Syllabus of Ph.D. Entrance Examination 2018

FACULTY OF SCIENCE

13. PHYSICS

1. **Mathematical Methods of Physics:** Vector algebra and vector calculus; matrices, Cayley Hamilton theorem, eigenvalue problems; Linear differential equations; Hermite, Bessel, Laguerre and Legendre; Fourier series, Fourier and Laplace transforms; complex analysis: poles, residues and evaluation of integrals

2. **Classical Mechanics: Central-force motion:** Two-body collisions, Rigid body dynamics, moment of inertia tensor, Variational principle, Lagrangian and Hamiltonian formalisms and equations of motion; Poisson brackets and canonical transformations, Special theory of relativity, Lorentz Transformations, relativistic kinematics and mass–energy equivalence.

3. **Electromagnetic Theory:** Gauss' Law and its applications; Biot-Savart law, electromagnetic induction; Maxwell's equations in free and linear isotropic media; Gauge invariance; Electromagnetic waves in free space, dielectrics, and conductors; Lorentz invariance of Maxwell's equations.

4. **Quantum Mechanics:** Wave-particle duality; Heisenberg's uncertainty principle; Dirac's bra and Ket notations, time-dependent and time-independent Schroedinger equation ; Time independent perturbation theory and applications; Time dependent perturbation and Fermi's Golden Rule; Elementary theory of scattering, partial waves and Born Approximation; Identical particles, Pauli's exclusion principle, Klein Gordon and Dirac equations.

5. **Thermodynamic and Statistical Physics:** Laws of thermodynamics and their consequences; Phase space, Micro canonical, canonical and grand-canonical ensembles;partition functions; Free Energy and connection with thermodynamic quantities; Classical and quantum statistics, ideal Fermi and Bose gases.

6. **Electronics:** Semiconductor devices: diodes, junctions, transistors, field effect devices; Optoelectronic devices: including solar cells, photodetectors, and LEDs; Operational amplifiers and their applications; Digital techniques and applications (registers, counters, comparators and similar circuits); A/D and D/A converters.

7. **Experimental Techniques and data analysis:** Data interpretation and analysis; Precision and accuracy, error analysis; chi-square test; Transducers (temperature, pressure/vacuum, magnetic field, vibration, optical, and particle detectors), impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding.

8. **Atomic & Molecular Physics:** Quantum states of an electron in an atom; Electron spin; Stern-Gerlach experiment; Spectrum of Hydrogen, helium and alkali atoms; Relativistic corrections for energy levels of hydrogen; Hyperfine structure; LS & JJ coupling; Zeeman, Paschen Back & Stark effect; X-ray spectroscopy.

9. **Condensed Matter Physics:** Bravais lattices; Elastic properties, phonons, lattice specific heat; Free electron theory; Drude model of electrical and thermal conductivity; Hall effect; Dia,, Para , and Ferromagnetism; band theory of metals, insulators and Semiconductors; Superconductivity.

10. Nuclear and Particle Physics: Basic nuclear properties: size, shape, charge distribution, spin and parity; Binding energy, Semi-empirical mass formula; Liquid drop model; Fission and fusion; Isospin; Elementary ideas of alpha, beta and gamma decays ; Nuclear reactions, Classification of fundamental forces; Elementary particles (quarks, Baryons, mesons, leptons); isospin, strangeness; Gell-Mann-Nishijima formula; C, P, and T invariance ; parity non-conservation in weak interaction.