

1. Semester – I

Course – CC 1 (Subject – Mathematical MethodsI)

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
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| Calculus | Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. | 3 | At the end of this topic the students will be able to have a clear concept on plotting graphs of functions and will be able to understand the continuity and differentiability of functions |
| | Convergence of infinite series: Convergence of power series. Idea of interval of convergence. Different convergence tests of power series: D'Alembert's ratio test, Cauchy's root test, Integral test. Alternating series test. Absolute and conditional convergence. Taylor series of one variable, Maclaurin series. Approximation errors. | 4 | At the end of this topic the students will be able to calculate the convergence tests of a given series and students will have a clear concept on error calculations and approximations. |
| | First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral. | 4 | At the end of this topic the students will be able to solve first and second order differential equations and will be able to apply them in various physical problems. |
| | Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating Factor with simple illustration. Taylor series of two variable functions, Maxima, minima, saddle point evaluation of two variable functions using Taylor series. Constrained Maximization using Lagrange Multipliers. | 3 | At the end of this topic the students will be able to generalize the concept of maxima and minima of many variable functions. |
| Vector Algebra and Vector Calculus | Recapitulation of Vector Algebra. Idea of linear independence, completeness, basis and representation of vectors. Properties of vectors under rotations. Scalar product and its invariance under coordinate rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. | 5 | At the end of this topic the students will be able to grasp a clear concept on the structure of vector algebra along with basic preliminary concepts about basis and dimension. |
| | Vector Differentiation: Scalar and Vector fields. Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities. | 5 | At the end of this topic the students will be able to explore the local nature of vector fields and their geometrical significance. |

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
|------------------------------------|--|-------------------------|--|
| Vector Algebra and Vector Calculus | Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their Applications (no rigorous proofs). | 5 | At the end of this topic the students will be able to understand different theorems connecting surface area, volume and line. |
| | Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Spherical and Cylindrical Coordinate Systems | 5 | At the end of this topic the students will be able to generalize the concept on a general coordinate system. |
| Matrices | Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar and Unit Matrices. Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew-Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrices. Trace of a Matrix. | 6 | At the end of this topic the students will be able to understand different properties of matrices and will be able to use them in different physical problems. |
| | Eigen-values and Eigenvectors (Degenerate and non-degenerate). Cayley- Hamilton Theorem. Diagonalization of Matrices. Solutions of Coupled Linear Ordinary homogeneous Differential Equations. Functions of a Matrix. | 6 | At the end of this discussion the students will be able to learn about the eigenvalues and eigenvectors which will be crucial in future studies. |
| Practical | Introduction to plotting graphs with Gnuplot | 6 | At the end of this topic the students will be able to plot different functions and explore their connections with theoretical knowledge. |
| | Introduction to programming in python | 10 | At the end of this topic the students will be able to write programs and explore their connection with the theoretical concept. |

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
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| Fundamentals of Dynamics | Review of Newton's Laws: Mechanistic view of the Universe. Concepts of Inertial frames, force and mass. Galilean transformations and Galilean invariance. Solution of the equations of motion (E.O.M.) in simple force fields in one, two and three dimensions using cartesian, cylindrical polar and spherical polar coordinate systems. | 4 | At the end of this discussion the students will be able to understand the meaning of Newton's laws and their applicability in diverse physical phenomena. |
| | Dynamics of systems of particles: Difficulty of solving the E.O.M. for systems of particles. Newton's third Law. External and Internal forces. Momentum and Angular Momentum of a system. Torque acting on a system. Conservation of Linear and Angular Momentum. Centre of mass and its properties. Two-body problem. | 4 | At the end of this topic the students will be able to have a clear understanding on the conservation laws and their applications. |
| | Variable mass system: motion of rocket | 2 | At the end of this topic the students will be able to learn the basic mechanism of rocket motion. |
| Work and Energy | Work Kinetic Energy Theorem. Conservative Forces: Force as the gradient of a scalar field. Concept of Potential Energy. Other equivalent definitions of a Conservative Force. Conservation of Energy. | 4 | At the end of this topic the students will be able to learn the principle of conservation of energy and its connection to mechanical systems. |
| | Qualitative study of one dimensional motion from potential energy curves. Stable and Unstable equilibrium. | 2 | At the end of this topic the students will be able to understand the concept of Energy diagrams and also will be analyse the motion from potential energy curves. |
| | Energy of a system of particles. | 4 | At the end of this topic the students will be able to calculate the energy of a many-particle system. |
| Gravitation and Central Force Motion | Central Force. Reduction of the two body central force problem to a one body problem. Setting up the E.O.M. in plane polar coordinates. | 3 | At the end of this topic the students will be able to get the basic idea of motion of particle in a plane under central force. |
| | Differential equation for the path. Motion under an Inverse square force. Newton's Law of Gravitation. Inertial and gravitational mass. Kepler's Laws. Satellite in circular orbit and applications. Weightlessness. | 4 | At the end of this topic the students will be able to learn the characteristics of inverse square law and apply them in our common Earth-Sun system. |
| | Gravitational potential energy. Potential and field due to spherical shell and solid sphere | 2 | At the end of this topic the students will be able to find the gravitational potential energy of different geometrical shapes. |

| Topic | Sub-Topic | Number of Lecture | Learning Outcome |
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| Non-Inertial Systems | Non-inertial frames and idea of fictitious forces. E.O.M with respect to a uniformly accelerating frame. E.O.M with respect to a uniformly rotating frame - Centrifugal and Coriolis forces. Laws of Physics in a laboratory on the surface of the earth. | 10 | At the end of this topic the students will be able to learn the concept of non-inertial frame and pseudo forces. |
| Rotational Dynamics | The Rigid Body: Constraints defining the rigid body. Degrees of freedom for a rigid body. | 2 | At the end of this topic the students will be able to understand the basic properties of rigid body. |
| | Relation between Angular momentum and Angular Velocity: Moment of Inertia Tensor. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. | 4 | At the end of this topic the students will be able to learn the concept of moment of inertia . |
| | Equation of motion for rotation about a fixed axis. Principal Axes transformation. Transformation to a body fixed frame. E.O.M for the rigid body with one point fixed (Euler's equations of motion). Torque free motion. Kinetic energy of rotation. | 4 | At the end of this topic the students will be able to calculate the fundamentals to motion of top and related mechanisms. |
| Fluid Motion | Kinematics of Moving Fluids: Idea of compressible and incompressible fluids, Equation of continuity; streamline and turbulent flow, Reynold's number. Euler's Equation. The special case of fluid statics $\vec{F} = -\nabla p$. Simple applications (e.g: Pascal's law and Archimedes principle). Bernoulli's Theorem. | 5 | At the end of this topic the students will be able to understand the basic concepts of hydrodynamics. |
| Experiments | To determine the Moment of Inertia of a metallic cylinder / rectangular bar about an axis passing through the C.G. and to determine the Modulus of Rigidity of the suspension wire. | 3 | At the end of these experiments students will develop skill to study various mechanical properties and their inter connections experimentally. |
| | To determine the Moment of Inertia of a Flywheel. | 3 | |
| | To determine the Young modulus, modulus of rigidity and Poisson ratio of the material of a wire by Searle's dynamic method. | 3 | |
| | To determine the value of g using Bar Pendulum. | 3 | |
| | To determine the height of a building (or a suitable vertical height) using sextant. | 3 | |
| | Determination of Young's modulus of the material of a beam by the method of flexure | 3 | |

Semester – II

Course – CC 3 (Subject – Electricity and Magnetism)

