AKPC MAHAVIDYALAYA

DEPT.OF PHYSICS

SUBHASNAGAR, BENGAI, HOOGHLY, PIN- 712611

COURSE OUTCOME

Class: B.Sc (SEM-I), **Course Code**: PHYH-C I, **Name of the Course**: Mathematical Physics-I

Indexing	Name of the topic	COURSE OUTCOME
C.O.-1.1	**Calculus**	Students will be able to • interpret a function, • verify the value the limit, • find point of discontinuity, and • interpret the derivative and the value of first and second order derivative of a function at a point, and partial derivative and solution of differential equation
C.O.-1.2	**Vector Calculus**	Students will be able to • learn what is vector with its properties , • dot and cross product that is vector algebra , • explain the concept of vector differentiation • ,understand the concept the integrals of functions and vector fields and • recognize the statement the stock's and Divergence theorem and also Green's theorem and their application in physical and mechanical engineering.
C.O.-1.3	**Orthogonal Curvilinear Coordinates**	Students will be able to • find the divergence ,gradient ,curl of a vector or scalar field • express in terms of orthogonal curvilinear coordinates and also Laplacian in cartesian ,spherical and cylindrical coordinate system.
C.O.-1.4	**Introduction to Probability**	Students are able to • understand the meaning of probability ,concept of random variable ,meaning of conditional probability • identify the important types of distribution such as binomial ,Gaussian ,Poisson distribution , Bayes' theorem and the idea of hypothesis testing.
CO-1.5	**Dirac Delta function and its properties**	Students are able to understand what is Dirac Delta function and properties of this function.
	LAB	Students will be enriched not just by learning computer programming and numerical analysis but to emphasize its role in solving problem in physics. Students are highlighted with the use of computational methods to solve physical problems by both theory and practical lectures in the lab .student are able to construct the computational problems to be solve

COURSE OUTCOME

Class: B.Sc (SEM-I), **Course Code**: PHYH-C II, **Name of the Course**: Mechanics

Indexing	Name of the topic	COURSE OUTCOME
CO-2.1	**Fundamentals of Dynamics**	Students are able to know about • Frame of references and its types • review of Newton's laws of motion , Galilean transformation and its invariance • Momentum of variable mass system: motion of rocket • Motion of projectile, centre of mass system, principle of conservation of momentum and impulse
CO-2.2	**Work and Energy**	Students are familiar with • work, kinetic energy, potential energy and energy diagram. • conservative and non conservative force • stable and unstable equilibrium • law of conservation of energy.
CO-2.3	**Collisions**	The outcome of the course are • concept about different type of collisions • difference between elastic and inelastic collision • Idea about centre of mass and laboratory frames.
CO-2.4	**Rotational Dynamics**	From this section students are know about • angular momentum of a particle/ system of particles • idea about torque • laws of conservation of angular momentum • moment of inertia and calculation of M.I for different type of bodies • kinetic energy of rotation • also know about the motion involving both translation and rotation • also know about the motion involving both translation and rotation
CO-2.5	**Elasticity**	This section help the students to know about • concept of elasticity • different types of elastic constant and their relationship • twisting torque on a cylinder or wire

