

SYLLABUS OF M. Sc. Entrance Exam (PHYSICS)

Approved by Board of Studies in Physics



School of Studies in Physics & Astrophysics

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[Signatures]
19/05/2025

Syllabus and Pattern of Entrance Examination 2025-26

M.Sc. Physics and M.Sc. Electronics

Question Pattern

- There will be 50 Multiple Choice Questions.
- Each question will carry 01 mark.
- There is no negative marking.
- The paper will be bilingual (Hindi & English).
- Duration of examination will be one hour.

Syllabus

1. MECHANICS, OSCILLATIONS AND PROPERTIES OF MATTER

Cartesian, Cylindrical and Spherical coordinate system, Inertial and non-inertial frames of reference, uniformly rotating frame, Coriolis force and its applications. Motion under a central force, Kepler's laws. Effect of Centrifugal and Coriolis forces due to earth's rotation, Center of mass (C.M.), Lab and C.M. frame of reference, motion of C.M. of system of particles subject to external forces, elastic, and inelastic collisions in one and two dimensions, Scattering angle in the laboratory frame of reference, Conservation of linear and angular momentum, Conservation of energy.

Rigid body motion, rotational motion, moments of inertia and their products, principal moments & axes, introductory idea of Euler's equations. Potential well and Periodic Oscillations, case of harmonic small oscillations, differential equation and its solution, kinetic and potential energy, examples of simple harmonic oscillations: spring and mass system, simple and compound pendulum, torsional pendulum.

Bifilar oscillations, Helmholtz resonator, LC circuit, vibrations of a magnet, oscillations of two masses connected by a spring. Superposition of two simple harmonic motions of the same frequency, Lissajous figures, damped harmonic oscillator, case of different frequencies. Power dissipation, quality factor, examples, driven (forced) harmonic oscillator, transient and steady states, power absorption, resonance.

Effect of E and B on charge particles, E as an accelerating field, electron gun, case of discharge tube, linear accelerator, Transverse B field, mass spectrograph, principle of a cyclotron. Mutually perpendicular E and B fields, Parallel E and B fields, principle of magnetic focusing lens.

Elasticity: Strain and stress, elastic limit, Hooke's law, Modulus of rigidity, Poisson's ratio, Bulk modulus, relation connecting different elastic- constants, twisting couple of a cylinder (solid and hollow), Bending moment, Cantilever, Young modulus by bending of beam.

Viscosity: Poiseuille's equation of liquid flow through a narrow tube, equations of continuity. Euler's equation, Bernoulli's theorem, viscous fluids, streamline and turbulent flow. Poiseuille's law, Coefficient of viscosity, Stoke's law, Surface tension.

2. ELECTRICITY, MAGNETISM AND ELECTROMAGNETIC THEORY

Gradient of a scalar field and its geometrical interpretation, divergence and curl of a vector field, and their geometrical interpretation, line, surface and volume integrals, flux of a vector field. Gauss's divergence theorem, Green's theorem and Stoke's theorem and their physical significance. Kirchoff's law.

Coulomb's law, Work done on a charge in a electrostatic field expressed as a line integral, conservative nature of the electrostatic field. Relation between Electric potential and Electric field, torque on a dipole in a uniform electric field and its energy, flux of the electric field. Gauss's law and its applications.

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Dielectric constant, Polar and Non Polar dielectrics, Dielectrics and Gauss's Law, Dielectric Polarization, Electric Polarization vector P , Electric displacement vector D . Dielectric susceptibility and permittivity, Polarizability and mechanism of Polarization, Lorentz local field, Clausius Mossotti equation, Debye equation.

Ferroelectric and Paraelectric dielectrics, Steady current, current density J , non-steady currents and continuity equation, rise and decay of current in LR, CR and LCR circuits, decay constants, AC circuits, complex numbers and their applications in solving AC circuit problems, complex impedance and reactance, series and parallel resonance, Q factor, power consumed by an AC circuit, power factor.

Magnetization Current and magnetization vector M , three magnetic vectors and their relationship, Magnetic permeability and susceptibility, Diamagnetic, paramagnetic and ferromagnetic substances. B.H. Curve, cycle of magnetization and hysteresis, Hysteresis loss, Biot-Savart's Law and its applications, Ampere's law.

Electromagnetic induction, Faraday's law, electromotive force, Mutual and self inductance, Transformers, energy in a static magnetic field. Maxwell's displacement current, Maxwell's equations, electromagnetic field energy density. The wave equation satisfied by E and B , plane electromagnetic waves in vacuum, Poynting's vector.