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
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| Dirac delta function and it's properties | Definition of Dirac delta function. Delta function as limit of different representations. Properties of delta function. Three dimensional delta function. | 2 | At the end of this topic the students will be able to learn the definition and various properties of dirac delta function. |
| Electrostatics | Coulombs law, principle of superposition, electrostatic field. Electric field and charge density, surface and volume charge density, charge density on the surface of a conductor. Force per unit area on the surface. | 2 | At the end of this topic the students will be able to learn the fundamentals of coulomb's law. |
| | Divergence of the Electrostatic field, flux, Gauss's theorem of electrostatics, applications of Gauss theorem to find Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. | 3 | At the end of this topic the students will be able to learn the Gauss's theorem and its application to different charged configurations. |
| | Curl of the Electrostatic Field. Conservative nature of electrostatic field, Introduction to electrostatic potential, Calculation of potential for linear, surface and volume charge distributions, potential for a uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. | 4 | At the end of this topic the students will be able to learn the nature of electrostatic field and it's connection to electric potential. |
| Dielectric properties of matter | Electric dipole moment, electric potential and field due to an electric dipole, force and Torque on a dipole. Electric Fields inside matter, Electric Polarisation, bound charges, displacement density vector. Gauss's theorem in dielectrics, linear Dielectric medium, electric susceptibility and permittivity. Electrostatic Boundary conditions | 4 | At the end of this topic the students will be able to get a vivid concept of the behavior of electric fields inside a medium. |
| Method of Images | Laplace's and Poisson equations. Uniqueness Theorems. Method of Images and its application to: Plane Infinite metal sheet, Semi-infinite dielectric medium and metal Sphere. | 3 | At the end of this topic the students will be able to learn the use of image in calculating electric fields in different configurations. |
| Electrostatic Energy | Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Energy per unit volume in electrostatic field. | 2 | At the end of this topic the students will be able to calculate the electrostatic energy of sphere. |

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
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| The Magnetostatic Field | Biot-Savart's law. Application of Biot- Savart's law to determine the magnetic field of a straight conductor, circular coil. Force on a moving point charge due to a magnetic field: Lorentz force law. Force between two straight current carrying wires. | 3 | At the end of this topic the students will be able to learn the defining features and properties of magnetostatic field. |
| | Divergence of the magnetic field and its solenoidal nature. Magnetic vector potential, calculation for simple cases. | 3 | At the end of this topic the students will be able to learn the idea of vector potential. |
| | Curl of the magnetic field. Ampere's circuital law. Its application to (1) Infinite straight wire, (2) Infinite planar surface current, and (3) Infinite Solenoid | 3 | At the end of this topic the students will be able to apply the laws in various current carrying conductors. |
| Magnetic properties of matter | Potential and field due to a magnetic dipole. Magnetic dipole moment. Force and torque on a magnetic dipole in a uniform magnetic field. | 3 | At the end of this topic the students will be able to learn the properties of magnetic dipole. |
| | Magnetization, Bound currents. The magnetic intensity H. Relation between B, H and M. Linear media. Magnetic Susceptibility and Permeability. Boundary conditions for B and H. Brief introduction of dia-, para- and ferro-magnetic materials. B-H curve and hysteresis. | 4 | At the end of this topic the students will be able to learn the magnetic properties of matter. |
| Electro-magnetic induction | Ohms law and definition of E.M.F. Faraday's laws of electromagnetic induction, Lenz's law. Self-Inductance and Mutual Inductance. Reciprocity Theorem. Introduction to Maxwell's Equations. Charge conservation. Displacement current and resurrection of Equation of Continuity. | 4 | At the end of this topic the students will be able to understand the basic details of electromagnetic induction and introduction to displacement current. |
| Electrical circuits | AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit. | 4 | At the end of this topic the students will be able to understand the basics of LCR circuit and their properties regarding resonance. |
| Experiments | To determine an unknown Low Resistance using Potentiometer. | 3 | At the end of these experiments students will develop skill to study various electrical and magnetic properties of different instruments . |
| | To determine an unknown Low Resistance using Carey Foster's Bridge. | 3 | |
| | To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width. | 3 | |
| | To study the ac characteristics of a series RC Circuit. Study as low/high pass filter. Calculation of capacitance from current reactance graph. | 3 | |
| | To study mutual inductance between two coils. | 3 | |
| | Determination of horizontal component of the Earth's magnetic field. | 3 | |

Course – CC 4 (Subject – Waves and Optics)

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
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| Oscillations | Differential equation of Simple Harmonic Oscillation and its solution. Kinetic energy, potential energy, total energy and their time average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. | 6 | At the end of this topic the students will be able to learn the fundamentals of simple harmonic motion and their properties. |
| Superposition of Harmonic Oscillations | Superposition of Two Collinear Harmonic oscillations having equal frequencies and different frequencies (Beats). | 2 | At the end of this discussion the students will be able to learn the superposition of SHM. |
| | Superposition of Two Perpendicular Harmonic Oscillation for various phase difference. Graphical and Analytical Methods, Lissajous Figures with equal and unequal frequency and their uses. | 2 | At the end of this topic the students will be able to apply superposition via graphical and analytical methods. |
| Wave Motion | Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Traveling) Waves. Wave Equation for travelling waves. Particle and Wave Velocities. | 3 | At the end of this topic the students will be able to learn the concept of group and phase velocities. |
| Vibration of strings | Velocity of Transverse Vibrations of Stretched Strings, Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. | 9 | At the end of this topic the students will be able to learn the dynamical features of vibrating strings. |
| Wave Optics | Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. | 2 | At the end of this topic the students will be able to understand the basic properties of EM nature of light. |
| | Temporal and Spatial Coherence | 2 | At the end of this topic the students will be able to get the basic idea of coherence. |
| Interference | Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index | 7 | At the end of this topic the students will be able to learn the Interference phenomenon and its various applications. |

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| Interferometers | Michelson Interferometer (1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3)Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. | 2 | At the end of this topic the students will be able to learn the working principle of Michelson interferometer. |
| | Multiple beam interferometry, Fabry-Perot interferometer | 2 | At the end of this topic the students will be able to learn the multiple beam interference |
| Diffraction | Fraunhofer diffraction: Single slit. Circular aperture (solution may be assumed), Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. Rayleigh criterion for resolution. | 6 | At the end of this topic the students will be able to learn the basics of Fraunhofer diffraction and its application in resolving power . |
| | Fresnel Diffraction: Fresnel's assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit. | 5 | At the end of this topic the students will be able to understand the Fresnel diffraction and its use in calculating fringe patterns. |
| Experiments | To determine the frequency of an electric tuning fork by Melde's experiment and to study variation of wavelength with tension | 3 | At the end of this topic the students will be able to explore the variation of tension with wavelength. |
| | To study the variation of refractive index of the Material of a prism with wavelengths and hence the Cauchy constants using mercury/helium source. | 3 | At the end of these experiments students will develop skill to study various optical properties experimentally. |
| | To determine wavelength of sodium light using Fresnel Biprism | 3 | |
| | To determine wavelength of sodium light/radius of plano convex lens using Newton's Rings. | 3 | |
| | To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film. | 3 | |
| | Measurement of the spacing between the adjacent slits in a grating by measuring $\sin\theta$ vs graph of a certain order of grating spectra. | 3 | |

Semester – III
Course – CC 5 (Subject – Mathematical MethodsII)

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
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| Fourier Series | Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Applications. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity. | 6 | At the end of this discussion students will learn the definition of Fourier series and its application in various physical problems. |
| Frobenius Method and Special Functions | Singular Points of Second Order Linear Differential Equations and their importance. Power series solution of 2nd order differential equation. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Multipole expansion in Electrostatics. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions ($J_0(x)$ and $J_1(x)$) and Orthogonality. Airy's disc for Fraunhofer diffraction through circular aperture. | 14 | At the end of this discussion students will be able to grasp the technique in solving differential equations in a sufficiently general manner. |
| Some Special Integral Functions | Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral). | 2 | At the end of this discussion students will learn the use of integral functions which will be useful in solving problems. |
| Integral Transforms | Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations. | 8 | At the end of this discussion students will learn the technique of Fourier transform and related properties which they can use in different branches of physics. |

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
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| Introduction to probability | Independent random variables: Sample space and Probability distribution functions. Binomial, Gaussian, and Poisson distribution with examples. Mean and variance. | 2 | At the end of this discussion students will be able to get a basic working knowledge about various probability distributions. |

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| Partial Differential Equation | Solutions to partial differential equations using separation of variables: Solutions of Laplace's equation in problems with cylindrically and spherically symmetric boundary conditions. Examples from Electrostatics. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. Diffusion Equation. | 8 | At the end of this topic students will be able to solve partial differential equations in a sufficiently general manner. |
| Python Programming | Introduction to numpy and scipy. | 16 | At the end of this discussion students will be able to solve differential equations numerically. |
| | Introduction to matplotlib | 12 | |

