I SEM – B.Sc

Subject – MECHANICS AND PROPERTIES OF MATTER

Syllabus

UNIT	Content	Hours Allotted
I	*1.PLANAR MOTION*: Review of vector algebra, Scalar and Vector product. Derivative of a vector. Review of polar coordinates. Derivative of a vector of constant magnitude (derivation of $\frac{d\vec{A}}{dt} \perp \vec{A}$).Radial and transverse components of velocity and acceleration (meaning and derivation of R and T components) – application to uniform circular motion- centripetal force, areal velocity(derivation), problems	05
II	*2.FRAMES OF REFERENCE*: Concept of frames of reference. Galilean transformations, Galilean principle of relativity (statement and explanation using various examples). Inertial frames: Newton's laws of motion (statements and their significance). A frame of reference moving with a uniform velocity with respect to an inertial frame is also inertial (Proof). *Non-inertial frames* – A frame of reference moving with uniform Acceleration with respect to an inertial frame – a non-inertial frame (proof). Fictitious force – examples. Measurement of acceleration using plumb line (derivation). Rotating frames of reference - derivation for expression of force. Types of forces in rotating frame. Discussion of the earth as an inertial frame, Foucault pendulum (brief explanation).Conical pendulum – expression for Time period (derivation)w.r.t an inertial (lab) and non inertial (rotating frames).Problems.	11
III	*3.SYSTEM OF PARTICLES*: Newton's laws for a system of particles (qualitative)–centre of mass (definition)– External and internal forces. Linear momentum of system of particles, motion of CM, Law of conservation of linear momentum -Rocket motion – expression for instantaneous and final velocities – effect of earth's gravity – multi stage rockets – brief account of Indian rockets. *Angular momentum* – Relation between the torque and momentum, theorems on total angular momentum about CM. Law of conservation of angular momentum - examples. Work done by a variable force: Work – energy theorem(derivation) – conservative force fields, potential energy - conservation of energy, examples – oscillation of a loaded spiral spring Atwood machine (calculation of acceleration using conservation of energy). *Collisions:* Elastic and inelastic collisions – elastic head on collision – oblique collision of identical masses in a plane. Central forces – characteristics of central motion. problems.	13
IV	*4.GRAVITATION:* Newton's law of gravity in vector form. Gravitational potential and field for spherical mass distributions –thin spherical shell and solid sphere (derivation in both case).*Kepler's laws* – statements and derivation, conditions for different orbits, brief account on physics of tides. *Elements of satellite motion* – orbital velocity, time period andescape velocity (Brief explanation). geosynchronous	8

	orbits, applications of artificial satellites, GPS (in brief).problems.	
V	*5.ROTATIONAL MOTION*: Concept of a rigid body. Moment of inertia-definition and its significance. Equation of motion for rotation motion- K.E of a rotating body (derivation), General Theorems on moment of inertia. (1) perpendicular axes theorem- for plane lamina and for three dimensional body (2) parallel axes theorem (Statement and proof for both).Mention of expression of M I for rectangular plate and circular disc about different axes. Expression for MI of solid cylinder and solid sphere about different axes (derivation).motion of a cylinder rolling down in an inclined plane – expression for velocity and energy(derivation). Theory of compound pendulum – time period, problems.	7
VI	*6.ELASTISITY*: Stress and strain – elastic limits – Hooke's law – molecular origin –Elastic constants for an isotropic solid, Poisson's ratio-limiting value of Poisson's ratio (for both theoretical and practical), the inter-relation between elastic constants $k = \frac{q}{3(1-2\sigma)}$, $n = \frac{q}{2(1+\sigma)}$, & $q = \frac{9nk}{(3k+n)}$. Work done in stretching and work done in twisting a wire - Torsion of a cylinder – couple per unit twist derivation, torsional pendulum- frequency expression (derivation). Theory of Bending moment and Single cantilever, I Section girders -problems. 8 Hrs	8
VII	*7.VISCOSITY:* Streamline and turbulent motion, coefficient of viscosity, critical velocity, Reynold's number, Poiseuille's equation (derivation), Stokes law (derivation from dimensional formula), terminal velocity, factors affecting viscosity of a liquid (qualitative), Applications.Problems.	4
VIII	*8.SURFACE TENSION:* Synclastic and anticlastic surface –Illustration of surface tension with examples, relation between surface tension and surface energy, molecular theory of surface tension. *Excess pressure within a curved surface* (derivation) - application to spherical and cylindrical drops and bubbles. Factors affecting surface tension of a liquid. Applications. Problems	4

