers: Holography.

Mathematical Physics: Fourier series and Fourier transforms, their properties & applications. Definition and properties of Dirac delta function. The method of separation of variables for partial differential equation. Linear ordinary differential equations with constant coefficients and the Euler equation. Linear Integral Equations, Notation and conventions of Tensors, Tensors of higher rank, Addition, Subtraction, Outer product, Inner product, Contraction of tensor, Quotient law, Christoffel Symbols. Eigen Values and Eigen vectors of Matrices, Diagonalization of real symmetric matrix.

Solid State Physics: Crystal lattice – Primitive and Unit cells – Bravais lattices, Miller Indices, X ray diffraction and reciprocal space lattice. Drude-Lorentz and Sommerfield Theory of Electrical Conductivity, and Widemann-Franz's Law, Hall Effect. Formation of bands, Defects in Solids, Wave function in a Periodic Lattice and Bloch Theorem, Kronig Penny model. Magnetic Materials, Semiconductors & Superconductivity.

Nuclear and Particle Physics: Nuclear Structure & Properties: Rutherford scattering. Nuclear mass, charge, size, shape, binding energy, spin and electric/magnetic moments; Unstable Nuclei: α , β & γ – decay. Geiger-Nuttal law, GM Counter, Scintillation Detector. Elementary particles: Four basic interactions in nature Quantum Numbers: Mass, charge, spin, Isotopic spin, strangeness, hypercharge, Conservation laws. Classification of elementary particles: Hadrons and leptons, Baryons and mesons. Particle accelerators: Cyclotron, Synchrotron, linear accelerator.