Syllabus for PhD Admission Test – 2026-27

PHYSICS & MATERIALS SCIENCE

1. **Classical Mechanics:**

   Conservation laws; central forces, Kepler problem and planetary motion; collisions and scattering in laboratory and centre of mass frames; Variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations.

2. **Electromagnetic Theory:**

   Solution of electrostatic and magnetostatic problems including boundary value problems; Maxwell's equations; Electromagnetic waves and their reflection, refraction, interference, diffraction and polarization. Poynting vector, Poynting theorem, energy and momentum of electromagnetic waves. Special theory of relativity – Lorentz transformations, relativistic kinematics, mass-energy equivalence. Compton Effect.

3. **Atomic and Molecular Physics:**

   Spectra of one- and many-electron atoms; Stern-Gerlach experiment, LS and JJ coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; Lasers-spontaneous and stimulated emission, optical pumping, population inversion, coherence (temporal and spatial) simple description of Ruby laser, CO_2 and He-Ne Lasers, optical fibers.

4. **Thermodynamics and Statistical Physics:**

   Laws of thermodynamics; macrostates and microstates; phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

5. **Quantum Mechanics:**

   Wave-particle duality; uncertainty principle; Schrodinger equation; one, two and three dimensional potential problems; particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momenta; time independent perturbation theory; elementary scattering theory.

6. **Solid State Physics:**

   Crystal classes and systems, 2d & 3d lattices, Bonding of common crystal structures, unit cells, Miller indices, reciprocal lattice, diffraction methods for structure determination; Concept of amorphous, single and polycrystalline structures and their effect on properties of materials. Crystal growth techniques, elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; crystal growth techniques, imperfections in crystalline solids and their role in influencing various properties. Free electron theory of metals, Band theory of solids – metals, semiconductors and insulators, electrical conductivity, effect of temperature on conductivity, intrinsic and extrinsic semiconductors, Hall effect, effective mass of electron and hole in semiconductor, p-n junction, Photo diode, Solar cell.