Statements of Course Outcomes (COs)

By the end of the course, the student will be able to

CO-1	Understand the Basics of vector algebra and learn application of centripetal force.
CO-2	Understand the Concept of frames of reference and Newton's laws of motion.
CO-3	Understand the effect of gravitation on objects and understand the principle of rocket.
CO-4	Understand the effect of gravitation on objects .
CO-5	Understand the principle of rocket.
CO-6	Analyze and comprehend regarding the strength of the solid materials of different size.
CO-7	Compare the viscosity and interfacial surface tension between the liquids.
CO-8	Differentiate between the streamline and turbulent flow of liquids and reason out the effectsof liquids while flowing.

II SEM – B.SC

SUBJECT – HEAT & THERMODYNAMICS, RADIATION, WAVES, OSCILLATIONS & SOUND.

SYLLABUS

UNIT	Content	Hours Allotted
I	***1.THERMODYNAMICS***: Concept of heat and temperature, Zeroth law and first law of thermodynamics .Brief discussion of isothermal and adiabatic processes, Equation of state of a gas in adiabatic processes (derivation). Relation between P,V and T. Slopes of Isothermal and adiabatics. Relation between Isothermal and adiabatic elasticities.P-V diagram. Carnot cycle: Expression for efficiency (no derivation). Second law of thermodynamics: Kelvin and Clausius statements. Applications of Second law of Thermodynamics-Refrigerator. Carnot theorem-Statement and proof. Thermo-dynamic scale of temperature. Clausius-Clayperon equation (derivation)- It's application for Melting point and boiling points.	12
II	***2.ENTROPY:*** Concept of entropy, Change of entropy in reversible and irreversible processes with examples. T-S diagrams-Carnot's cycle. Change in entropy during change of state, entropy disorder, heat death. Entropy and second law of thermodynamics. The applications of entropy.Third law of thermodynamics - statement and brief explanation. Thermodynamic Potentials: Extensive and intensive thermodynamic variables. Thermo- dynamic Potentials U, H, F and G. Maxwell thermodynamic relation- Their definitions, properties and applications , Derivations and applications - TdS equation	10
III	***3.KINETIC THEORY OF GASES:*** Maxwell's law of distribution of velocities (statement and expression).Expression for mean free path.Degrees of freedom, law of equipartition of energy (statement and derivation) Calculation of value of γ for monoatomic, diatomic and triatomic gases.	05
IV	***4.REAL GASES :*** Comparison between ideal and real gases, isotherms of a real gas, Vanderwal's equation of state –discussion of correction for pressure and volume, expression for critical temperature, volume and pressure. Liquefaction of gases – porous plug experiment with theory – derivation of expression for temperature of inversion. Principle of adiabatic demagnetization. Joule- Thomson Cooling (using Maxwell relation).	06
V	***5.RADIATION:*** Distribution of energy in the spectrum of a black body. Wein's displacement law, Wein's law of radiation, Rayleigh- Jeans law. Planck's law of radiation and derivation from the concept of harmonic oscillators – deduction of Wein's law, Wein's displacement law, Rayleigh – Jeans law, and Stefan's law from Planck's law of radiation. Solar constant – temperature of the sun from solar constant.Radiation pressure (definition)	9
VI	***6.OSCILLATIONS:***	6

	Review of simple harmonic motion, expression for frequency from the equation f α –x (derivation). Equation for damped simple harmonic oscillator. Theory of forced vibrations and resonance – mechanical and electrical examples of resonance. Superposition of SHMs, theory of Lissajous figures	
VII	***7.WAVES:*** Characteristics of wave motion - derivation of general equation of one dimensional progressive wave – differential equation of a wave – complex representation of a wave. Phase of a wave, wave front, expression for intensity of progressive wave(Derivation). Wave groups – phase velocity and group velocity – relation between them. Brief discussion of different types of waves (mechanical waves, seismic waves , water waves and matter waves).	6
VIII	***8.SOUND:*** Velocity of longitudinal waves : 1) in a gas. Newton's formula, derivation.Laplace correction – variation of pressure in a sound wave.2) Velocity of longitudinal waves in a rod. Theory of beats.Expression for velocity of transverse waves in a stretched string-derivation. Theory of stationary waves (theory). Doppler Effect- brief explanation.	6

