



# POST GRADUATE DEPARTMENT OF PHYSICS

## UNIVERSITY OF KASHMIR, SRINAGAR-06

### Syllabus of M.Sc. Physics

### Entrance Examination: 2024

#### UNIT-I

**Laws of Motion:** Frames of reference. Newton's Laws of motion, Dynamics of a system of particles. Centre of Mass. **Momentum and Energy:** Conservation of momentum. Work and energy. Conservation of energy. **Special Theory of Relativity:** Galilean and Lorentz transformations. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

#### UNIT-II

**Rotational Motion:** Angular velocity and angular momentum. Torque. Conservation of angular momentum. Moment of Inertia, Rolling without slipping, Torque about center of mass, Moments and products of inertia, principal axis, Euler's equation. **Gravitation:** Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws. Satellites in circular orbit and applications.

#### UNIT-III

**Oscillations:** Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations. **Gradient, Divergence and Curl.** Electrostatic Field, electric flux. Gauss theorem in electrostatics. Differential form of Gauss's Law, Applications. Electric field and potential due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor.

#### UNIT-IV

**Capacitance** of an isolated spherical conductor. Parallel plate, spherical and cylindrical capacitors. Energy per unit volume in electrostatic field. Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric. **Magnetism:** Magnetostatics: Biot-Savart's law & its application: straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility.



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### UNIT-V

**Electromagnetic Induction:** Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance;  $L$  of single coil and  $M$  of two coils. Energy stored in magnetic field.

**Maxwell's equations and Electromagnetic wave propagation:** Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.

### UNIT-VI

**Laws of Thermodynamics:** Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between  $C_p$  &  $C_v$ , Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes. Second law & Entropy. Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

### UNIT-VII

**Thermodynamic Potentials:** Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications – Joule-Thompson Effect, Clausius-Clapeyron Equation. Maxwell's law of distribution of velocities, Mean free path. Transport Phenomena: Viscosity, Conduction and Diffusion, Law of equipartition of energy and its applications to specific heat of gases; mono-atomic and diatomic gases.

### UNIT-VIII

**Theory of Radiation:** Blackbody radiation, Spectral distribution, Concept of Energy Density, Planck's law, Rayleigh-Jeans Law, Stefan-Boltzmann Law and Wien's displacement law.

**Statistical Mechanics:** Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity. Quantum statistics - Fermi-Dirac distribution, Bose-Einstein distribution, comparison of three statistics.



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#### UNIT-IX

Superposition of Two Collinear Harmonic oscillations: Linearity and Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats). Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal and unequal frequency and their uses. Waves Motion- General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity.

#### UNIT-X

Interference: Young's Double Slit experiment. Phase change on reflection: Stokes' treatment. Interference in Thin parallel Films. Newton's Rings: measurement of wavelength and refractive index. Michelson's Interferometer: Idea of form of fringes, Determination of wavelength, Wavelength difference, Refractive index and Visibility of fringes. Fraunhofer diffraction: Single slit; Double Slit. Multiple slits & Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge. Polarization: Transverse nature of light waves. Plane polarized light.

#### UNIT-XI

Black body radiation; Planck's radiation law; Photoelectric effect; Compton Effect. Pair Production. De-Broglie's matter wave; The concept of wave packets and group velocities; Heisenberg's uncertainty relation for  $p$  and  $x$ ; Its extension to energy and time; Applications of uncertainty principle. Schrödinger's wave equation (Time independent form); linearity and superposition; Expectation values; operators; Particle in a box; Finite potential well; Potential Barrier, Tunnel effect. Quantum numbers ( $n, l, m$ ) for an electron in hydrogen atom; Space quantization; Electron probability density .

#### UNIT-XII

Stern-Gerlach experiment; Pauli's exclusion principle; Spin-orbit coupling; Total angular momentum  $J$ , L-S coupling; j-j coupling; Normal and anomalous Zeeman Effect; Lande g-factor. Rotational energy levels; Pure rotational spectra; Vibrational energy levels, pure vibrational spectra; Rotation-Vibration. Spectra of diatomic molecules. Nuclear composition; Nuclear properties (size, spin, magnetic moment), Stable Nuclei, Liquid drop model, Alpha decay, beta-decay, gamma decay, Nuclear Reactions. Interaction and particles; Classification; Leptons and hadrons, Elementary particle quantum



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numbers; Baryon, lepton and strangeness numbers; Quarks; colour, flavour.

#### UNIT-XIII

Bravais lattice and seven crystal systems; Reciprocal Lattice. Elastic waves, density of states of continuous medium; Specific heat; Einstein and Debye models; Lattice waves; One-dimensional monoatomic lattice; Density of states of a lattice; The concept of Phonons, Electrical conductivity; Electrical resistivity versus temperature; Heat capacity of conduction electrons. Thermal conductivity in metals. Concept of Brillouin zones; Explanation of energy bands on the basis of Brillouin zones; Metals, insulators and semiconductors. Band structure.

#### UNIT-XIV

Intrinsic semiconductors; Temperature dependence of carrier concentration. Extrinsic semiconductors; The electron-hole concentration product; Electrical conductivity; Temperature dependence; The effect of magnetic field on a semiconductor; The Hall effect. p-n junction: working (on the basis of energy band diagram); Rectification property; The junction transistor, Its working (on the basis of energy band diagram), Tunnel diode.

#### UNIT-XV

Transistor load line; Transistor biasing techniques (Voltage divider); bias stability; Thermal runaway. h-parameters; h-parameter equivalent circuit for CE configuration; FET and its characteristics, MOSFET; types and characteristics, applications of MOSFET. Transistor amplifiers, Two-stage RC coupled amplifier; Equivalent circuit at mid-frequency, Gain at mid – frequency; Emitter follower.