1.1 Course – CC 6 (Subject – ThermalPhysics)

| Topic | Sub Topic | Number of Lecture Hours | Learning Outcome |
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| | Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature. Concept of Work & Heat, State Functions, Internal Energy and First Law of Thermodynamics. Its differential form, First Law & various processes. Applications of First Law: General Relation between C_p and C_v , Work Done during Isothermal and Adiabatic Processes. | 4 | At the end of this discussion students will be able to understand the basic features of thermodynamics and related properties. |
| Introduction to Thermodynamics | Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. | 5 | At the end of this discussion students will learn the second law of thermodynamics and its application to various heat engines. |
| | Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. | 4 | At the end of this discussion students will learn the concept of thermodynamic scale of temperature. |
| | Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Principle of Increase of Entropy. Temperature-Entropy diagrams for Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. | 5 | At the end of this discussion students will learn the concept of entropy and its wide variety of use in different physical problems. |
| Thermodynamic Potentials | Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibbs Free Energy, Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius-Clapeyron Equation and Ehrenfest equations. Maxwell's Thermodynamic Relations. Derivations and applications of Maxwell's Relations: (1) Clausius-Clapeyron equation, (2) Values of $C_p - C_v$, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. | 7 | At the end of this discussion students will be able to get an idea of thermodynamic potentials and their use in exploring first and continuous phase transitions. |
| | Joule-Thomson Porous Plug Experiment: Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule Thomson Cooling. | | At the end of this discussion students will learn the basics of porous plug experiment. |

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| Kinetic Theory of Gases | Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases. | 4 | At the end of this discussion students will be able understand the MB distribution and law of equipartition of energy. |
| | Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its significance. | 3 | At the end of this discussion students will learn the concept of mean free path and transport properties of gases. |
| | Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO ₂ Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. | 4 | At the end of this discussion students will be able to explore the behavior of real gases under different conditions. |
| Conduction of Heat | Thermal conductivity, diffusivity. Fourier's equation for heat conduction its solution for rectilinear flow of heat. | 3 | At the end of this discussion students will be able to learn the macroscopic mechanism of thermal conductivity. |
| Experiments | Determination of the coefficient of thermal expansion of a metallic rod using an optical lever. | 3 | At the end of these experiments students will develop sufficient skill to perform experiments related to different thermal properties of matter. |
| | Calibration of a thermocouple by direct measurement of the thermo-emf using potentiometer and the constants. [one end in ice and another end at water bath which to be heated. | 3 | |
| | To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method. | 3 | |
| | To determine the boiling point of a liquid using Platinum Resistance Thermometer (PRT). | 3 | |
| | To determine Temperature Coefficient of Resistance using Carey Foster bridge | 3 | |

1.1 Course – CC 7 (Subject – ModernPhysics)

| Topic | Sub Topic | Number of Lecture Hours | Learning Outcome |
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| Radiation and its nature | Blackbody Radiation, Planck's quantum hypothesis, Planck's constant (derivation of Planck formula is not required). Photoelectric effect and Compton scattering - light as a collection of photons. Davisson-Germer experiment. De Broglie wavelength and matter waves. Wave-particle duality. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Probability interpretation: Normalized wave functions as probability amplitudes. | 4 | At the end of this discussion students will be able to get the basic understanding of black body radiation and connection between wavelike and particle like characters of photons and other material particles. |
| | Two-slit experiment with photons and electrons. Linear superposition principle as a consequence | 3 | At the end of this discussion students will get an basic idea of Quantum mechanics. |
| | Position measurement, gamma ray microscope thought experiment. Heisenberg uncertainty principle. Impossibility of a particle following a trajectory | 3 | At the end of this discussion students will be able to get an idea of uncertainty principle through various examples. |
| Basic Quantum Mechanics | Quantum measurements: Deterministic vs probabilistic view points. States as normalised vectors (normalized wave functions). Dynamical variables as linear Hermitian operators (position, momentum, angular momentum, and energy as examples). | 3 | At the end of this discussion students will be able to get an idea of measurement in Quantum Mechanics and its relation to linear operators. |
| | Schrödinger equation as a first principle. Probabilistic interpretation of wavefunction and equation of continuity (in 1D). Time evolution of wavefunction. Stationary states. Eigenvalue equation | 3 | At the end of this discussion students will be able to understand the schrodinger equation and working rules of Quantum mechanics. |
| | Application to one dimensional systems: Boundary conditions on wave functions. Particle in an infinitely rigid box: energy eigenvalues and eigenfunctions, normalization. Quantum dot. Quantum mechanical tunneling across a step potential & rectangular potential barrier, α -decay as an example. | 3 | At the end of this discussion students will be able to solve TISE in basic physical problems. |
| | Simultaneous measurements: Compatible and incompatible observables and their relation to commutativity. Heisenberg's uncertainty relation for a pair of incompatible observables. | 3 | At the end of this discussion students will be able to learn the concept of simultaneous measurement and associated problems. |
| Nuclear Structure | Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. | 2 | At the end of this discussion students will be able to get the basic idea of nucleus. |
| | Nature of nuclear force, NZ graph. Nuclear Models: Liquid Drop model. semi-empirical mass formula and binding energy. Nuclear Shell Model. Magic numbers. | 5 | At the end of this discussion students will be able to explore the salient features of nuclear models. |

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| Interaction with and within nucleus | Radioactivity: Beta decay - energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. | 5 | At the end of this discussion students will be able to understand the radioactive decay of nuclei and prediction of neutrino. |
| | Fission and fusion: mass deficit, relativity and generation of energy. Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions) | 4 | At the end of this discussion students will be able to get the basic idea of nuclear fission and fusion. |
| LASERS | Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He- Ne Laser. Basic lasing action. | 5 | At the end of this discussion students will be able to understand the basic theory and working principle of different level lasers. |
| Experiments | Measurement of Plank constant using LED | 3 | At the end of these experiments students will develop a skill in performing experiments related to black body radiation and photo electric effect. |
| | Verification of Stefan's law of radiation by the measurement of voltage and current of a torch bulb glowing it beyond draper point. | 3 | |
| | To study the photoelectric effect: variation of photocurrent versus intensity and wavelength of light. | 3 | |
| | Determination of e/m of electrons by using bar magnet | 3 | At the end of this experiment student will get an idea of e and m of an electron experimentally. |
| | To show the tunneling effect in tunnel diode using I-V characteristics. | 3 | At the end of this experiment student will get an idea of quantum mechanical tunneling. |

1.1 Course – SEC A1 (Subject – Scientific Writing)

| Topic | Sub Topic | Number of Lecture Hours | Learning Outcome |
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| Introduction to LATEX | The difference between WYSIWYG and WYSIWYM. Preparing a basic LATEX file. Compiling LATEX file. | 2 | At the end of this discussion students will be able to get an introductory overview of Latex. |
| Document Classes, Page Layout | Different type of document classes, e.g., article, report, book etc. Titles, Abstract, Chapters, Sections, subsections, paragraph, verbatim, References, Equation references, citation. | 4 | At the end of this discussion students will be able to write short paragraphs using Latex command. |
| Representation of mathematical equations | Inline math, Equations, Fractions, Matrices, trigonometric, logarithmic, exponential functions, line-surface volume integrals with and without limits, closed line integral, surface integrals, Scaling of Parentheses, brackets etc. | 5 | At the end of this discussion students will be able to write Latex command for mathematical equations . |
| Customization of fonts | Bold fonts, emphasise, mathbf, mathcal etc. Changing sizes Large, Larger, Huge, tiny etc. | 1 | At the end of this discussion students will be able learn about thefont sizes and relateddetails. |
| Writing tables | Creating tables with different alignments, placement of horizontal, vertical lines. | 2 | At the end of this discussion students will be able to form tables with different structures. |
| Figures | Changing and placing the figures, alignments Packages: amsmath, amssymb, graphics, graphicx, Geometry, algorithms, color, Hyperref etc. Use of different LATEX commands and environments, Changing the type style, symbols from other languages. special characters. | 1 | At the end of this discussion students will be able to insert figures in the latex file. |

