**PhD Admission Entrance Test**

**Department of Physics**

**Subject: Physics (Syllabus)**

**1. Mathematical Physics:**

Linear vector space; matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis.

**2. 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.

**3. 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.

**4. Atomic, Molecular and Laser 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, CO2 and He-Ne Lasers, optical fibers.

**5. 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.

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**6. Quantum Mechanics:**

Wave-particle duality; uncertainty principle; Schrodinger equation; one-, two- and three (1D, 2D and 3D) 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.

**7. Condensed Matter 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. Elastic properties of solids; lattice vibrations and thermal properties of solids; dielectric and magnetic properties, superconductivity.

**8. Electronics:**

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, Field Effect Transistors, amplifier and oscillator circuits; operational amplifier, negative feedback circuits, active filters and oscillators; rectifier circuits, regulated power supplies; basic digital logic circuits, sequential circuits, flip-flops, counters, registers, A/D and D/A conversion.

**9. Nuclear Physics:**

Nuclear Constituents and their properties, Nuclear Models, Liquid drop model: Weizsacker's Semi-empirical mass formula, Bohr-Wheeler theory of fission, Spin-orbit coupling, Magic numbers, Angular momenta and parities of nuclear ground state, Magnetic moments and Schmidt lines, Collective model of a nucleus, Nuclear Forces, Yukawa potential, Nuclear reactions, Centre of mass frame in nuclear Physics, Nuclear decay, : Alpha decay, Beta decay, Fermi's theory- Fermi-Kurie Plot, Decay rates, Gamma decay

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