Medi-Caps University
Department of Physics

Syllabus for Ph. D. Entrance Exam- Physics

1. Mathematical & Classical Physics

Vector algebra and vector calculus. Matrices, Linear ordinary differential equations of first & second order, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transform. Elements of complex analysis. Newton's laws of motion and their explanation with problems, various types of forces in nature (explanation), pseudo forces (e.g. Centrifugal force), Coriolis force and its applications, Motion under a central force, Gravitational law and field, Potential due to a spherical body, Lagrangian and Hamiltonian formalism and equations of motion, Special theory of relativity.

2. Quantum Mechanics

Schrödinger wave 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. 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.

3. Electronics

Semiconductor devices (diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices), device structure, device characteristics, frequency dependence and applications. Opto-electronic devices (solar cells, photo-detectors, LEDs). Operational amplifiers and their applications. Digital techniques and applications (registers, counters, comparators and similar circuits). A/D and D/A converters. Microprocessor and microcontroller basics.

4. Atomic & Molecular Physics

Quantum states of an electron in an atom. Electron spin. The spectrum of helium and alkali atoms. Relativistic corrections for energy levels of the 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.

5. Laser and Fiber Optics

Principle of Laser, Gain and absorption coefficients, Population inversion, Optical resonator, and Condition necessary for active Laser action, line broadening mechanism, Ruby, He-Ne, CO_2 and Nd: YAG Laser, Optical Fibers, comparison of optical fiber with other interconnectors, Core and cladding, Principle of light guidance in optical fiber, numerical aperture, acceptance angle, Types of optical fiber, Rays and modes, Basic wave guide equation.

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