CO-2.6	**Fluid Motion**	This portion help the students to know about different things like • Kinematics of moving fluids • Poiseuille's equation for a liquid through a capillary tube.
CO-2.7	**Gravitation and Central Force Motion**	Students are enriched with the following • law of gravitation • gravitational potential energy • inertial and gravitational mass • derivation of mathematical expression of field and potential due to spherical shell and solid sphere
CO-2.8	**Motion of a particle under a central force field**	Students are well known about • two body problem and reduction to one body problem with its solution • equation of energy and energy diagram • Kepler's law • satellite in circular orbit and its applications • geosynchronous orbits • basic idea about global positioning system (GPS)
CO-2.9	**Oscillations:**	This section help the students to know about • simple harmonic oscillation • differential equation of SHM and its solution • K.E, P.E, total energy and their time average values • damped and forced oscillations • resonance, sharpness of resonance, power dissipation • quality factor
CO-2.10	**Non-Inertial Systems**	Students are well known about • non inertial frames and fictitious force • laws of physics in rotating coordinate systems • centrifugal and coriolis force with their applications • cylindrical and spherical coordinates and their velocity and acceleration components
CO-2.11	**Special Theory of Relativity**	This section give a brief idea about the new branch of mechanics with the followings • Michelson-Morley experiment and its outcome • postulates of special theory of relativity(STR) • Lorentz transformations • simultaneity of events • length contraction and time dilation • relativistic transformation of velocity, frequency and wave number • addition of velocities • variation of mass with velocity

		• mass-energy equivalence • relativistic Doppler effect • • relativistic kinematics • transformation of energy and momentum
	LAB	Students can perform the following experiment in laboratory • clear idea about the uses of vernier caliper , screw gauge and travelling microscope • Study the motion of spring and calculate (a Spring constant, (b) g and (c) Modulus of rigidity. • Determine the moment of inertia • determine g and velocity for a freely falling body using Digital Timing Technique • determine coefficient of viscosity of water by capillary flow Method • Young's Modulus of a Wire by Optical Lever Method • Modulus of Rigidity of a Wire by dynamical method. • elastic Constants of a wire by Searle's method • value of g using Bar pendulum / Kater's Pendulum • determine the value of Young's Modulus by Flexure method.

COURSE OUTCOME

Class: B.Sc. (SEM-II), Course Code: PHYH-C III, Name of the Course: Electricity and Magnetism

Indexing	Name of the topic	COURSE OUTCOME
CO-3.1	**Electric Field and Electric Potential**	Students are able to understand what is the definition of electric field ,how to draw electric field lines, the concept of electric flux ,and application of Gauss law in regular object , conservative nature of electric field . They know that electric potential decreases in the direction of the field . Students are able to draw equipotential surfaces , calculate the work required to move a charge in an electric field and how a dipole feels a torque when placed in a electric field. Students can understand how a capacitor works, calculate the capacitance and amount of energy stored in a capacitor .
CO-3.2	**Dielectric Properties of Matter**	Students are able to understand electric field in matter ,polarization and polarization charge ,how dielectrics make capacitor more effective, the relation between E P D .
CO-3.3	**Magnetic Field**	Students are able to understand what is magnetic field and what situations can create a magnetic field , understand Biot-Savart's law to calculate the magnetic field of straight wire and circular loop , application of Ampere's law in case of solenoid and toroid, how a current loop feels a torque when placed in a magnetic field.
CO-3.4	**Magnetic Properties of**	Students are able to understand what is magnetization vector , magnetic susceptibility and permeability , significance of B-H loop.

	Matter	
CO-3.5	**Electromagnetic Induction**	Students are able to understand that changing magnetic flux through a wire induce a current and EMF in the wire ,understand Faraday's law to calculate the EMF ,use of Lenz's law to predict the direction of current, know what is inductance, know the equations of Maxwell's.
CO-3.6	**Electrical Circuits**	Students are able to understand Kirchhoff's law for AC circuits, how to calculate impedance of a circuit . Students know about LCR series resonant circuit , its power dissipation ,Quality factor ,band width.
CO-3.7	**Network theorems**	Students are able to understand what is ideal voltage source and current source , Thevenin theorem, Norton Theorem, Superposition theorem ,maximum power transfer theorem.
CO-3.8	**Ballistic Galvanometer**	Students know how a ballistic galvanometer work ,its charge and current sensitivity , significance of CDR.
	LAB	The following experiments can help the students to clear ideas about the theory • Use of a Multimeter • characteristics of a series RC Circuit. • Uses of Potentiometer and to determine an unknown Low Resistance • Carey Foster's Bridge. • De'Sauty's bridge to compare capacitances • By using search coil Measurement of field strength B • verify the Thevenin, Norton and Maximum power transfer theorems • determine self inductance of a coil by Anderson's bridge • determine (a) Resonant frequency, (b)Impedance at resonance, (c) Quality factor Q, and (d) Band width of a series and parallel LCR circuit • by using Ballistic Galvanometer measure the CDR value, current and charge sensitivity also the high resistance by the method of leakage • measurement of mutual inductance of two coils by Carey-Foster's method • Construction of one ohm coil.

