Elective Papers offered by the Dept. of Physics

SEM I : PAPER 1 : Module A : Math. Methods, Mechanics and General properties of matter (24L)

Math. Methods

Vectors, Dot and cross products, scalar triple product, vector triple product. Scalar and vector fields - gradient, divergence and curl. Statements of Stoke's and Divergence theorem, polar coordinates.

[5 L]

Mechanics

Newton's laws of motion, principles of conservation of linear momentum, time and path integral of forces, Central forces, conservative force field (few examples), concept of potential, conservation of total energy
Rotational kinematics and dynamics - equations of rotational motion, kinetic energy of a rotating body, conservation of angular momentum. Moment of inertia - its physical significance, radius of gyration, parallel and perpendicular axes theorem. Problems involving rotational dynamics.

[7 L]

Properties of matter

Elasticity - Stress, strain, Hooke's law, different types of moduli of elasticity for isotropic homogeneous bodies, interrelations of elastic moduli (no derivation), torsion of a cylinder, internal bending moment, bending of beam supported at ends with a concentrated load at the centre.

[4 L]

Surface Tension – Surface tension forces, relation between surface tension and surface energy, molecular theory(property of surface layer), angle of contact, expression for the excess pressure over a curved surface (without deduction), capillarity, Jurin's law, factors affecting surface tension of a liquid(qualitative).

[4L]

Dynamics of fluids - Streamline and turbulent motion, equation of continuity, coefficient of viscosity, critical velocity, Reynold's number, Poiseuille's equation, Stokes law (statement only), terminal velocity, Bernoulli's theorem and applications.

[4 L]

SEM I : PAPER 1 : Module B : Vibration, Waves and Optics (24L)

Vibrations and Waves

Simple harmonic motion - Superposition of simple harmonic motion, analytical treatment, Lissajous figures, analytical solution for natural, damped and forced vibration, resonance, sharpness of resonance.
Differential equation of wave motion - plane progressive wave, energy and intensity of plane wave.
Superposition of waves - stationary waves, beats, speed of transverse vibrations in stretched strings. Doppler effect.

[10 L]

Optics

Fermat's principle and its application to reflection and refraction in plane surfaces. optical systems. Refraction of light at curved surface, Lens-maker's formula in paraxial approximation, combination of thin lenses, equivalent focal length.
Dispersion and dispersive power. Dispersive power of prisms.
Light as electromagnetic wave, Statement of Huygen's principle, Validation of the principle in case of reflection.
Interference : Concept of spatial and temporal coherence, Young's Double slit experiment, intensity distribution, shapes of fringes and fringe width, Newton's ring.
Diffraction - Fresnel and Fraunhofer class. Fraunhofer diffraction, Single slit diffraction, plane transmission grating.
Resolving power , Rayleigh's criterion, resolving power of telescope and diffraction grating (Qualitative).
Polarisation - States of polarization, Brewster's law, Polaroid.
Laser: Stimulated emission and absorption, Einstein coefficient, Population inversion, Block diagram and principle of operation of a ruby laser.

[14 L]

SEM I : PAPER 1 : Module C : Gen. Lab. I

1. Determination of the modulus of rigidity of the material of a given wire by dynamical method.
2. Determination of the moment of inertia of a cylinder about an axis passing through its centre of gravity and perpendicular to its length using a cylinder as an auxillary body and comparison of the moment of inertia thus obtained with the theoretical value calculated with the measured mass and dimensions of the bar.
3. Determination of the refractive index of a liquid and that of the material of the convex lens by using the lens and a plane mirror.
4. Determination of the surface tension of water by capillary rise method.
5. Determination of the Young's modulus of the material of the given uniform bar supported at two ends and loaded at the centre.
6. Calibration of a given polarimeter and determination of the concentration of an unknown sugar solution.

SEM II: PAPER 2 : Module A : Electrical Networks and Electromagnetism (24L)

Coulomb's law, potential and field intensity for discrete and continuous charge distribution, Gauss's theorem and its applications (for charged spherical shell, charged solid sphere)
Capacitors - parallel plate, energy stored by a charged capacitor (parallel plate), effect of dielectric in a capacitor.

[6L]

Steady current - Network analysis, Kirchhoffs laws, Thevenin, Norton and Maximum power transfer theorems (statements only), applications to simple circuits.
Magnetic effect of current : Biot Savart's law, application for simple cases – [straight conductor, circular coil], Ampere's theorem, Ampere's circuital law (statement only), applications of circuital law [long straight conductor, solid cylinder, circular loop]
Force on a current carrying conductor in a magnetic field, Lorentz force, action of current on current.