Semester – IV

Course – CC 8 (Subject – Mathematical MethodsIII)

| Topic | Sub Topic | Number of Lecture Hours | Learning Outcome |
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| Complex Analysis | Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals. Only single valued integrals; simple poles on and off the real axis. | 15 | At the end of this discussion students will learn complex analysis in details and will be able to apply the idea to study various physical problems. |
| Variational calculus in Physics | Functionals. Basic ideas of functionals. Extremization of action as a basic principle in mechanics. Lagrangian formulation. Euler's equations of motion for simple systems: harmonic oscillators, simple pendulum, spherical pendulum, coupled oscillators. Cyclic coordinates. Symmetries and conservation laws. Legendre transformations and the Hamiltonian formulation of mechanics. Canonical equations of motion. | 15 | At the end of this discussion students will learn variational calculus in details and will develop concept to solve problems using Lagrangian and Hamiltonian approach. |
| Special Theory of Relativity | Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity. Relativistic Dynamics. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. | 10 | At the end of this discussion students will have clear basic idea about special theory of relativity. |
| | A short introduction to Covariant and contravariant tensors. Contraction. Covariant, contravariant, and mixed tensors of rank-2, transformation properties. The metric tensor. Raising and lowering of indices with metric tensors. (Consistent use of convention \rightarrow $\text{diag}(1,-1,-1,-1)$.) | 10 | At the end of this discussion students will learn about tensors and will be able to apply the idea to the study of Relativity. |
| | Four Vector Notation: Four-vectors, Lorentz Transformation and Invariant interval, Space-time diagrams. Proper time and Proper velocity. Relativistic energy and momentum - Four momentum. Conservation of four momentum. Minkowski Force. | 5 | At the end of this discussion students will be able to apply four vector notation in the study of Relativity. |
| Python Programming | On Gaussian integrals and delta functions | 6 | At the end of these classes students will develop computational skill to solve various mathematical problems. |
| | On solution of differential equation | 5 | |
| | On special functions | 5 | |
| | On solution of partial differential equation | 10 | |
| | On Fourier Series | 4 | |

Course – CC 9 (Subject – Analog Electronics)

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
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| Circuits and Network | Discrete components, Active & Passive components, Ideal Constant voltage and Constant current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits. | 3 | At the end of this discussion students will be able to apply network theorems to analyze circuits. |
| Semiconductor Diodes and application | P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. | 7 | At the end of this discussion students will have clear idea about various semiconductor devices constructed with diodes. |
| | Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, L and C filter. Clipping and clamping circuit. | | |
| | Principle and structure of LEDs., Photodiode, Solar Cell, Varactor diode | | |
| Bipolar Junction transistors and biasing | n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Physical Mechanism of Current Flow. Current gains α and β , Relations between them. Active, Cut-off and saturation Regions. DC Load line and Q- point. | 9 | At the end of this discussion students will have clear idea about construction, properties and application of BJTs. |
| | Transistor Biasing and Stabilization Circuits; Fixed Bias, collector to base bias, emitter or self bias, voltage Divider Bias. Transistor as 2 port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. | | |
| Field Effect transistors | JFET and MOSFET (both depletion and enhancement type) as a part of MISFET. Basic structure & principle of operations and their characteristics. Pinch off, threshold voltage and short channel effect. | 4 | At the end of this discussion students will have clear idea about construction, properties and application of FETs. |
| Regulated Power Supply | Load regulation and line regulation. Zener diode as a voltage regulator. The problem with the zener regulator circuit. Requirement of feedback and error amplifier. Study of series regulated power supply using pass and error transistor assisted by zener diode as a reference voltage supplier. | 2 | At the end of this discussion students will learn to construct and work with regulated power supply. |

Course – CC 10 (Subject – Quantum Mechanics)

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
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| Wavepacket description | Description of a particle using wave packets. Spread of the Gaussian wave-packet for a free particle in one dimension. Fourier transforms and momentum space wavefunction. Position-Momentum uncertainty. | 4 | At the end of this discussion students will develop concept about wavepackets |
| Bound states in an arbitrary potential | Continuity of wave function, boundary condition and emergence of discrete energy levels. One dimensional square well potential of finite depth. | 6 | Students will be able to solve different bound state problems. |
| Simple harmonic oscillator | Setting up the eigenvalue equation for the Hamiltonian. Energy levels and energy eigen functions in terms of Hermite polynomials Ground state, zero point energy & uncertainty principle. | 5 | Students will have detailed knowledge about simple harmonic oscillator |
| Quantum theory of hydrogen-like atoms | Reduction of a two body problem to a one body problem. The time independent Schrodinger equation for a particle moving under a central force, Schrodinger equation in spherical polar coordinates. Angular equation and orbital angular momentum. Spherical Harmonics. Radial equation for attractive coulomb interaction - Hydrogen atom. Solution for the radial wave functions. Shapes of the probability densities for ground & first excited states. Orbital angular momentum quantum numbers | 7 | At the end of this discussion students will have detailed knowledge about hydrogen like atoms |
| Generalized Angular Momenta and Spin | Generalized angular momentum. Electron's magnetic Moment and Spin Angular Momentum. $J = L + S$. Gyromagnetic Ratio and Bohr Magneton and the g factor. Energy associated with a magnetic dipole placed in magnetic field. Larmor's Theorem. Stern-Gerlach Experiment. Addition of angular momenta - statement only. | 8 | At the end of this discussion students will learn about angular momentum in quantum mechanical approach |
| Spectra of Hydrogen atom and its fine structure | Formula for first order nondegenerate perturbative correction to the eigenvalue statement only, Spin-orbit interaction and relativistic correction to the kinetic energy and Darwin term, Fine structure of the hydrogen atom spectrum | 5 | At the end of this discussion students will learn about H atom spectrum |
| Atoms in Electric & Magnetic Fields | Zeeman Effect: Normal and Anomalous Zeeman Effect (Formula for first order perturbative correction to the eigenvalue to be assumed). Paschen Back effect & Stark effects | 6 | Students will have idea about Zeeman effect, Paschen Back effect, Stark effect |
| Many electron atoms | Identical particles. Symmetric & Antisymmetric Wave Functions. Pauli's Exclusion Principle. Hund's Rule. Periodic table. Fine structure splitting. L-S and J-J coupling scheme. Spectral Notations for Atomic States and Term symbols. Spectra of Alkali Atoms (Na etc.). | 8 | At the end of this discussion students will have idea about coupling of angular momenta |
| Python programming | On solution of transcendental equation to find eigen states of bound states | 5 | At the end of these classes students will develop computational skill to solve different quantum mechanical problems |
| | On solution of bound state problems using shooting algorithm | 10 | |
| | On time evolution of wave packet | 10 | |

