SYLLABUS IN PHYSICS

Mechanics, sound and properties of matter:

Simple harmonic motion, damped harmonic motion, underdamped, overdamped and critically damped motion, forced vibration, resonance, sharpness of resonance, Q-factor, Composition of simple harmonic motions, Lissajous figures for superposition of two orthogonal SHM (i) with the same frequency and (ii) frequencies in the ratio 2:1. Vibration of strings, theory of plucked, struck and bowed strings. Production, properties and uses of ultrasonic waves.

Gravitational potential and field due to homogeneous solid sphere and spherical shell. Compound pendulum, Katers pendulum, Central force motion, reduction of two body central force motion into an equivalent one body motion, general features of central force motion, differential equation of orbit, Kepler's laws of planetary motion, Virial theorem.

Thermal and statistical physics:

Thermodynamic system, thermodynamic equilibrium, zeroth law of thermodynamics, Thermodynamic processes, work done in isothermal and isobaric processes, internal energy, the first law of thermodynamics, application to various processes, expression for C_p - C_v, equation of state for adiabatic process, work done in adiabatic process, polytropic process, Heat engine, Carnot engine, Carnot cycle, Carnot's theorem, the second law of thermodynamics, entropy, enthalpy, Helmholtz free energy, Gibbs function, Maxwells thermodynamic relations, Clausius-Clapeyron equation, Joule-Thomson effect, first order phase transition. Statistical system, microstate and macrostate, ensembles in statistical systems, microcanonical, canonical and grand canonical ensembles, entropy and thermodynamic probability, partition function.

Electricity, magnetism and electromagnetic theory:

Coulomb's law, electric field, field due to (i) electric dipole, (ii) discrete distribution of charge and (iii) continuous distribution of charge. Gauss law of electrostatics, field due to (i) linear, (ii) spherical and (iii) plane charge distributions, curl of the electrostatic field, electrostatic potential, relation between electric field

and electric potential, work done in moving a charge in electric field, electrostatic energy of discrete and continuous charge distributions, electrostatic boundary conditions surface charge on conductors, differential form of Gauss law of electrostatics, Laplace's equation, Poisson's equation, solution of Laplace's equation in spherical polar coordinate system, conducting sphere in uniform electric field, dielectric polarization, electric field inside a dielectric material, Gauss law in a dielectric medium, linear dielectric medium, electric susceptibility, permittivity, dielectric constant, boundary conditions on the displacement vector $\vec{D}$, dielectric sphere in an external uniform electric field, force on a point charge embedded in a dielectric medium, molecular field in a dielectric, Clausius-Mossotti relation, energy in a dielectric medium. Electric current, current density, equation of continuity, electromotive force, Ohm's law.

Magnetic induction $\vec{B}$, Lorentz force law, force on a straight current carrying conductor in uniform magnetic field, Biot-Savart law, magnetic induction due to straight, circular and solenoidal currents, Ampere's circuital law and its differential form, magnetic vector potential, magnetic field due to a distant circuit. magnetic scalar potential, torque on a current loop placed in an external uniform magnetic field, moving coil and ballistic galvanometer, Magnetic properties of matter, magnetization, Ampere's law in a magnetized medium, magnetic susceptibility and permeability, boundary conditions on $\vec{H}$ and $\vec{D}$. Langevin theory in magnetism, diamagnetism and paramagnetism, Weiss theory of ferromagnetism, magnetic hysteresis.

Motional e.m.f., Faraday's laws of electromagnetic induction, its differential and integral forms, induced electric field due to a long conductor carrying slowly varying current, self-inductance, mutual inductance, self-inductance of a solenoid and of a straight conductor, energy stored in an inductor in an electromagnetic field, growth and decay of currents in RC, RL and LCR circuits, alternating current, sinusoidal voltage applied to RC. RL, LC and LCR circuits, power in AC circuit, series and parallel resonant circuits, sharpness of resonance, Q-factor of a resonant circuit, displacement current, its physical significance, Maxwells modification of Ampere's law, Maxwells electromagnetic equations in free space and in a medium, vector potential and scalar potential for electromagnetic field, gauge transformation,

Coulomb gauge and Lorenz gauge, electromagnetic wave, Poynting vector, Poynting theorem, energy and momentum of electromagnetic wave, propagation of e.m. wave in free space and in non-conducting medium, reflection and transmission of e.m. wave at non-conducting surface for normal incidence.

