

GE: Mechanics Credit :
06 (Theory-04, Practical-02)



Theory : 60 Hours

Unit 1

Vectors: Vector algebra. Derivatives of a vector with respect to a parameter. Scalar and vector products of two, three and four vectors. Gradient, divergence and curl of vectors fields. Polar and Axial vectors.
(5 Lectures)

Ordinary Differential Equations: 1st order homogeneous differential equations, exact and non-exact differential equations, 2nd order homogeneous and non-homogeneous differential equations with constant coefficients (Operator Method Only).
(8 Lectures)

Unit 2

Laws of Motion: Review of Newton's Laws of motion. Dynamics of a system of particles. Concept of Centre of Mass, determination of center of mass for discrete and continuous systems having cylindrical and spherical symmetry (1-D, 2-D, 3-D objects)
(6 Lectures)

Work and Energy: Motion of rocket. Work-Energy theorem for conservative forces. Force as a gradient of Potential Energy. Conservation of momentum and energy. Elastic and inelastic collisions.

(5 Lectures)

Unit 3

Rotational Dynamics: Angular velocity, Angular momentum, Torque, Conservation of angular momentum, Moment of Inertia. Theorem of parallel and perpendicular axes. Calculation of Moment of Inertia of discrete and continuous objects (1-D, 2-D and 3-D). Kinetic energy of rotation. Motion involving both translation and rotation. (10 Lectures)

Unit 4

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 (statements only). Satellite in circular orbit and applications. Geosynchronous orbits. (5 Lectures)

Unit 5

Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Compound pendulum. Differential equations of damped oscillations and its solution. (7 Lectures)

Unit 6

Special Theory of Relativity: Frames of reference. Galilean Transformations. Inertial and Non-inertial frames. Outcomes of Michelson Morley's Experiment. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic transformation of velocity. Relativistic variation of mass. Mass-energy equivalence. Transformation of Energy and Momentum. (14 Lectures)

- Generic Elective-(GE)

GE: Electricity and Magnetism Credit : 06 (Theory-04,

Practical-02) Theory : 60 Hours

Practical : 60 Hours

Course Objective

This course begins with elementary vector analysis, an essential mathematical tool for understanding static electric field and magnetic field. By the end of the course student should appreciate Maxwell's equations.

Course Learning Outcomes

At the end of this course, students will be able to

- ☐ Demonstrate Gauss law, Coulomb's law for the electric field, and apply it to systems of point charges as well as line, surface, and volume distributions of charges.
- ☐ Explain and differentiate the vector (electric fields, Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics.
- ☐ Apply Gauss's law of electrostatics to solve a variety of problems.
- ☐ Articulate knowledge of electric current, resistance and capacitance in terms of electric field and electric potential.
- ☐ Demonstrate a working understanding of capacitors
- ☐ Calculate the magnetic forces that act on moving charges and the magnetic fields due to currents (Biot- Savart and Ampere's laws)
- ☐ Have brief idea of dia-, para- and ferro-magnetic materials
- ☐ Understand the concepts of induction and self-induction, to solve problems using Faraday's and Lenz's laws
- ☐ Have an introduction to Maxwell's equations.

Unit 1

Vector Analysis: Vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

(20 Lectures)

Unit 2

Electrostatics: Electrostatic Field, electric flux, Gauss's theorem of electrostatics.

Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor.

Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

(22 Lectures)

Unit 3

Magnetism:

Magnetostatics: Biot-Savart's law and its applications- 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. Brief introduction of dia-, para- and ferro-magnetic materials.

(10 Lectures)

Unit 4

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

(6 Lectures)

Introduction to Maxwell's equations.

(2 Lectures)

Practical : 60 Hours

PRACTICALS-GE LAB:

Electricity and Magnetism Lab



Unit 1

GE SEM III

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 and C_v , Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law, Entropy, Carnot's cycle & theorem, Entropy changes in reversible and irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

Unit 2

(22 lectures)

Thermodynamical Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thomson Effect, Clausius Clapeyron Equation, Expression for $(C_p - C_v)$, C_p/C_v , TdS equations.

Unit 3

(10 lectures)

Kinetic Theory of Gases: Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases.

(10 lectures)

Unit 4

Theory of Radiation: Blackbody radiation, Spectral distribution, Derivation of Planck's law, Deduction of Wien's law, Rayleigh-Jeans Law, Stefan Boltzmann Law & Wien's displacement law from Planck's law.

(6 lectures)

Unit 5

Statistical Mechanics: Macrostate and Microstate, phase space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann law, Fermi-Dirac distribution law - Bose-Einstein distribution law - comparison of three statistics.

(12 lectures)

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**GE: Waves and Optics Credit : 06 (Theory-04,
Practical-02) Theory : 60 Hours**

Practical : 60 Hours

Scm 12



Course Objective

The physics and mathematics of wave motion underlie many important phenomena. The water wave on the sea, the vibration of a violin string, etc. can all be described in a similar way. Light too, often displays properties that are wave-like. The course is aimed at equipping the students with the general treatment of waves. This begins with explaining ideas of oscillations and simple harmonic motion and go on to look at the physics of travelling and standing wave. This understanding applies to have a more elaborate analysis for sound waves and this further considers a number of phenomena in which the wave properties of light are important such as interference, diffraction, and polarization with emphasis of examples as seen in daily life.

Course Learning Outcomes

On successfully completing the requirements of this course, the students will have the skill and knowledge to:

- ☐ Understand Simple harmonic oscillation and superposition principle.
- ☐ Understand superposition of a range of collinear and mutually perpendicular simple harmonic motions and their applications.
- ☐ Understand the importance of classical wave equation in transverse and longitudinal waves and solving a range of physical systems on its basis.
- ☐ Understand different types of waves and their velocities: Plane, Spherical, Transverse, Longitudinal.
- ☐ Understand Concept of normal modes in transverse and longitudinal waves: their frequencies and configurations

- ② Understand the concept of temporal and spatial coherence.
- ② Understand Interference as superposition of waves from coherent sources derived from same parent source
- ② Demonstrate understanding of Interference experiments: Young's Double Slit, Fresnel's biprism, Lloyd's Mirror, Newton's Rings.
- ② Demonstrate basic concepts of Diffraction: Superposition of wavelets diffracted from apertures
- ② Understand Fraunhofer Diffraction from slit.
- ② In the laboratory course, student will gain hands-on experience of using various optical instruments and making finer measurements of wavelength of light using Newton Rings experiment, Fresnel Biprism etc. Resolving power of optical equipment can be learnt firsthand.
- ② The motion of coupled oscillators, study of Lissajous figures and behaviour of transverse, longitudinal waves can be learnt in this laboratory course.

Unit 1

Superposition of Two Collinear Harmonic oscillations: Simple harmonic motion (SHM). Linearity and Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).

(6 Lectures)

Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses.

(2 Lectures)

Unit 2

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.

(8 Lectures)

Unit 3

Sound: Sound waves, production and properties. Intensity and loudness of sound. Decibels. Intensity levels. General idea of musical notes and musical scale. Acoustics of buildings (General idea).