COURSE OUTCOME

Class: B.Sc (SEM-II), **Course Code**: PHYH-C IV, **Name of the Course**: Waves and Optics

Indexing	Name of the topic	COURSE OUTCOME
CO-4.1	**Superposition of Collinear Harmonic oscillations**	Students are able to know about • Linearity and superposition principle. • Superposition of two and N collinear oscillations With different conditions
		Students can verify and visualize the above principle by

CO-4.2	**Superposition of two perpendicular Harmonic Oscillations**	• Graphical and analytical method. • Lissajous figure
CO-4.3	**Wave Motion**	Students are familiar with • Plane and Spherical waves. • Longitudinal and Transverse wave • Plane Progressive (Travelling) Wave • Wave Equation with Particle and Wave Velocities • Pressure, Energy and intensity of a Longitudinal Wave • Water Waves, Ripple and Gravity Waves.
CO-4.4	**Velocity of Waves**	Students can apply the previous knowledge to • Measure the velocity of transverse Vibrations of Stretched Strings. • Also measure the Velocity of Longitudinal Waves in a Fluid in a Pipe. • Establish Newton's Formula for Velocity of Sound and Laplace's Correction.
CO-4.5	**Superposition of Two Harmonic Waves**	Students are able to know about • Analytical Treatment of standing waves in a String. • Phase and Group Velocities. • Energy of Vibrating String. • Normal Modes of Stretched Strings. • Plucked and Struck Strings. • Melde's Experiment. • Longitudinal Standing Waves and Normal Modes. • Open and Closed Pipes. • Superposition of N Harmonic Waves.
CO-4.6	**Wave Optics**	Students can revise the previous idea of • Electromagnetic nature of light • Definition and properties of wave front. • Huygens Principle. • Temporal and Spatial Coherence.
CO-4.7	**Interference**	Students are able to know about • Division of amplitude and wavefront • Young's double slit experiment • Lloyd's Mirror and Fresnel's Biprism. • Stokes' treatment. • Interference in parallel and wedge-shaped films. • New types of fringes like Haidinger Fringes, Fizeau Fringes etc • Newton's Rings for measurement of wavelength and refractive index
CO-4.8	**Interferometer**	Students are familiar with Michelson Interferometer and can apply to determine wavelength, wavelength difference, Refractive Index and Visibility of Fringes. Also get a preliminary idea about Fabry-Perot interferometer.
		Students are able to know about

CO-4.9	**Diffraction**	Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula
CO-4.10	**Fraunhofer diffraction**	Students are familiar with new optical instruments and their resolving power like- • Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating.
CO-4.11	**Fresnel Diffraction**	Students are able to know about • Fresnel's assumptions for Fresnel's Half-Period Zones for Plane Wave. • Explanation of Rectilinear Propagation of Light. • Theory of a Zone Plate. • Fresnel diffraction pattern of a straight edge.
CO-4.12	**Holography**	Students can apply wave theory by knowing • Principle of holography. • Recording and Reconstruction Method of production. • Theory of Holography as Interference between two Plane Waves. • Point source holograms.
	LAB	Students can aware about the following experiment • investigate the motion of coupled oscillators, study Lissajous Figures • Familiarization with Schuster`s focusing and determine the angle of prism and R.I. of the material of the prism using sodium source • determine the dispersive power and Cauchy constants of the material of a prism using mercury source • determine wavelength of sodium light using Fresnel Bi prism and Newton's Rings • determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film • determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating • determine dispersive power and resolving power of a plane diffraction grating

