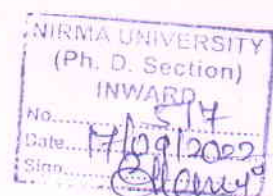


P. H. P

Syllabus: Ph.D. Entrance Exam 2022

PHYSICS

- 1. Mathematical Methods of Physics**
Dimensional analysis; Vector algebra and vector calculus; Linear algebra, matrices
Fourier series, Fourier and Laplace transforms; Elementary ideas about tensors
- 2. Classical Mechanics**
Newton's laws; Two-body collisions, scattering in laboratory and centre-of-mass frames;
Rigid body dynamics, moment of inertia tensor, non-inertial frames and pseudoforces;;
Lagrangian and Hamiltonian formalisms and equations of motion; Theory of
relativity
- 3. Electromagnetic Theory**
Electrostatics: Gauss' 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;
Scalar and vector potentials; Electromagnetic waves in free space, dielectrics, and
conductors; various Optical phenomena; Dynamics of charged particles in static and
uniform electromagnetic fields
- 4. Quantum Mechanics**
Wave-particle duality; Schrodinger equations; particle-in-a-box, harmonic oscillator;
Tunneling through a barrier; Motion in a central potential; Orbital angular momentum,
Angular momentum algebra, spin; Addition of angular momenta; Hydrogen atom,
spin-orbit coupling, Time- independent perturbation theory and applications; Time
dependent perturbation theory and Fermi's Golden Rule; Selection rules; Semi-classical
theory of radiation
- 5. Statistical Physics**
Classical and quantum statistics, ideal Fermi and Bose gases; Principle of detailed
balance; Blackbody radiation and Planck's distribution law; Bose-Einstein condensation
- 6. Electronics**
Semiconductor device physics, diodes, junctions, transistors, field effect devices,
homo and heterojunction devices, device structure, device characteristics,
frequency dependence and applications; Optoelectronic devices, High-frequency
devices, Operational amplifiers and their applications; Digital techniques and
applications, A/D and D/A converters, optical sensors
- 7. 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 and isotopic shift; width of spectral lines;
LS & JJ coupling; Zeeman, Paschen Back & Stark effect; X-ray spectroscopy; Electron
spin resonance, Nuclear magnetic resonance; Physics of Lasers, stimulated emission,
optical resonator, excimer lasers
- 8. 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; Relaxation phenomena; Drude model of electrical and
thermal conductivity; Fermi's Golden rule, Hall effect and thermoelectric power;
Types of magnetism ; Electron motion in a periodic potential, band theory solids;
Superconductivity, type - I and type - II superconductors, Josephson junctions,
BCS theory, London equations
- 9. 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; Nature of the nuclear force, form of nucleon-nucleon potential; Elementary ideas of alpha, beta and gamma decays and their selection rules; Nuclear reactions, reaction mechanisms, compound nuclei and direct reactions; Elementary particles

10. Physics of Nanomaterials:

Introduction – Nanoscale; Nanomaterials: Methods for synthesis of nanomaterials, Properties of nanomaterials – Electrical, Magnetic, Optical, Mechanical, Characterization techniques – X ray Diffraction (XRD), Electron Microscopies, Nanostructures (0D, 1D, 2D); Carbon nanotubes Characteristics and applications, Nanoelectronics and Nanoelectromechanical systems (NEMS), 2D nanomaterials and nanoparticle characteristics

Sd. 
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Nirma University