COURSE OUTCOME
PHYSICS HONOURS/GENERAL (UNDER CBCS)

1. **Semester – I**
   Course – CC 1 (Subject – Mathematical Methods I)

Topic	Sub-Topic	Number of Lecture Hours	Learning Outcome
Calculus	Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves.	3	Upon completion of these topics, students will be able to understand the concept of limits and continuity, differentiation and apply them to various functions. They learn about functions and plotting of curves.
	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 these class's students will be able to understand the concept of convergence of infinite, power series and applications. Students will learn about various convergence tests, including D'Alembert's ratio test, Cauchy's root test, Integral test, and Alternating series test, to determine the convergence or divergence of a power series. Also, students will be able to develop an understanding of Taylor series and Maclaurin series and their application in approximating functions.
	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 topics, Students will be able to solve first, second order differential equations and their applications in various fields. Also, they understand the concept of homogeneous differential equations with constant coefficients, the existence and uniqueness theorem for initial value problems and their applications.
	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	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 these topics, students will be able to: Recapitulate the fundamental concepts of vector algebra, including the idea of linear independence, completeness, basis, and representation of vectors. Understand the properties of vectors under rotations and their applications in various fields. Understand the concept of scalar product and its invariance under coordinate rotations. Understand the concept of vector product, scalar triple product, and their interpretation in terms of area and volume, respectively. Apply the concepts learned in this course to solve problems in various fields.
	Vector Differentiation: Scalar and Vector fields. Directional derivatives and normal derivative. Gradient of a scalar field and its	5	Upon completion of this course, students will be able to: 1. Understand the concept of scalar and vector fields

	geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities.		and differentiate them with respect to a given direction. 2. Calculate the directional derivative and normal derivative of a given scalar or vector field. 3. Understand the concept of the gradient of a scalar field and its geometrical interpretation. 4. Understand the concept of divergence and curl of a vector field and their physical interpretations. 5. Apply the del and Laplacian operators to solve problems in various fields, including physics, engineering, and mathematics. 6. Understand and apply various vector identities to simplify complex vector equations.
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	Upon completion of this course, students will be able to: 1. Understand the concept of vector integration and its applications in various fields, including physics, engineering, and mathematics. 2. Calculate ordinary integrals of vectors and multiple integrals using the Jacobian matrix. 3. Understand the notion of infinitesimal line, surface, and volume elements and their applications in vector calculus. 4. Calculate line, surface, and volume integrals of vector fields and understand their physical interpretations. 5. Calculate the flux of a vector field and understand its significance in various fields, including fluid mechanics and electromagnetism. 6. Understand and apply Gauss' divergence theorem, Green's theorem, and Stokes' theorem in solving problems related to vector fields and their applications. 7. Apply vector calculus concepts and techniques to solve problems in various fields, including physics, engineering, and mathematics.
	Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Spherical and Cylindrical Coordinate Systems.	5	Upon completion of this course, students will be able to: 1. Understand the concept of orthogonal curvilinear coordinates and their applications in various fields, including physics, engineering, and mathematics. 2. Derive the gradient, divergence, curl, and Laplacian operators in spherical and cylindrical coordinate systems. 3. Apply the gradient, divergence, curl, and Laplacian operators in solving problems related to vector fields in spherical and cylindrical coordinate systems. 4. Understand the physical interpretations of the gradient, divergence, curl, and Laplacian operators in various fields, including fluid mechanics and electromagnetism. 5. Solve problems related to vector fields using orthogonal curvilinear coordinates and the gradient, divergence, curl, and Laplacian operators in spherical and cylindrical coordinate systems. 6. Understand and apply the concepts of curvilinear coordinates, coordinate transformations, and vector calculus in solving problems in various fields, including physics, engineering, and mathematics.

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 they will be able to use them in different physical problems.
	Eigen-values and Eigenvectors (Degenerate and non- degenerate). Cayley- Hamiliton 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. They will be able to solve different matrices related problems.
Practical	Introduction to plotting graphs with Gnuplot	6	At the end, 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 a program and explore their connection with the theoretical concept. Students will be able to handle mathematical problems using python programming Also, they will learn the beauty of python programming in real life.