Geometrical optics, physical optics and LASER:

Fermat's principle, reflection and refraction at plane interface, matrix formulation of geometrical optics, cardinal points of coaxial optical system, cardinal points of combination of two thin lenses, cardinal points of a thick lens, monochromatic aberration in lenses and mirrors, spherical aberration and its minimization, elementary idea of coma, astigmatism, curvature, distortion and their remedies, chromatic aberration and its removal, achromatic combination, Ramsdens eyepiece, Huygens eyepiece, dispersion of light, theory of formation of primary and secondary rainbow.

Wave theory of light, Huygens principle, reflection and refraction at plane interface, condition of interference of light, coherent sources of light, division of wavefront and division of amplitude, biprism, interference by plane parallel thin film, interference by wedge shaped thin film, colour of thin films, Newton's rings, Michelson interferometer, determination of wavelength of monochromatic light, determination of wavelength difference, Fabry-Perot interferometer, determination of wavelength by it, resolving power of Fabry-Perot interferometer.

Fresnel and Fraunhoffer diffraction, Fresnel's half period zone, zone plate, its analogy with converging lens, diffraction at straight edge, Fraunhoffer diffraction by single slit, double slit and plane transmission grating, Rayleigh scattering, Raman scattering.

Electromagnetic nature of light, polarised and unpolarised light, plane polarised, circularly polarised and elliptically polarised light, polarisation by reflection, refraction and scattering, Malus law, Brewsters law, double refraction, ordinary and extraordinary rays, construction and working of Nicol prism, its use as polariser and analyser, half wave plate, quarter wave plate, Babinet compensator, Laurents half shade polarimeter.

Spontaneous and stimulated emission, optical pumping, properties and uses of LASER.

Solid state physics and electronics:

Intrinsic and extrinsic semiconductor, p-type and n-type semiconductor, pn junction as rectifier, half wave and full wave rectifier, centre tap and bridge type rectifier, efficiency and ripple factor of rectifier, series inductor, shunt capacitor and π- filters, Zener diode as voltage regulator, working of pnp and npn transistors, static characteristics of transistors in CE and CB configurations, relation between α and β, load line, operating point, transistor as a four port device, impedance parameter, admittance parameter and hybrid parameter, equivalent circuit for transistor.

Classification of amplifiers, CE, CB and CC configurations, input output resistance, current gain, voltage gain and power gain, RC coupled amplifier, gain, frequency response and band width, Class A, Class B, push-pull amplifiers, distortion in amplifiers, field effect transistor (FET), operation and volt-ampere curve of JFET.

Positive and negative feedback, condition for sustained oscillation, Hartley and Colpitt oscillators, phase shift oscillator, their principle, circuit operation and uses. Modulation and demodulation, AM, FM and phase modulation, modulation index and its significance, principle of demodulation, linear diode detector. Integrated circuit (IC), fabrication of monolithic IC. Digital electronics, binary and decimal number systems, logic gates, AND, OR, NOT, NAND, NOR gates, truth table, DTL and TTL circuits for gates.

Atomic and nuclear physics:

Planck's quantum hypothesis, photoelectric effect, Einstein's photoelectric equation, particle nature of electromagnetic wave, photon, de Broglie hypothesis, matter wave, wave nature of particles, wave-particle duality, Heisenberg's uncertainty principle, Bohr's theory of hydrogen atom, explanation of hydrogen spectra.

Atomic nucleus, charge, mass, spin and composition of nucleus, mass defect, binding energy, characteristics of nuclear force, radioactivity, laws of radioactivity, α, β and γ rays, nuclear fission and fusion.

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