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
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| Amplifiers | Transistor amplifier; CB, CE and emitter follower circuit and their uses. Load Line analysis of Transistor amplifier. Classification of Class A, B & C Amplifiers with respect to placement to Q point. Frequency response of a CE amplifier. The role of series and parallel capacitors for cut off frequencies. The idea about the value of coupling and bypass capacitor with respect to lower cut-off frequencies. Miller capacitance and its role in higher cut-off frequency | 4 | At the end of this discussion students will learn about different amplifier configuration. |
| Feedback Amplifiers and OPAMP | Effects of Positive and Negative Feedback. Voltage series, current series, voltage shunt and current shunt feedback and uses for specific amplifiers. Estimation of Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise for voltage series feedback | 4 | At the end of this discussion students will acquire knowledge about feedback mechanism. They will learn about working principle and use of feedback amplifiers and OPAMPs. |
| | Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op- Amp. (IC 741) Open-loop and Closed-loop voltage Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. | 4 | |
| | Application of OPAMP: D.C. Application: • Inverting and non-inverting amplifiers • Inverting and non inverting Adder • Differentiator as Subtractor • Logarithmic & anti logarithmic amplifiers • Error amplifier, Comparator, Schmidt Trigger A.C. Application: Differentiator, Integrator | 5 | |
| Multivibrator | Transistor as a switch, Explanation using CE output characteristics. Calculation of component values for a practical transistor switch. Transistor switching times, use of speed up capacitor (Physical explanation only) Construction and operation, using waveshapes of collector coupled Bistable, Monostable and Astable Multivibrator circuits, time period. | 4 | At the end of this discussion students will acquire knowledge to develop and use multivibrator |
| Oscillators | Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, Wein Bridge oscillator, feedback factor and frequency of oscillation. Reactive network feedback oscillators: Hartley's & Colpitt's oscillators. Relaxation oscillator | 4 | At the end of this discussion students will acquire knowledge about working principle of oscillator |
| Experiments | To study the reverse characteristics of Zener diode and study the load and line regulation. | 3 | At the end of these experiments students will develop skill to design various electronic circuits. |
| | To study the static characteristics of BJT in CE Configuration. | 3 | |
| | To design and study the frequency response of the BJT amplifier in CE mode. | 3 | |
| | Construction of a series regulated power supply from an unregulated power supply. | 3 | |
| | To study OPAMP: inverting amplifier, non-inverting amplifier, adder, subtractor, comparator, Schmitt trigger, Integrator, differentiator, relaxation oscillator. | 3 | |
| | To design a Wien bridge oscillator for given frequency using an op-amp | 3 | |

Course – SEC B1 (Subject – Arduino)

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
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| Introduction to Arduino | Brief history of the Arduino; open-source electronics prototyping. | 2 | At the end of this discussion students will learn about basics of Arduino. |
| Basic ideas | Basic ideas of Arduino, Familiarize the Arduino board, Setting up the arduinoboard. Installation of IDE in PC/ laptop for Arduino Programming (Sketch) | 3 | At the end of this discussion students will be familiar with microcontroller system |
| Arduino Programming | Program structure: data types, variables and constants, operators, control statements, loops, functions, string. | 5 | At the end of this discussion students will learn hardware programming, will have idea of IoT. |
| | Interfacing: serial communication, digital and analog input/output, getting input from sensors (e.g. temperature sensor, ultrasonic sensor etc) | 5 | |

Semester – V

Course – CC 11 (Subject – Electromagnetic Theory)

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
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| Maxwell Equations | Maxwell's equations. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density. | 8 | At the end of this discussion students will learn basics of electromagnetic theory |
| EM Wave Propagation in Unbounded Media | Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant. Propagation through conducting media, relaxation time, skin depth. | 6 | At the end of this topic student will have knowledge about EM wave propagation in vacuum. |
| EM Wave in Bounded Media | Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media. Laws of Reflection & Refraction. Fresnel's formulae for perpendicular & parallel polarization cases, Reflection & Transmission coefficients, Brewster's law. Total internal reflection, evanescent waves. Metallic reflection | 6 | At the end of this topic student will have knowledge about EM wave propagation in bounded medium. |
| Polarization | Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in birefringent medium. | 5 | At the end of this discussion students will learn basics of polarization phenomena. |
| Polarization in uniaxial crystals | Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Production & analysis of polarized light. Babinet Compensator and its Uses. | 10 | At the end of this discussion students will learn to produce polarized light. |
| Rotatory polarization | Optical Rotation. Biot's Laws. Fresnel's Theory of optical rotation. Angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade and biquartz polarimeters. | 8 | At the end of this discussion students will have knowledge about rotation of plane of polarization. |
| Experiments | To determine Brewster's angle for air-glass interface using a prism. | 3 | At the end of these experiments students will develop skill to study various optical properties experimentally. |
| | To study Fresnel's law by the reflection on the surface of a prism. | 3 | |
| | To verify the Malus law using a pair of polaroids. | 3 | |
| | To study the specific rotation of optically active solution using polarimeter. | 3 | |
| | To determine dispersive power and resolving power of a plane diffraction grating | 3 | |

Course – CC 11 (Subject – Statistical Mechanics)

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
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| Classical Statistical Mechanics | Macrostate & Microstate, Elementary Concept of Ensemble and Ergodic Hypothesis. Phase Space. | 8 | At the end of this discussion students will learn basics of statistical mechanics. |
| | Microcanonical ensemble, Postulate of Equal a-priori probabilities. Boltzmann hypothesis: Entropy and Thermodynamic Probability. | 5 | At the end of this discussion students will learn to study isolated system statistically. |
| | Canonical ensemble, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox. Equivalence of microcanonical and canonical ensemble. | 5 | At the end of this discussion students will learn to study systems which are in thermal contact with environment. |
| | SackurTetrode equation, Law of Equipartition of Energy (with proof) Applications to Specific Heat and its Limitations. Thermodynamic Functions of a Two-Energy Level System. Negative Temperature. | 4 | At the end of this discussion students will learn to apply statistical idea to solve various problems. |
| | Grand canonical ensemble. Application of ideal gas using grand canonical ensemble. chemical potential. | 4 | At the end of this discussion students will learn to study systems which exchange both heat and particle with environment. |
| Systems of Identical particles | Classical approach and quantum approach: distinguishability and indistinguishability. Occupation number and MB distribution, emergence of Boltzmann factor. Composite system postulate and symmetry postulate of quantum mechanics. Bosons and Fermions. Symmetric and Antisymmetric wave functions. | 5 | At the end of this discussion students will develop their idea of studying macroscopic systems. |
| Bose-Einstein Statistics | Distribution law. Thermodynamic functions of a strongly degenerate Bose Gas, Bose Einstein condensation and properties of liquid He IV | 5 | Students will learn properties of bosons and application of BE stat. |
| Radiation: classical and quantum aspects | Spectral Distribution of Black Body Radiation. Rayleigh-jeans law, UV catastrophe, Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of Rayleigh- Jeans Law, Stefan Boltzmann Law, Wien's Displacement law from Planck's law. | 3 | At the end of this discussion students will be able to understand the radiation phenomena. |
| | Bose derivation of Planck's law. Radiation as a photon gas and Thermodynamic functions of photon gas. Chemical potential of photon gas | 3 | |
| Fermi-Dirac Statistics | Distribution Law. Thermodynamic functions of strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal | 5 | Students will learn properties of fermions and application of FD stat. |
| Python Programming | Study of Random Numbers and Time series | 10 | Students will develop computational skill to solve statistical problems. |
| | Applications of Random Numbers | 10 | |
| | Scaling and plots, exponents and parameters | 10 | |

Course – DSE A1 (Subject – Laser and FibreOptics)

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
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| Einstein coefficients and Rate equations | Historical background of laser, Einstein coefficients and stimulated light amplification: population inversion. Three level & four level lasers: Rate equation, condition for population inversion and threshold condition. Minimum amount of pump power. | 8 | At the end of this discussion students will be able to study 2, 3 and 4 level systems |
| Basic properties of laser | Coherence, directionality, monochromaticity, brightness. | 3 | At the end of this discussion students will have detailed knowledge on four striking properties of Laser radiation. |
| Resonators | Optical resonators. Different configurations of optical resonators. stability condition and stability diagram for optical resonators. Cavity lifetime. The Quality factor. | 7 | At the end of this discussion students will learn the mechanism within the Laser cavity |
| Transient effect | Transverse and Longitudinal mode selection. Principle of Q-switching and Mode locking. Different methods of Q-switching: electro-optic Q-switching, Pockels cell | 4 | At the end of this discussion students will learn about Q switching, mode locking. |
| Basic Laser Systems | (i) Gas Laser: He-Ne laser, CO ₂ Laser ii) Solid state laser: Ruby Laser, Nd:YAG laser, Semiconductorlaser (iii) Liquid laser: Dyelaser. | 7 | At the end of this discussion students will learn about different types of Lasers |
| Practical properties and uses of laser | The Line-shape function. Various Line broadening mechanisms: collision broadening Natural broadening, Doppler broadening. Basic idea of Laser cooling and trapping. | 4 | At the end of this discussion students will understand broadening mechanism. |
| Fiber optics | Optical fiber, coherent bundle, Numerical aperture. Attenuation of optical fibers. Ray paths, Ray paths in a homogeneous medium, in square law media. Pulse dispersion in parabolic index medium and in planar step index waveguide. Modes of a planar waveguide: TE and TM modes. Physical understanding of modes, Optical fibers: Guided modes of step-index and graded index fibers. Applications of optical fibers in Communication and Sensing. | 6 | At the end of this discussion students will have basic idea about optical fibres, waveguides. |
| Holography | Principle of Holography. Recording and Reconstruction Method. Theory of Holography between two plane waves. Point source holograms. | 2 | At the end of this discussion students will have basic idea of holography. |
| Introductory Nonlinear Optics | Origin of nonlinearity, susceptibility tensor, phase matching, second harmonic generation, Sum frequency generation, Difference frequency generation, Sum and Difference Frequency generation, for second-order nonlinear optical medium. Nonlinear susceptibility of a classical anharmonic oscillator in case of noncentrosymmetric medium. | 6 | At the end of this discussion students will have basic idea of non-linear optics. |

