

## PhD Entrance Syllabus

### PHYSICS: Paper II

**Momentum and Energy** : Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.

**Gravitation**: Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only).

**Oscillations** : Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations. Compound pendulum.

**Elasticity**: Hooke's law - Stress-strain diagram – Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants – Work done in stretching and work done in twisting a wire – Twisting couple on a cylinder – Determination of Rigidity modulus by static torsion - Torsional pendulum.

**Special Theory of Relativity**: Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

**Electrostatics** - Laplace and Poisson equations, boundary value problems.

**Magnetostatics** - Ampere's theorem, Biot - Savart Law, electromagnetic induction. Maxwell's equations in free space and in linear isotropic media. Boundary conditions on the fields at interfaces. Scalar and vector potentials. Gauge invariance.

**Electromagnetic waves** - reflection and refraction, dispersion, interference, coherence, diffraction, polarization. Electrodynamics of a charged particle in electric and magnetic fields. Radiation from moving charges, radiation from a dipole.

**Thermodynamics and Statistical Physics**: Laws of thermodynamics and their consequences, Thermodynamic potentials and Maxwell's relations.

Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity.

**Vectors & Tensor Analysis:** Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients.

Different tensors, Christoffel's symbols, geodesics, covariant derivatives, curvature tensor, Ricci tensor and scalar, Bianchi identities, energy momentum tensor.

**Electronics:** Physics of p n junction. Diode as a circuit element; Transistor as a circuit element: CC, CB and CE configuration. Transistor as a switch, OR, AND, NOT gates. Digital integrated circuits NAND & NOR gates as building blocks, X OR Gate

**Condensed matter Physics:** Crystal classes and systems, 2d & 3d lattices, Bonding of common crystal structures, reciprocal lattice.

**Nuclear Physics:** Nuclear reaction, Nuclear Energy: Nuclear fission: Energy release, mass and energy distribution of fission fragments.

**Quantum Mechanics:** Wave - particle duality. Heisenberg's uncertainty Principle. The Schrodinger equations and its applications.

**Plasma Physics:** Introduction to plasma, definition, concept of temperature, Debye shielding and different plasma parameters. Fluid theory in plasma.

**Astrophysics:** Introduction to celestial objects, Co-ordinates and the concept of time. Evolution of stars, HR diagram, classification of Galaxy.

**Operating system and Programming:** Introduction to operating systems: DOS, WINDOWS, UNIX; Algorithms and flow charts. Programming Languages : FORTRAN / C/ MATLAB / PYTHON

**Experimental techniques:** Generation and measurement of vacuum;

Analytical Instruments: X-ray diffractometer, spectrometers (UV-Vis, FTIR), microscopes (SEM, TEM, AFM), Photometer