COURSE OUTCOME

Class: B.Sc (SEM-III), **Course Code**: PHYH-C V, **Name of the Course**: Mathematical Physics-II

Indexing	Name of the topic	COURSE OUTCOME
CO-5.1	Fourier Series	Students are able to know about • the Fourier series representation of a function of one variable. • the solution of the wave, diffusion and Laplace equations using the Fourier series. • Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients • Summing of Infinite Series, Term-by-Term differentiation and integration of Fourier Series. Parseval Identity.
		Students can apply Frobenius Method by knowing • Singular Points of Second Order Linear Differential Equation and

CO-5.2	Frobenius Method and Special Functions	their importance • Applications of Frobenius method to differential equations • Legendre, Bessel,Hermite and Laguerre Differential Equations and Properties of Legendre Polynomials • Expansion of function in a series of Legendre Polynomials and Bessel Functions of the First Kind. • Generating Function, simple recurrence relations.
CO-5.3	Some Special Integrals	Students are able to know about • Beta and Gamma Functions and Relation between them • Expression of Integrals in terms of Gamma Functions • Error Function (Probability Integral).
CO-5.4	Theory of Errors	Students are familiar with • Systematic and Random Errors • Propagation of Errors. Normal Law of Errors • Standard and Probable Error. • Definition of Least-squares fit. Application Error on the slope and intercept of a fitted line.
CO-5.5	**Partial Differential Equations**	Students are able to understand • How to solve partial differential equations, using separation of variables • Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. • Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes • What is Diffusion Equation.
	LAB	*The aim of this Lab is to use the computational methods to solve physical problems* • Introduction to Scilab, Advantages anddisadvantages, Scilab environment, Commandwindow, Figure window, Edit window, Variables and arrays • Scalar and array operations, Hierarchy of operations • Introduction to Scilab functions • Scilab file processing, file opening and closing • Binary I/o functions,comparing binary and formatted functions, Numerical methods and developing the skills of writing a program(2) • Curve fitting, Least square fit, Goodness of fit, standard deviation • Ohms law to calculate R, Hooke's law to calculate spring constant • Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method • Generation of Special functions using User defined functions in Scilab • ODE Solution of • First order Differential equation Euler, modifiedEuler and Runge-Kutta second order methods • Second order differential equation Fixed difference method • Partial differential equations

COURSE OUTCOME

Class: B.Sc (SEM-III), **Course Code**: PHYH-C VI, **Name of the Course**: Thermal Physics

Indexing	Name of the topic	COURSE OUTCOME
CO -6.1	Zeroth and First Law of Thermodynamics	Thermodynamics and concept of temperature from Students learns about • Thermodynamics variables which are used to represent different thermodynamics. • system and boundaries. • The idea of thermodynamics system and thermodynamic equilibrium. • The Zeroth law of it. • first law of thermodynamics and its mathematical formulation of the quantitative aspect of the law. • conservation and transformation of energy and various forms of energy including heat transfer and work and formulation leads to internal energy. • isochoric , isobaric and adiabatic process . • general expression of heat capacities c_p and c_v of chemical system also for an ideal gases. • work done during isothermal and adiabatic process. • Volume expansion and isothermal compression.
CO- 6.2	Second Law of Thermodynamics	Students are learns about • reversible and irreversible process. • a complete conservation of heat into useful work cannot thus be made, although the converse is possible. • the concept of thermodynamic cycle and use cycle to compute efficiencies of heat engine, Carnot's engine and refrigerator. • Kelvin-Planck and Clausius statement of the second law. • . scale of temperature and perfect gas scale.
		Students able to understand that • what is entropy and the concept of entropy which follows directly from Clausius theorem? • the second law of thermodynamics in term of entropy. • Entropy increases in all natural process.