Course – CC 2 (Subject – Classical Mechanics)

Topic	Sub-Topic	Number of Lecture Hours	Learning Outcome
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 inertial frame of reference and Newton's laws and their applicability in different 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 dynamics of systems of particles, momentum, 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 system of particles.
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 and will be able to solve its problems.
	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, Kepler's 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 Hours	Learning Outcome

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 study physical problems using inertial and non-inertial frames 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 for different shaped bodies.
	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 learn axis transformation and 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 ~F = ~∇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 fluid dynamics.
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 them 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
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 in electrostatics.
	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 electrostatic field and its 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 succeptibility 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 and vector application.
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
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 magnetostatic field, properties of magnetostatic field and applications.
	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 and it's calculation.
	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 Ampere's circuital 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, dipole moment, torque.
	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.
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 ofthe Earth's magnetic field.	3	

Course – CC 4 (Subject – Waves and Optics)

Topic	Sub-Topic	Number of Lecture Hours	Learning Outcome
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 oscillations, 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 Simple Harmonics Motion.
	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 wave motion, 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 nature of light and 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 applications.

Topic	Sub-Topic	Number of Lecture Hours	Learning Outcome
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 and idea of form of fringes.
	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, experiment of slit 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 wavelength with tension.
	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 experiment.
	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 sinθvs graph of a certain order of grating spectra.	3	

Semester – III
Course – CC 5 (Subject – Mathematical Methods II)

Topic	Sub-Topic	Number of Lecture Hours	Learning Outcome
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 recurrencerelations. Expansion of function in a series of Legendre Polynomials. Multipole expansion in Electrostatics. Bessel Functions of the First Kind: Generating Function, simple recurrencerelations. Zeros of Bessel Functions (J0 (x) and J1 (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. They will learn some special functions.
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 some 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
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 probability distributions and related topics.
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 general manner with various physical problem.
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 mathplotlib	12	

1.1 Course – CC 6 (Subject – Thermal Physics)

Topic	Sub Topic	Number of Lecture Hours	Learning Outcome

Introduction to Thermodynamics	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 first law of thermodynamics and basic features of thermodynamics and related properties.
	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 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 ofAbsolute 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, Gibb's 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 coecient 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, phase transitions, Maxwell's thermodynamics relations, 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 porus plug experiment.

Topic	Sub Topic	Number of Lecture Hours	Learning Outcome
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 equipartion 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 phenomenon 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 optial 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 3conductor 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 – Modern Physics)

Topic	Sub Topic	Number of Lecture Hours	Learning Outcome

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 and probabilistic interpretation.
	Two-slit experiment with photons and electrons. Linear superposition principle as a consequence	3	At the end of this discussion students will get a 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.

Topic	Sub Topic	Number of Lecture Hours	Learning Outcome

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

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 Methods III)

Topic	**Sub Topic**	**Number of Lecture Hours**	**Learning Outcome**

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 andbranch points, order of singularity, branchcuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor'sexpansion. 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 → 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

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
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, boundarycondition and emergence of discrete energy levels. One dimensional square well potential of finitedepth.	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 angularmomentum. 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 nondegenerateperturbative 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
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 lineregulation.	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 amplifer, 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
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 Arduino board. 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

In this systematic course of learning, in semester V, students will study four basic branches in Physics, e.g., The electromagnetic theory, Statistical mechanics, Laser and fibre optics and nuclear and particle physics. Task for a physicist is to give explanation of events occurring in nature. Once we can explain a phenomenon, we can perform the same by ourselves and apply it for human well beings. Now phenomena are nothing but time evolution of systems, i.e., changes in a system due to causality. Thus, first of all we have to model a system (by defining its mass, charge, etc.) then predict or calculate the changes in system after passage of time. Nature follow a systematic rule to evolve its system to occur a natural phenomenon. With the help of mathematics, Scientists are now able to develop these rules now known as mathematical formulations or collectively called mechanics corresponding to different branches in physics. Primary motivation of the course curriculum is to reach these knowledges systematically to our students to learn the nature. So, the outcome of a course curriculum signifies the extent of knowledge in a specified field gathered by students, the understanding of the field gained by the students, the efficiency they gain in solving a problem as well as the capability they earned towards the application of the acquired knowledge for the progress of science as well as the well beings of the society.