Course – DSE B1 (Subject – Astronomy and AstroPhysics)

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
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| Tools of Astronomy | Contents of our Universe: basic introduction of stars, galaxies, clusters, interstellar medium, black holes, our own galaxy Milky Way. | 3 | At the end of this discussion students will get a basic idea about the components of the Universe. |
| | Mass, length, time and magnitude scales in astronomy. | 2 | At the end of this discussion students will be able to grasp an idea of different length scales in Astronomy. |
| | Interaction of light and matter fundamentals of radiative transfer (emission, absorption, radiative transfer equation, mean free path, optical depth), thermal radiation and thermodynamic equilibrium (Kirchhoff's law of thermal emission, Boltzmann and Saha equation, thermodynamics of black body radiation, concept of local thermodynamic equilibrium). | 4 | At the end of this discussion students will be able to learn the basics of Saha ionization and properties of radiative transfer. |
| | Observational tools for multi-wavelength astronomy - telescope as a camera, optical telescopes (refracting and reflecting telescopes), radio telescopes, astronomical instruments and detectors, observations at other wavelengths (infrared, ultraviolet, X-ray and Gamma ray astronomy), all-sky surveys. | 3 | At the end of this discussion students will be able to get an idea about basic measurements in astronomy. |
| Stars and stellar systems | Properties of stars (distance, brightness, size, mass, temperature, luminosity). | 3 | At the end of this discussion students will learn about the properties of stars. |
| | Measurement of stellar parameters: distance parallax, Cepheid variables, nova and supernovae, red shift), stellar spectra, spectral lines, the Hertzsprung-Russell diagram, luminosity and radius, binary system and mass determination, scaling relation on the Main Sequence. | 4 | At the end of this discussion students will be able to understand the HR diagram and its use in calculating different properties of stars. |
| | Basic equation of stellar structure hydrostatic equilibrium and the virial theorem, radiative and convective energy transport inside stars, nuclear energy production. Equation of state, opacity, Derivation of scaling relations. | 4 | At the end of this discussion students will be able to understand the basic features of hydrostatic equilibrium. |
| | Formation and evolution of stars star formation, pre-main-sequence collapse (gravitational instability and mass scales, collapse of spherical cloud, contraction onto the Main Sequence, Brown Dwarfs), evolution of high-mass and low-mass stars (core and shell hydrogen burning, helium ignition), late-stage evolution of stars, evolution of Sun-like stars and solar system. | 4 | At the end of this discussion students will learn about the evolution of stars and their different stages of life cycle. |
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| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
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| Stars and stellar systems | End stages of stars white dwarfs (electron-degeneracy pressure, mass-radius relation), neutron stars (mass limit of neutron stars, neutron stars observable as pulsars), black holes as end point of stellar evolution, supernovae. | 4 | At the end of this discussion students will learn about the white dwarf and Chandrasekhar limit. |
| Galaxies and the Universe | Milky Way galaxy: components, morphology and kinematics of the Milky way, the galactic center, spiral arms. | 3 | At the end of this discussion students will have a basic idea about galaxies. |
| | Classification and morphology of galaxies - quiet and active galaxies, types of active galaxies, Active Galactic Nuclei (AGN) and Quasars, accretion by supermassive black holes. | 3 | At the end of this discussion students will get an idea about AGN and supermassive black holes. |
| Cosmology | Newtonian cosmology, Olber's paradox, Hubble's law and the expanding Universe, scale factor and comoving coordinate. | 8 | At the end of this topic students will have an introductory idea about cosmology. |
| | Standard cosmology, the Friedmann equations from Newtonian cosmology, fluid equation, equation of state for matter, dust etc. from basic thermodynamics, cosmological redshift, dark matter, dark energy and the accelerating universe, tests and probes of Big Bang cosmology (the Cosmic Microwave Background, primordial nucleosynthesis) | 8 | At the end of this discussion students will be able to learn the basics of FRW cosmology and its various features in exploring the Big Bang and CMB radiation. |

Semester – VI
Course – CC 13 (Subject – Digital Systems and Applications)

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
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| Integrated Circuits | Design of monolithic Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI | 3 | Students will have basic idea of integrated circuits. |
| Number Systems | Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. Signed and unsigned number representation of binary system. Representation of negative number. 1's Complement and 2's Complement method of subtraction. | 4 | At the end of these classes students will acquire knowledge on different number systems. |
| Digital Circuits | Difference between Analog and Digital Circuits. Switching algebra, Huntington's postulates. Combinational logic, Truth table. Basic logic functions AND, OR and NOT. Implementation of OR, AND, NOT Gates. De Morgan's Theorems. Universal Gates. XOR and XNOR Gates and application as Parity Checkers. Circuit representation of gates. Introduction to different logics like DTL, TTL, MOS and CMOS. MOS and CMOS inverter circuit. | 6 | At the end of these classes students will have basic idea of logic circuits. |
| | Product term and sum term in logical expression. Sum of Product and Product of Sum and mixed expression. Minterm and Maxterm in the expressions. Conversion between truth table and logical expression. Use of Karnaugh Map. | 5 | Students will learn the conversion between truth table and logical expression. |
| Implementation of circuits | Half and Full Adders. Subtractors, 4-bit binary adder/Subtractor. Combinational logic circuits using PAL/PLA, use of IC 7483 as adder and subtractor. | 3 | Students will be able to implement simple logic circuits. |
| Data processing | Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. | 3 | Student will learn the basics of data processing. |
| Sequential Circuits | Introduction to Next state present state table, excitation table and truth table for Sequential circuits. SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race condition in SR and Race-around | 4 | At the end of these classes students will learn to construct sequential circuits. |
| Registers and Counters | Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out ShiftRegisters (only up to 4 bits). | 3 | At the end of these classes students will learn to construct registers. |
| | Counters: Asynchronous counters: ripple counter, Decade Counter. Synchronous Counter, Ring counter. | 3 | Students will learn to construct counters. |
| Computer Organization | I/O Devices. Data storage (idea of RAM and ROM, EPROM). Computer memory. Memory organization & addressing. Memory Interfacing. | 3 | At the end of these classes students will have basic idea needed to organize a computer. |
| Data Conversion | A/D (Ladder and weighted resistance) and D/A conversion circuit. | 3 | Students will have idea of analog-digital conversion. |
| Experiments | To design basic logic gates with diode, resistor, transistors. | 3 | At the end of these experiments students will develop skill needed for construction of digital circuits. |
| | To verify the logics by universal gate NAND/ NOR. | 3 | |
| | Construction of half adder and full adder | 3 | |
| | Construction of SR, D, JK FF circuits using NAND gates. | 3 | |
| | Construction of 4 bit shift registers using D type FF IC 7476. | 3 | |
| Construction of 4×1 Multiplexer using basic gates and IC 74151. | | | |

Course – CC 14 (Subject – Solid StatePhysics)