Statements of Course Outcomes (COs)

By the end of the course, the student will be able to

CO-1	Differentiate the terms heat and temperature and measure temperature using thermometer andconvert one scale of temperature to another scale.
CO-2	Understand specific heat capacity of gas and the different theories on specific heat capacity
CO-3	Differentiate between principles and methods to produce low temperature, liquefy air, heliumand hydrogen
CO-4	Define postulates of kinetic theory of gases and arrive at theorem of equipartition of energy andderive Van der Waal"s equation.
CO-5	Define different thermal processes and understand laws of thermodynamics and identify itsoutcomes
CO-6	Learn the fundamentals of harmonic oscillator model, including damped and forced oscillators.
CO-7	Describe the waves and applications.
CO-8	Explain the absorption and reflection of sound by various materials anddescribe the requirements for good architectural acoustics

III SEM – B.SC

SUBJECT – *OPTICS AND ELECTROSTATICS*

SYLLABUS

UNIT	Content	Hours Allotted
I	*1.**GEOMETRICAL OPTICS*** Optical path, Fermat's principle – statement and explanation.Derivation of Snell's law of refraction using Fermat's principle.*Cardinal points*:Mention of Gauss sign conventions. Meaning of thick lens.Definition and explanations of cardinal points – focal points, principal points and nodal points and corresponding planes, properties of these points and planes.Combination of two thin converging lenses not in contact as an example of combination of two optical systems.*Defects of lenses:Abberations* – types, chromatic aberration. Achromatisation of two thin lenses not in contact (derivation). Mention of condition for two thin lenses in contact. Monochromatic aberrations – mention of five types and brief explanation – problems	8
II	***2.OPTICAL INSTRUMENTS**:* Eye-pieces, Huygen's and Ramsden's eye-pieces - construction, expression for equivalent focal length (derivation), correction for aberrations, positions of principal and focal planes (no derivation). Comparison	3
III	***3.WAVE THEORY OF LIGHT*:** Wave front, Huygen's principle, explanation of advance of wave front using concept of the secondary waves.Refractive index in terms of velocity (taking refraction of a spherical wave front at a plane surface).Mention of Experimental confirmation of wave theory. Derivation of lens maker's formula in the case of double convex lens using spherical wave front.	3
IV	***4.INTERFERENCE OF LIGHT*:** Review of Young's double slit experiment, coherent sources, conditions for interference. Biprism - explanation, expression for fringe width. Explanation of measurement of distance between two coherent sources ($d = \sqrt{d_1 d_2}$). Lloyd's mirror –brief explanation, comparision of interference pattern with Biprism. Interference in thin films – reflected system – derivation, transmitted system qualitative). Complimentary nature of the two patterns.Interference due to an air wedge- expression for band	11

	width (or wavelength) – derivation.Theory of Newton's rings – reflected system, determination of wavelength and refractive index of a liquid- theory, problems. Michelson's interferometer – construction and working, formation of interference pattern, Conditions for circular, straight fringes, mention of fringes of equal inclination(Haidingers fringes) and thickness. Applications - determination of wavelength λ and difference in wavelength dλ - Problems. Interference filters(qualitative).	
V	***5.DIFFRACTION OF LIGHT*:** Introduction, Types of diffraction. Fresnel's half period zones, expression for radii- (derivation) – Explanation of rectilinear propagation of light. Zone plate – of variation of intensity in the diffraction pattern. Diffraction at a straight wire(qualitative).Plane transmission grating – normal and oblique incidence (derivation).Dispersive and resolving power of a grating (qualitative) comparison of grating and prism spectra.Problems.	11
VI	***6.POLARISATION OF LIGHT:*** Double refraction in a uniaxial crystal.Optic axis. Mention of biaxial crystals. Principal refractive indices – Huygen's construction for O and E wave fronts in the case of optic axis in the plane of incidence and parallel to crystal surface – oblique and normal incidence (in detail).Retarding plates – production with theory, derivation of general equation for an ellipse and discussion of different cases, expression for the thickness of quarter and half wave plates (mention) – problems. Production and detection of linearly, circularly and elliptically polarized light, (qualitatively explanation). Optical activity-Fresnel's theory. Kerr and Faraday Effect (brief explanation and comparison).	8
VII	***7.SCALAR AND VECTOR FIELDS:*** Concept of scalar and vector fields: Del operator – gradient of scalar function – physical significance. Divergence and curl of a	4