Course – CC 11 (Subject – Electromagnetic Theory)

Topic	Sub-Topic	Number of Lecture Hours	Learning Outcome
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	Starting from the concept of scalar and vector potentials, students will learn the mathematical background of electro-magnetic theory and deduce the expressions for different dynamical parameters associated to the electromagnetic wave.
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	During this discussion student will learn different properties of the medium in the light of EM wave propagation.
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	Outcome of this content is to apply the theory of EM wave to clear theoretical understanding regarding laws of different optical phenomena, e.g. reflection, refraction, etc.
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 the basic transverse characteristics of EM waves leading to its classification and its behavior in optically active medium.
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	During this discussion students will gather theoretical understanding about the creation and analysis of 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 biquartzpolarimeters.	8	At the end of this discussion students will learn to apply the concept of polarization to study some physical properties of substances.
Experiments	To determine Brewster's angle for air-glass interface using a prism.	3	After performing these experiments students will develop skill to verify optical laws and to measure various optical properties of substances. They will be motivated to design new experiments exploiting the properties of light.
	To study Fresnels 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
Classical Statistical Mechanics	Macrostate& Microstate, Elementary Concept of Ensemble and Ergodic Hypothesis. Phase Space.	8	During this discussion students will learn to model a system that is a mapping of the actual system consisting of a large number of particles on which measurement is performed.
	Microcanonical ensemble, Postulate of Equal a-priori probabilities. Boltzmann hypothesis: Entropy and Thermodynamic Probability.	5	After realization of the model system here the students will learn some basic postulates and hypothesis 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	In this discussion students will learn some mathema-tical tricks to deduce thermodynamic properties of systems which are in thermal contact with the 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	Build up knowledge about the model, postulates and mathematical tricks will help the student to apply statistical ideas to solve various classical problems.
	Grand canonical ensemble. Application of ideal gas using grand canonical ensemble. chemical potential.	4	In the realm of SM here the students will learn to study systems in a situation when both heat and particle of the system exchange with environment.

Systems of Identical particles	Classical approach and quantum approach: istinguishability 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	In this part students will learn how the introduction of the concept of indistinguishability of the microscopic constituent of a system leads to a separate branch of SM known as Quantum statistical Mechanics, in particular the MB statistics and the FD statistics, in contrast to the classical statistical mechanics applicable for the distinguishable particle systems.
Bose-Einstein Statistics	Distribution law. Thermodynamic functions of a strongly degenerate Bose Gas, Bose Einstein condensation and properties of liquid He IV	5	From this discussion students will learn to formulate fundamental formulae for the symmetric quantum systems and apply it to study the properties of different Bosonic systems.
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	The main outcome of this part is to interpret the laws and properties of radiation from quantum statistical view point.
	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	This part will enrich the knowledge of the students to formulate various thermodynamic properties of the Fermi-Dirac systems.
Python Programming	Study of Random Numbers and Time series	10	Students will develop programming skill to solve statistical problems neumerically.
	Applications of Random Numbers	10	
	Scaling and plots, exponents and parameters	10	

Course – DSE A1 (Subject – Laser and Fibre Optics)

Topic	Sub-Topic	Number of Lecture Hours	Learning Outcome
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	During this discussion students will acquire a clear theoretical concept on light amplification, particularly systems necessary (2, 3 and 4 level systems) and conditions fulfilled for lasing action.

Basic properties of laser	Coherence, directionality, monochromaticity, brightness.	3	Students will acquire a deep understanding regarding the basic properties and characteristics of laser radiation.
Resonantors	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 about the basic structure (Laser cavity) for laser production and its performance.
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, CO2Laser i) Solid state laser: Ruby Laser, Nd:YAG laser, Semiconductorlaser (iii) Liquid laser: Dyelaser.	7	The students will learn about the principle and operational mechanism of different types of Laser sources.
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	As an outcome of this discussion students will understand different mechanisms broadening and some useful applications.
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	Students will gather know-ledge about the medium guiding optical signal and some of their applications in daily life.
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 a method of generating real 3D images.
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 non centrosymmetric medium.	6	The invention of laser has placed some optical mediums to a new height for which polarization is a non-linear function of intensity of light leading to a new branch of optics called Nonlinear optics. As an outcome of the present discussion students will have basic idea of non- linear optics.