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
|-------|-----------|-------------------------|------------------|
|-------|-----------|-------------------------|------------------|

| | | | |
|------------------------------------|--|----|--|
| Crystal Structure | Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis; Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Laue and Bragg's Law and their equivalence. Atomic and Geometrical Structure Factor. Idea of crystal indexing: examples with SC, BCC, FCC structure. | 8 | At the end of this discussion students will acquire knowledge about different types of crystals. |
| Elementary Lattice Dynamics | Linear Monatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids, T^3 law. | 8 | At the end of this discussion students will acquire knowledge thermal properties of crystals. |
| Magnetic Properties of Matter | Dia, Para, Ferri and Ferromagnetic Materials. Langevin Theory of Dia and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism. Discussion of B-H Curve. Hysteresis and Energy Loss. | 6 | At the end of this discussion students will acquire knowledge different magnetic properties of crystals. |
| Dielectric Properties of Materials | Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius-Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeier relations. Langevin-Debye equation. | 4 | At the end of this discussion students will acquire knowledge dielectric properties of crystals. |
| Drude's theory | Free electron gas in metals, effective mass, drift current, mobility and conductivity, Hall effect in metals. Thermal conductivity. Lorentz number, limitation of Drude's theory. | 3 | Students will learn about conduction mechanism within the crystal. |
| Elementary band theory | Kronig Penny model. Band Gap. effective mass and effective mass tensor. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity | 10 | Students will learn basic band theory and be able to understand properties of metals, insulators, semi-conductors. |
| Superconductivity | Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and II Superconductors, London's Equation and Penetration Depth. Isotope effect. | 3 | At the end of this discussion students will have idea of superconducting materials. |
| Experiments | To study BH hysteresis of ferromagnetic material | 3 | At the end of these experiments students will develop skill to study properties of solid materials experimentally. |
| | To determine dielectric constant of different materials using fixed frequency alternating source. | 3 | |
| | Measurement of variation of resistivity in a semiconductor and investigation of intrinsic band gap using linear four probe. | 3 | |
| | Measurement of hall voltage by four probe method | 3 | |
| | To study temperature coefficient of a semiconductor, construction of temperature controller with comparator and relay switch. | 3 | |
| | Measurement of magnetic susceptibility of solids | 3 | |

Course – DSE A2 (Subject – Nano Materials and Applications)

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
|-------|-----------|-------------------------|------------------|
|-------|-----------|-------------------------|------------------|

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|---------------------------------------|---|----|---|
| Nanoscale Systems | Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures, Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation: Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences. | 6 | At the end of this discussion students will have basic idea of nano-scale physics. |
| Synthesis of nano structure materials | Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition • Physical vapor deposition(PVD) • Thermalevaporation – Electron beamevaporation – Pulsed Laserdeposition • Chemical vapor deposition(CVD) • MBE growth of quantumdots Chemical Synthesis • Chemical bath deposition • Electrodeposition • Spraypyrolysis • Hydrothermalsynthesis • Sol-Gelsynthesis • Preparation through colloidal methods | 12 | At the end of this discussion students will learn the techniques of synthesis. |
| Characterization | X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy. | 5 | At the end of this discussion students will learn the techniques of characterization |
| Optical Properties | Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization, absorption, emission and luminescence. Optical properties of heterostructures and nanostructures. | 10 | At the end of this discussion students will have basic idea of optical properties of nanoscale materials. |
| Electron Transport | Carrier transport in nanostructures. Coulomb blockade effect, thermionic emission, tunneling and hopping conductivity. Defects and impurities: Deep level and surface defects. | 6 | At the end of this discussion students will have basic idea of electron transport within nanoscale materials. |
| Applications | Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices. Single electron transfer devices. CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots -magnetic data storage. Electromechanical Systems. | 10 | At the end of this discussion students will learn the uses of nanoscale materials . |

Course – DSE B2 (Subject – Advanced StatisticalMechanics)

| Topic | Sub-Topic | Number of Lecture Hours | Learning Outcome |
|-------|-----------|-------------------------|------------------|
|-------|-----------|-------------------------|------------------|

| | | | |
|---|---|----|--|
| Review of Classical Statistical Mechanics | Idea of phase space, classical Liouville theorem, different ensembles. Evaluation of thermodynamic parameters using microcanonical ensemble for (i) harmonic oscillator, (ii) classical ideal gas (SackurTetrode Equation), (iii) paramagnets. Partition function and thermodynamic parameters evaluation for other simple examples. Anharmonic oscillator: mean energy ,mean position, specific heat using canonical ensemble, idea of thermal expansion of solids. Virial theorem and equipartition theorem . Energy fluctuation in canonical ensemble. Grand canonical ensemble, various thermodynamic parameters in grand canonicalensemble. Chemical potential for classical ideal gas. Saha ionization equation Density and energy fluctuation in grand canonicalensemble. Equivalence of different ensembles. | 20 | At the end of these review classes the students will have more clear concept of classical statistical mechanics discussed in semester V. |
| Quantum statistical mechanics | Density matrix formulation. Random phase approximation. Ensemble average for micro, canonical and grand canonical ensemble. Density matrix Examples: electron in magnetic field, free particle, harmonic oscillator. Distribution function of identical particles: bosons and fermions. | 10 | At the end of this discussion students will be able solve physical problems applying quantum statistical mechanics. |
| Ideal Bose systems and Fermi systems | Ideal bosegas. Thermodynamic relations, equation of state. Bose-Einstein condensation: evaluation of various thermodynamic parameters. Chemical potential for bose gas. Ideal fermi gas: thermodynamic relations, equation of state. Pauli paramagnetism, degenerate and non-degenerate fermi gas. Relativistic fermigas. White dwarf and Chandrasekhar masslimit. | 10 | At the end of this discussion students will be able to study different Bosonic and Fermionicsystems. |
| Ising Model | Ising model: Bragg-Williams theory and relation with binary alloy. | 6 | At the end of this discussion students will have basic idea of Ising model. |
| Non-equilibrium statistical mechanics | Equilibrium time scales, irreversibility and role of fluctuation; coarse grained description. Random walk: calculation of occupation probability. | 7 | At the end of these classes students will have basic idea of statistical approach in non-equilibrium situations. |

GENERAL COURSES

Semester – I

Course – CC1/GE1 (Subject – Mechanics)

| Topic | Sub-Topic | No. of Lecture Hours | Learning Outcome |
|-------------------------------------|--|----------------------|---|
| Mathematical Methods | Addition of vectors and multiplication by a scalar. Scalar and vector products of two vectors, vector triple product. | 3 | At the end of discussions related to vectors students will learn to apply their idea to solve various physical problems. |
| | Derivatives of a vector with respect to a parameter. Gradient, divergence and Curl. Vector integration, line, surface and volume integrals of vector fields. Gauss divergence theorem and Stoke's theorem | 4 | |
| | 1st order homogeneous differential equations. 2nd order homogeneous and inhomogeneous differential | 3 | Students will learn to solve equation of motion. |
| Introduction to Newtonian Mechanics | Idea of space time for Newtonian Mechanics, frames of reference, Newton's Laws of motion. Dynamics of a system of particles. Conservation of momentum. Centre of Mass. Work-energy theorem. Conservative forces. Potential Energy. Conservation of energy. | 5 | At the end of this discussion students will develop basic idea on Newtonian Mechanics. |
| Rotational Motion | Rotation of a rigid body about a fixed axis. Angular velocity and angular momentum. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Torque. | 5 | At the end of this discussion students will develop basic idea of rigid body motion. |
| Central force and Gravitation | Motion of a particle in a central force field. Conservation of angular momentum leading to restriction of the motion to a plane and constancy of areal velocity. Kepler's Laws. Newton's Law of Gravitation. Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of GPS. | 6 | At the end of this discussion students will be able to understand many central force problem including planetary motions. |
| Oscillations | Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations. Forced oscillations with harmonic forces. | 6 | At the end of this discussion students will learn basic idea about oscillatory motions. |
| Elasticity | Hooke's law, elastic moduli, relation between elastic constants, Poisson's Ratio, Expression for Poisson's ratio in terms of elastic constants. Twisting couple on a cylinder. Determination of Rigidity modulus by static torsion. Torsional pendulum. Bending of beams, Cantilever. Stretching and work done in twisting a wire. | 6 | At the end of this discussion students will learn about elastic property of materials. |
| Surface Tension | Molecular theory of surface tension, surface energy, comparison between surface tension and surface energy, variation of surface tension with temperature, spherical drops and bubbles Synclastic and anticlastic surface, excess of pressure, capillary rise of liquid. | 3 | At the end of this discussion students will develop idea about surface tension of fluids. |
| Experiments | Determination of Moment of inertia of cylinder/bar about axis by measuring the time period, of the cradle and with body of known moment of Inertia. | 3 | At the end of these experiments students will develop skill for accurate measurement of many physical parameters. |
| | Determination of Y modulus by the method of flexure. | 3 | |
| | Determination of rigidity modulus of the material of a wire. | 3 | |
| | Determination of Moment of Inertia of a flywheel. | 3 | |
| | Determination g using bar pendulum. | 3 | |

