Ph. D Written Test Format and Syllabus

Physics Department, Faculty of Science

Ph.D. Admission Test Format

The written test consists of two parts.

1. **Part A:** Research Methodology	25 questions.
2. **Part B**: Physics	25 questions

Part A: Research Methodology Syllabus

Research Fundamentals:

Meaning of research; objectives of research; characteristics of good research, Research problem: Identification, selection, and techniques for defining research problem, Research process, Research outcomes, Review of Literature, Hypothesis: Definition and Types

Types of Research:

Types of research, fundamental and applied research, qualitative and quantitative. Research Design: Types of research design – Exploratory, Descriptive, Casual Analytical

Sampling, Data Collection and analysis:

Types and sources of data: Primary and secondary, Methods of collecting data: questionnaire, interview, observation, case study, experiments etc., Sampling and sampling methods, characteristics of good sample, sampling techniques, Statistical Methods for Data Analysis: measures of central tendency and dispersion

Research Report:

Main body of report, abstract and keywords, Referencing styles and bibliography. Journal and author indexing

Ethics in Research:

Biasing: Definition and Types, Plagiarism -Definition and forms, IPR, copyright infringement, AI Generated Content

Part B: Physics

Mathematical & Classical Physics:

Vector calculus. Matrices and Linear Algebra, First and second order Linear ordinary differential equations, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier transform and Laplace transform. complex analysis.

Newton's laws of motion and their explanation with problems, 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.

Quantum Mechanics:

Schrödinger wave equation, particle in a box, harmonic oscillator, angular momentum, Hydrogen atom, Perturbation theory, Identical particles, Uncertainty principle, Tunnelling through a barrier. Dirac notation (bra-ket), Expectation values.

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.

Atomic & Molecular Physics:

Quantum states of an electron in an atom. Electron spin. The spectrum of helium and alkali atoms, 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.

Laser and Fibre 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 fibre with other interconnectors, Core and cladding, Principle of light guidance in optical fibre, numerical aperture, acceptance angle, Types of optical fibre, Rays and modes, Basic wave guide equation.