3. KINETIC THEORY AND STATISTICAL PHYSICS

The laws of thermodynamics : The Zeroth law, first law of thermodynamics, internal energy as a state function, reversible and irreversible change, Carnot's cycle, Carnot theorem, second law of thermodynamics. Clausius theorem inequality, Entropy, The thermodynamic scale of temperature, Third law of thermodynamics, Concept of negative temperature.

Thermodynamic functions, Internal energy, Enthalpy, Helmholtz function and Gibbs's free energy, Maxwell's thermodynamical equations, Application of Maxwell's equation, Joule-Thomson cooling, adiabatic cooling of a system, Van der Waals gas, Clausius-Clapeyron heat equation. Blackbody spectrum, Stefan-Boltzmann law, Wien's displacement law, Rayleigh-Jean's law, Planck's quantum theory of radiation.

Maxwellian distribution of speeds in an ideal gas: Distribution of speeds and velocities, experimental verification, distinction between mean, rms and most probable speed values. Doppler broadening of spectral lines. Transport phenomena in gases: Molecular collisions mean free path and collision cross sections. Estimates of molecular diameter and mean free path. Transport of mass, momentum and energy and interrelationship, dependence on temperature and pressure, Behaviour of Real Gases.

Probability and thermodynamic probability, principle of equal a priori probabilities, statistical postulates. Concept of Gibbs's ensemble, accessible and inaccessible states. Concept of phase space, Equilibrium before two systems in thermal contact, probability and entropy, Boltzmann entropy relation. Boltzmann canonical distribution law and its applications, law of equipartition of energy.

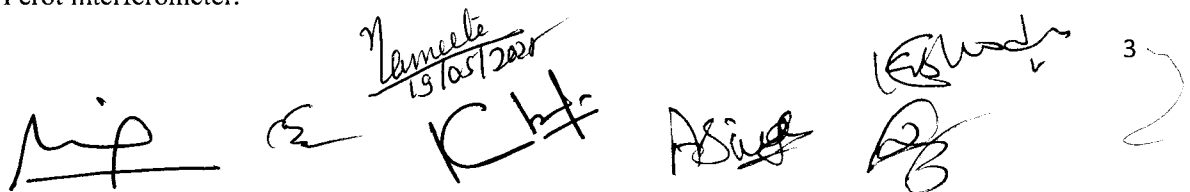
Bose-Einstein & Fermi-Dirac conditions, Concept of partition function, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac Statistics and their applications.

4. WAVES, ACOUSTICS AND OPTICS

Waves, Speed of transverse waves on uniform string, speed of longitudinal waves in a fluid, energy density and energy transmission in waves. Waves over liquid surface: gravity waves and ripples. Group velocity and phase velocity, Ultrasonic and infrasonic waves, Reflection, refraction and diffraction of sound, transducers, principle of a sonar system, sound ranging.

Fermat's Principle of extremum path, the aplanatic points of a sphere and other applications. Cardinal points of an optical system, thick lens and lens combinations. Lagrange equation of magnification, telescopic combinations, telephoto lenses. Monochromatic aberrations and their reductions; aspherical mirrors and Schmidt corrector plates.

Interference of light, Thin films. Newton's rings and Michelson interferometer and their applications, Fabry-Perot interferometer.

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Intrinsic and extrinsic semi conductors, Concept of Fermi level, Generation and recombination of electron hole pairs in semiconductors, Mobility of electrons and holes, drift and diffusion currents, p-n junction diode, depletion width and potential barrier, junction capacitance, I-V characteristics, Tunnel diode, Zener diode, Light emitting diode, solar cell, Bipolar transistors, pnp and npn transistors, characteristics of transistors, different configurations, current amplification factor, FET and MOSFET Characteristics.

Half and full wave rectifier, rectifier efficiency ripple factor, Bridge rectifier, Filters, Inductor filter, L and π section filters, Zener diode, regulated power supply using zener diode, Applications of transistors, Bipolar Transistor as amplifier, h-parameter, h-parameter equivalent circuit, Transistor as power amplifier, Transistor as oscillator, principle of an oscillator and Barkhausen's condition, requirements of an oscillator, Wein-Bridge oscillator and Hartley oscillator.

Digital Circuits: Difference between Analog and Digital Circuits, Binary Numbers, Decimal to Binary and Binary to Decimal Conversion, AND, OR and NOT Gates (Realization using Diodes and Transistor), NAND and NOR Gates as Universal Gates, XOR and XNOR Gate, De Morgan's Theorems, Boolean Laws, Simplification of Logic Circuit using Boolean Algebra, Digital to Analog Converter, Analog to Digital Converter.

Handwritten signatures and dates:
Mip, An, Kmt, Asw, (Eshwar), 2/5
15/05/2020