	vector function - physical significance with examples, problems. Laplacian operator-line, surface and volume integrals of a vector function, examples. Gauss divergence theorem, Stokes theorem and their physical meaning (no derivation). Proof of curl grad φ = 0 and div curl A = 0.	
VIII	***8.ELECTRIC FIELD AND POTENTIAL*** *: Electrostatic field, electric flux, expression for flux, Gauss theorem in electrostatics, (both differential and integral form). Application to deduce the expression for the* the field near a) charged conductor and force per unit area of its surface (derivation of both). Coulomb's law from Gauss law (derivation) – equivalence of two laws. The Electric Potential*: Concept of electric potential,* Electric field as the negative gradient of potential. Proof of $E = -\ grad\ V$. ($from\ d\phi = \nabla\phi.\ dr\ and\ E \cdot dr = -dV$).)Mention of Poisson and Laplace equations, uniqueness theorem (statement). Work and Energy in Electrostatics: Potential energy.The energy of a continuous charge distribution. (no derivation). Energy density in an electrostatic field, derivation from the example of a parallel plate capacitor.Loss of energy due to sharing of charges between two conductors (derivation by taking a capacitor).	5
IX	***9.ELECTRIC DIPOLE:*** Dielectric Materials: Basic terms, types of polarization in Dielectric Materials . Equation for Potential and field due to a dipole in polar coordinates(derivation). Lorentz local field (derivation) Relation between D and P. $D = \epsilon oE + P$.(derivation from parallel sided slab in an electric field). Definition and meaning of dielectric susceptibility. Brief account ofpara and ferro electric materials.Clausius – mossotti equation (no derivation).Concept of electrical images- Application to a point charge near the surface of a conducting plane (equation for $\vec{E}$ derivation).	7

Statements of Course Outcomes (COs)

By the end of the course, the student will be able to

CO-1	Distinguish the different types of aberrations and achromatism.
CO-2	Use different types of eyepieces according to their application.
CO-3	Understand the Basics of Wave Theory of Light.
CO-4	Calculate wavelength difference and fringe width from the interference pattern.
CO-5	Understand the different types of Diffraction of light.
CO-6	Explain diffraction pattern and calculate dispersive power of the grating Analyze different types of polarized light.
CO-7	Possess adequate knowledge to analyze electrical circuits and To Identify the presence of static electric charges and fields due to static charges.
CO-8	Distinguish between different types of magnetic materials and different kinds ofmagnetism manifested in materials.
CO-9	Analyze magnetic properties of a ferromagnetic solid by analyzing or recording its.

IV SEM – B.SC

SUBJECT – ELECTRICITY AND ELECTROMAGNETIC THEORY
SYLLABUS

UNIT	Content	Hours Allotted
I	**1.TRANSIENT CURRENTS:** Growth and decay of current in a series L-R circuit fed with direct emf. Derivation of expression for current in (growth – decay) – graphical representation, explanation of time constant. Charging and discharging of a capacitor through a resistance – derivation of expression for charge variation in a R-C circuit, mention of expression for voltage and current variation – explanation of time constant in each case. Series L-C-R circuit fed with direct emf – qualitative discussion-mention of expression for transient charge, condition for oscillation and expression for frequency(no derivation), Problems.	6
II	**2.ALTERNATING CURRENTS:** Types of AC (sinusoidal and non-sinusoidal) – derivation of expression for mean and RMS values of sinusoidal AC and relation between them.Complex representation of AC using j- operator, phase factor ($\omega t - \theta$). Response of LR, CR and LCR circuits fed with alternating emf – derivation of expressions for current and impedance (using j- notation), phase relation between current and applied emf. Series resonance – discussion from the expression for current , explanation of half power frequency, band width and quality factor, expression for quality factor in terms of f1, f2 and fr(derivation), significance of Q – factor, effect of resistance, frequency and quality factor. Voltage magnification. Parallel resonance (LR in parallel with C) expression for current and impedance (no derivation), current magnification.Comparison between series and parallel resonance.Power in an AC circuit-derivation of expression for average power, power factor and its significance.Skin effect (qualitative).Comparison of A C and D C w.r.t characteristics and applications.Problems.	12
III	**3.NETWORK ANALYSIS:** Mesh current method of circuit analysis. Thevenin's and Norton's theorems – DC and AC statements (proof for DC circuit) – explanation using DC circuits, problems involving both DC and AC circuits. Maximum power transfer theorem – AC and DC statements, proof for DC circuit, and problems with DC circuits. Problems	7
IV	**4.FREQUENCY FILTERS:**	2

