Department of Physics
School of Engineering and Sciences
SRM University-*AP*, Andhra Pradesh

Syllabus for Ph.D. Entrance Examination

I. **Mathematical Methods of Physics**

Dimensional analysis, Vector algebra and vector calculus, Linear algebra, Matrices, Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Fourier and Laplace transforms. Elements of complex analysis, analytic functions; Taylor & Laurent series; poles, residues and evaluation of integrals. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem.

II. **Classical Mechanics**

Newton's laws, Dynamical systems, Phase space dynamics, stability analysis, Central force motions, Two body Collisions - scattering in laboratory and Centre of mass frames, Rigid body dynamics- moment of inertia tensor, Non-inertial frames and pseudoforces, Variational principle, Generalized coordinates, Lagrangian and Hamiltonian formalism and equations of motion, Conservation laws and cyclic coordinates, Periodic motion: small oscillations, normal modes, Special theory of relativity- Lorentz transformations, relativistic kinematics and mass–energy equivalence.

III. **Electromagnetic Theory**

Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media. Electromagnetic waves in free space. Dielectrics and conductors. Reflection and refraction, polarization, Fresnel's law, interference, coherence, and diffraction. Dynamics of charged particles in static and uniform electromagnetic fields.

IV. **Quantum Mechanics**

Wave-particle duality, Schrödinger equation (time-dependent and time-independent), Eigenvalue problems (particle in a box, harmonic oscillator, etc.), Tunneling through a barrier, Wave-function in coordinate and momentum representations, Commutators and Heisenberg uncertainty principle, Dirac notation for state vectors, Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom, Stern-Gerlach experiment, Time-independent perturbation theory and applications, Variational method, Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, spin-statistics connection.

V. **Thermodynamic and Statistical Physics**

Laws of thermodynamics and their consequences, Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria, Phase space, Micro- and Macro-states, Micro-canonical, canonical and grand-canonical ensembles, partition functions, Free energy and its connection with thermodynamic quantities, Classical and quantum statistics, Ideal Bose and Fermi gases, Principle of detailed balance, Blackbody radiation and Planck's distribution law, Diffusion equation, Random walk, and Brownian motion.

VI. **Electronics**

Semiconductors in equilibrium: electron and hole statistics in intrinsic and extrinsic semiconductors; metal-semiconductor junctions; Ohmic and rectifying contacts; PN diodes, bipolar junction transistors, field effect transistors; negative and positive feedback circuits; oscillators, operational amplifiers, active filters; basics of digital logic circuits, combinational and sequential circuits, flip-flops, timers, counters, registers, A/D and D/A conversion.

VII. **Atomic & Molecular Physics**

Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle. Born-Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.

VIII. **Condensed Matter Physics**

Bravais lattices. Reciprocal lattice. Diffraction and the structure factor. Bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Response and relaxation phenomena. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power. Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors. Superconductivity: type-I and type-II superconductors. Josephson junctions. Superfluidity. Defects and dislocations. Ordered phases of matter: translational and orientational order, kinds of liquid crystalline order. Quasi crystals.

IX. **Nuclear and Particle Physics**

Nuclear radii and charge distributions, nuclear binding energy, electric and magnetic moments; semi-empirical mass formula; nuclear models; liquid drop model, nuclear shell model; nuclear force and two nucleon problem; alpha decay, beta-decay, electromagnetic transitions in nuclei; Rutherford scattering, nuclear reactions, conservation laws; fission and fusion; particle accelerators and detectors; elementary particles; photons, baryons, mesons and leptons; quark model; conservation laws, isospin symmetry, charge conjugation, parity and time-reversal invariance.