Course – DSE B1 (Subject – Nuclear and Particle Physics**)**

Topic	Sub-Topic	Number of Lecture Hours	Learning Outcome
Introduction	Recapitulation of general properties of nuclei, nuclear models and radioactivity	5	Students will be able to recapitulate their previous understanding about the structure and properties of the nuclei so that they can easily capture the complex ideas in this field.
Nuclear Reactions	Types of Reactions, Conservation Laws, kinematics of reactions, Q value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering).	10	From this discussion students will realize the theory of nuclear reactions that discovered the nature of nuclear particles and their interactions.
Interaction of Nuclear Radiation with matter	Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron's interaction with matter	15	In this discussion students will be able to learn the basic ways of interaction of radiation with matter.
Detector for Nuclear Radiations	Gas detectors: estimation of electric eld, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector	15	The discussion on the detectors will build up theoretical ideas about the construction and the principle of operation for various instruments that are used for detection of nuclear radiations.
Particle Accelerators	Accelerator facility available in India, Different type of accelerators • Van-de Graaf generator (Tandem accelerator) • Linear accelerator • Cyclotron • Betatron • Synchrotrons	15	Since for nuclear reactions we need high energy projectiles so the detailed knowledge of accelerators is very much essential for students going to be nuclear scientist in near future.
Particle Physics	Fundamental particles and their families. Fundamental particle-interactions and their basic features. Gellmann Nishijima formula. Quark structure of hadrons. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm. concept of quark model, color quantum number and gluons.	15	As an outcome of this content students will familiar with the ultimate constituents of the universe, their properties and interactions in the nature. They will be able to know why some reactions are allowed and others do not exist in nature.

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

Topic	Sub-Topic	Number of Lecture Hours	Learning Outcome
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 Organizati on	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. To verify the logics by universal gate NAND/ NOR. Construction of half adder and full adder Construction of SR, D, JK FF circuits using NAND gates. Construction of 4 bit shift registers using D type FF IC 7476. Construction of 4 × 1 Multiplexer using basic gates and IC 74151.	3 3 3 3 3	At the end of these experiments students will develop skill needed for construction of digital circuits.

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. ClausiusMosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir 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 andApplications)

Topic	Sub-Topic	Number of Lecture Hours	Learning Outcome

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 connement: Applications of Schrodinger equation: Infinite potential well, potential step, potential box, quantum confinnement 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 nanostrucutures. Coulomb blockade effect, thermionic emission, tunneling and hoping 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 nanoscate materials .

Course – DSE B2 (Subject – Advanced Statistical Mechanics)

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 equi-partition 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 these topics, students will learn to apply their idea to solve various physical problems related to vector.
	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 able to solve various types of differential equation.
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 understand and 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 and be able to solve complicated motion of rigid bodies problems.
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 solve many central force problems 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 the 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 and elasticity.
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 Lecture 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 toan electric dipole, force and Torque on a dipole. Electric Fields inside matter, Electric Polarisation, boundcharges, 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 electricfield from potential. Energy per unit volume in electrostaticfield.	5	
Magnetism	Introduction of magnetostatics through Biot-Savart's law. Application of BiotSavart'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 Maxwll'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 register 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 ofFirst Law: General Relation between C_P and C_V ,Work Done during Isothermal and Adiabatic Processes. Compressibilityand Expansion Coefficients, Reversible and irreversible processes.	6	At the end of this discussion students will learn about zeroeth, first law, Cp, Cv, 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 thermodynamics 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 displacementlaw 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 metalic rod using an optical lever.	3	At the end of these experiments students will develop skill to study various thermal properties of materials experimentally.
	Verication 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	