[10 L]

Magnetic materials - Intensity of magnetization, relation between B,H and M. Magnetic susceptibility, Dia-, para- and ferromagnets, Curie's law (only statement), Hysteresis (qualitative).
Electromagnetic induction - Self and Mutual inductances in simple cases [circular coil, long solenoid].
Alternating current : Mean and rms values of emf and current with sinusoidal waveform, L-C-R series circuits, resonance, Q factor.

[8 L]

SEM II: PAPER 2 : Module B : Thermal Physics (24L)

Kinetic theory of gases - Introduction, Maxwell's law of velocity distribution (no deduction), most probable speed, rms speed and mean speed. Degrees of freedom, principles of equipartition of energy, application in simple cases, Brownian motion. Example of a real gas EOS: Van der Waals equation.
Thermodynamics - Introduction, first law of thermodynamics and its applications, specific heats of a gas, isothermal, adiabatic, isochoric and isobaric processes, indicator diagrams, adiabatic relations for a perfect gas, reversible and irreversible processes, cyclic process. Work done by a perfect gas during isothermal and adiabatic process,
Second law of thermodynamics - Clausius and Kelvin statements and their equivalence, Carnot's theorem, entropy.

[12 L]

Statistical Mechanics: Essential concepts: Entropy and disorder, Introductory survey of partition functions. calculation of macroscopic properties from partition function.

[8 L]

Recapitulation of basic idea in nuclear physics: Radioactivity: decay rule and half life, Measurement of radioactivity. Significance of binding energy curve, preliminary idea of models of nucleus, nuclear reaction, fission and fusion, nuclear reactor.

[4 L]

SEM II: PAPER 2 : Module C : Gen. Lab. 2

1. Determination of the horizontal component of the earth's magnetic field by using a deflection and an oscillation magnetometer.
2. Determination of the wavelength of a monochromatic light by Newton's ring method.

3. Determination of the resistance of a galvanometer by the method of half-deflection.
4. Determination of temperature coefficient of resistance of the material of a coil by Carey-Foster bridge.
5. Study of resonance of a series LCR circuit and determination of Q-factor.
6. Determination of the coefficient of viscosity of water by Poiseuille's method.

SEM III: PAPER 3 : Module A : Quantum Physics and Relativity (24 L)

Basic idea about crystal structures, diffraction of x-rays, Bragg's law, Moseley's law - explanation from Bohr's theory.

[4 L]

Radiation - Introduction, Kirchoff's laws of black body radiation, Stefan's law, Newton's law of cooling. Wein's displacement law, Rayleigh-Jean's law, Planck's law of black body radiation (only statements of the last three laws), Solar constant.

[6 L]

Special theory of relativity - Postulates, Lorentz transformation (no deduction), length contraction, time dilation, velocity addition, mass variation, mass-energy equivalence.

[5 L]

Planck's theory of radiation (only statement), review of photoelectric effect, Compton, Raman effects. Wave particle duality, De-Broglie's wave, Heisenberg's uncertainty principle.

[5 L]

Schrödinger's equation, particle in one dimensional infinite well, energy eigenvalues, wave function, probabilistic interpretations.

[4 L]

SEM III: PAPER 3 : Module B : Electronics (24 L)

Semiconductor diodes - introduction, depletion region, biasing, bridge rectifier, filters. Zener diode - characteristics and voltage regulation.

[8 L]

Transistor - Modes of operation, output characteristics of CE mode, α and β, single stage CE amplifier, Negative and positive feedback, Barkhausan criterion, oscillator.

[8 L]

Binary number system, Logic gates - AND, OR, NOT gates using diodes/transistor, De-Morgan's laws, Universal gates: NOR, NAND. XOR gate: implementation using universal gates.

[8 L]

SEM III: PAPER 3 : Module C: Gen. Lab 3

1. Verification of Thevenin and Norton theorem for a Wheatstone bridge network.
2. Study of I-V characteristics of a resistor and p-n junction diode in forward biased condition.
3. Study of reverse characteristic and voltage regulation of a Zener diode.
4. Study of output characteristics of a transistor in CE configuration.
5. Determination of the focal length of a given concave lens by combination method.
6. Verification of the truth table of OR and AND logic gates using diodes and construction of AND, OR and NOT gates using NAND/NOR IC gates and verification of their truth tables.