Semester – II

Course – CC2/GE2 (Subject – Electricity and Magnetism)

| Topic | Sub-Topic | No.of Lectur e Hours | Learning Outcome |
|---------------------------|--|----------------------|--|
| Vector | Addition of vectors and multiplication by a scalar. Scalar and vector products of two vectors. Gradient, divergence and Curl. Vector integration, line, surface and volume integrals of vector fields. Gauss' divergence and Stoke's theorem. | 5 | Students will learn to apply their idea to solve various physical problems. |
| Electrostatics | Coulombs law, principle of superposition, electrostatic field. Electric field and charge density | 5 | At the end of these discussions students will develop clear basic idea of Electrostatics and will be able to solve various physical problems involving electric charges – single or continuous distribution. |
| | Electric dipole moment, electric potential and field due to an electric dipole, force and Torque on a dipole. Electric Fields inside matter, Electric Polarisation, bound charges, displacement density vector, linear Dielectric medium | 5 | |
| | Divergence of the Electrostatic field, flux, Gauss's theorem of electrostatics, applications of Gauss theorem to find Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, charged sheet, charged conductor. Gauss's theorem in dielectrics. | 5 | |
| | Curl of the Electrostatic Field. Conservative nature of electrostatic field, Introduction to electrostatic potential, Calculation of potential for linear, surface and volume charge distributions, potential for a uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Energy per unit volume in electrostatic field. | 5 | |
| Magnetism | Introduction of magnetostatics through Biot-Savart's law. Application of Biot-Savart's law to determine the magnetic field of a straight conductor, circular coil, solenoid carrying current. Force between two straight current carrying wires. Lorentz force law. | 4 | At the end of these discussions students will develop clear basic idea of Magnetism. They will be able to differentiate between materials according to their magnetic property. |
| | Divergence of the magnetic field, Magnetic vector potential. | 2 | |
| | Curl of the magnetic field. Ampere's circuital law. Determination of the magnetic field of a straight current carrying wire. Potential and field due to a magnetic dipole. Force and torque on a magnetic dipole. | 4 | |
| | Magnetic fields inside matter, magnetization, Bound currents. The magnetic intensity H. Linear media. Magnetic susceptibility and Permeability. Brief introduction of dia, para and ferro-magnetic materials. | 3 | |
| Electromagnetic Induction | Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. | 4 | Students will learn about induction. |
| Electrodynamics | Maxwell's Equations, Equation of continuity of current, Displacement current, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, Poynting vector, decay of charge in conducting medium. | 7 | At the end of these discussions students will have basic level idea of Maxwell's relations, Poynting vector etc. |
| Experiments | Determination of unknown resistance by Carey Foster method. | 3 | At the end of these experiments students will develop skill for accurate measurement of resistance, will be able to construct voltmeter, Ammeter. |
| | Measurement of a current flowing through a resistor using potentiometer. | 3 | |
| | Determination of the horizontal components of earth's magnetic field. | 3 | |
| | Conversion of an ammeter to voltmeter and reverse. | 6 | |

Semester – III

Course – CC3/GE3 (Subject –)

| Topic | Sub-Topic | No. of Lecture Hours | Learning Outcome |
|----------------------------|--|----------------------|--|
| 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 Coefficients, Reversible and irreversible processes. | 6 | At the end of this discussion students will learn about zeroth, first law, various thermodynamic processes. |
| | Second law and Entropy, Carnot's cycle & Carnot's theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams. | 6 | Students will second law, third law and their implications. |
| | Third law of thermodynamics, unattainability of absolute zero. | | |
| Thermodynamical Potentials | Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications: Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for (C_P and C_V). TdS equations. | 5 | At the end of this discussion students will learn about various potential functions. |
| 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; mono-atomic and diatomic gases. | 9 | At the end of this discussion students will about behaviour and properties of gases. |
| Theory of Radiation | Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh- Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law. | 4 | At the end of this discussion students will have basic idea of radiation process. |
| Statistical Mechanics | Phase space, Macrostate and Microstate. Ensemble, Ergodic hypothesis. Entropy and Thermodynamic probability, Boltzmann hypothesis. Maxwell-Boltzmann law of distribution of velocity. Quantum statistics (qualitative discussion only). Fermi-Dirac distribution law (statement only), electron gas as an example of Fermi gas. Bose-Einstein distribution law (statement only), photon gas as an example of Bose gas. Comparison of three statistics. | 10 | At the end of this discussion students will have basic idea on Statistical Mechanics. They will be able to solve problems using this idea. |
| Experiments | Determination of the coefficient of thermal expansion of a metallic rod using an optical lever. | 3 | At the end of these experiments students will develop skill to study various thermal properties of materials experimentally. |
| | Verification of Stefan's law of radiation by the measurement of voltage and current of a torch bulb glowing it beyond draper point. | 3 | |
| | To determine Thermal coefficient of Resistance using Carey foster bridge. | 3 | |
| | To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method. | 3 | |
| | Determination of the pressure coefficient of air using Jolly's apparatus. | 3 | |

Semester – IV

Course – CC4/GE4 (Subject – Waves and Optics)

| Topic | Sub Topic | No. of Lecture Hours | Learning Outcome |
|-----------------------------|---|----------------------|--|
| Acoustics | Review of SHM, damped & forced vibrations: amplitude and velocity resonance. Fourier's Theorem and its application for some waveforms e.g., Saw tooth wave, triangular wave, square wave. Intensity and loudness of sound. Intensity levels, Decibels. | 10 | At the end of this discussion students will develop basic concept of oscillatory motions. |
| Superposition of vibrations | Superposition of Two Collinear Harmonic oscillations having equal frequencies and different frequencies (Beats). Superposition of Two Perpendicular Harmonic Oscillations, Graphical and Analytical Methods, Lissajous Figures with equal and unequal frequency and their uses. | 4 | At the end of this discussion student will be able to analyze superposed oscillatory motions |
| Vibrations in String | Wave equation in stretched string and its solutions. Boundary conditions for plucked and struck strings. Expression of amplitude for both the cases (no derivation), Young's law, Ideal of harmonics. Musical scales and notes. | 6 | At the end of this discussion student will be able to understand the mechanism of string vibration. |
| Introduction to wave Optics | Definition and Properties of wave front. Huygens Principle, Electromagnetic nature of light. | 2 | Student will develop basic idea of wave optics. |
| Interference | Superposition of two waves with phase difference, distribution of energy, formation of fringes, visibility of fringes. Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stoke's treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index. Michelson's Interferometer (a) Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index. | 10 | At the end of this discussion student will have knowledge of Interference phenomenon in details. |
| Diffraction | Fraunhofer diffraction Single slit; Double Slit. Multiple slits and Diffraction grating. Fresnel Diraction: Half-period zones. Zone plate. | 8 | Student will have knowledge of Diffraction phenomenon in details. |
| Polarization | Transverse nature of light waves. Plane polarized light, production and analysis. Circular and elliptical polarization. Optical activity. | 6 | Student will have basic idea of Interference phenomenon. |
| Experiments | Determination of the focal length of a concave lens by auxiliary lens method. | 3 | At the end of these experiments students will learn to study various optical phenomena experimentally. |
| | Determination of the frequency of a tuning fork with the help of sonometer. | 3 | |
| | Determination of radius of curvature of plano convex lens/wavelength of a monochromatic or quasi monochromatic light using Newtons ring. | 3 | |
| | Measurement of thickness of a paper from a wedge shaped film. | 3 | |
| | Measurement of specific rotation of active solution | 3 | |