	Types of filters– derivation of expression for cut-off frequency in caseof High pass and low pass RC filters. Band pass and band stop filters (qualitative). Application of frequency filters(mention).	
V	**5.RECTIFIERS:** Review of rectifiers, Role of filters in rectifiers – C,L and π section filters(qualitative). Zener diode- construction and working – V-I characteristics- zener breakdown voltage. Regulated power supply -Construction and working using zener diode-voltage regulation in case of a) input voltage variation (in detail) and b) load variation (qualitative). Bleeder resistance –action.Problems.	5
VI	**6.ELECTRICAL MEASUREMENTS:** Ballistic Galvanometer – construction and theory of B.G. Charge sensitivity – origin of damping and damping correction. Logarithmic decrement, expression for decrement (derivation). Applications of BG. Theory of Anderson's and de Sauty's bridges. Cathode ray oscilloscope – construction of CR tube – block diagram of CRO- brief explanation of function of each block.Time – base with simple circuit – uses of CRO.Measurement of voltage and frequency (using time base and Lissajous figures).Watt meter – watt hour meter (brief explanation).	8
VII	**7.ELECTROMAGNETISM:** Explanation of magnetic field as that produces force on a moving charge – distinction between B and H – Lorentz force on a charge in an EM field, mention of expression F = q (E + V X B) and its explanation. Origin of induced emf in a conducting rod moving in a magnetic field (from force on charged particles). Ampere's circuital law – statement – proof from line integral over an irregular path which encloses current -comparison of Gauss's law and Ampere's law – application of Ampere's law to calculate magnetic fields due to (a) a straight long conductor (b) a long solenoid. Characteristics of magnetic field- Div B = 0 (qualitative)- concept of magnetic vector potential (brief). Current loop as a magnetic dipole, illustration from the magnetic loop due to a circular current loop- expression for torque on a magnetic dipole in a magnetic field.	9
VIII	**8.MAXWELL'S FIELD EQUATIONS:** Deduction of equations from empirical laws of Gauss, Faraday and Ampere.Limitations of Ampere's law, Maxwell's concept of displacement current, derivation of expression for displacement current density from charging of a capacitor – significance of displacement current. Derivations of EM wave equation(for E and B) for free space, velocity of EM waves, light as an EM wave, EM eave equation for dielectric medium, expression for refractive index. Plane wave solutions of EM wave equation in free space –characteristics of EM waves, transverse nature of EM waves (derivation), relation between E and B components(qualitative)- to	11

	show that E and B are perpendicular to each other- diagram of a plane Polarized EM wave. Poynting theorem, Poynting vector, significance of Poynting vector. Propagation of EM waves in isotropic and dielectric media.	

Statements of Course Outcomes (COs)

By the end of the course, the student will be able to

CO-1	Apply and analyze the behavior of ac/ dc circuits based on L,C and R.
CO-2	Demonstrate uses of filters and rectifiers.
CO-3	Distinguish between magnetic effect of electric current and .electromagnetic induction.
CO-4	Apply the related laws in appropriate circumstances.
CO-5	Demonstrate magnetic field of electric current/ electromagnetic induction through properunderstanding.
CO-6	Compare the principles and working of different types of galvanometer.
CO-7	Understand the unification of electric and magnetic fields and Maxwell‟s equations governingEM waves.