CO -6.3	Entropy	• For reversible transformation, the entropy remains unchanged. • Thermal efficiency from the temperature-entropy diagrams or heat diagram for Carnot's cycle. • The entropy of the universe can never decrease or the entropy of the entropy of the universe is on the increase. • The change of entropy of perfect gas in various process like that isothermal, isobaric, isochoric etc.
CO-6.4	Thermodynamic Potentials	Students can define • The thermodynamic potential, internal energy, enthalpy, Helmholtz free energy, Gibb's free energy and state their roles in determining equilibrium under different constraints. • manipulate(using suitable results from the theory of functions of many variables) a variety of thermodynamics derivatives, including a number of material properties such as heat capacity, thermal expansivity and compressibility, and solve problem in which such derivatives appear. • know about phase transition, first order phase transition characterized by Clapeyron equation and second order phase transition is characterized by Ehrenfest's equation. • sketch the phase diagram of the pure substance existing as an equilibrium mixture of its solid ,liquid, and vapour states from this phase diagram they define Triple point. • students know about the surface tension of a surface film, which become constant as $T \rightarrow 0$, by thermodynamic third law. • know about magnetic work and adiabatic demagnetization which is one of the most powerful methods of producing very low temperatures using a paramagnetic salt.
C.O-6.5	Maxwell's Thermodynamic Relations	Students are known about- • Maxwell's thermodynamics relations which are very much important in thermodynamics. • these relations are applied to deduce Clausius Clapeyron equation, developed the difference of heat capacities C_p & C_v and also use to derive the first, second and third TdS equations. • The internal energy of a real gas varies with volume and also with pressure, even if the temperature is kept constant, this is embodied in first and second energy equation. • Joule-Thomson coefficient for ideal and Vanderwaal gas and from this, heating effect and cooling effect of the gas can be discussed.

		• Inversion temperature and critical temperature and the relation between them.
C.O-6.6	Distribution of velocities	Student are able to understand that- • Maxwell's distribution law and most probable velocity of ideal gas. • the relation between mean, root mean square, and most probable velocity. • concept of temperature from kinetic theory of gas. • Laws of equipartition of energy, degrees of freedom. • they can calculate specific heats of different type of gases by using degrees of freedom.
C.O-6.7	Molecular Collisions	Students are known about- • what is mean free path and calculate mean free path from the concept of collision probability? • Survival equation • Transport of phenomenon in ideal gases and the quantity which transport are mass for diffusion, energy for thermal conductivity and momentum for viscosity. • Know about Brownian motion.
C.*O-6.8*	**Real Gases**	Students are understand about- • concept of ideal gas and the basic difference between real and ideal gas. • The virial form of gas equation. • concept of critical constants from Andrew's experiment on CO_2 gas. • Van der waal's equation of state and calculate critical constant from it • calculate Boyle's temperature and the relation between critical temperature and Boyle's temperature. • the state of laws of corresponding states.
	LAB	Students can perform the following experiment and clear about the theoretical concept • determine the Stefan's constant • determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus and thermal Conductivity of a bad conductor by Lee and Charlton's disc method • Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT) and determine the boiling point of a liquid • study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions • calibrate a thermocouple to measure temperature in a specified Range using (i)

		Null Method, (ii)Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature

COURSE OUTCOME

Class: B.Sc (SEM-III), **Course Code**: PHYH-C VII, **Name of the Course**: Digital Systems and Applications

Indexing	Name of the topic	COURSE OUTCOME
C.O- 7.1	Introduction to CRO	Students are known about – • Function of CRO and to study the wave form, measure voltage, current , frequency and phase difference.
C.O- 7.2	Integrated Circuits	Students are known about- • The idea of active , passive and discrete components. • About IC_S, and classification of IC_s. • Basic idea about SSI,MSI,LSI and VLSI. • Concept of linear and digital IC_s.
C.O- 7.3	Digital Circuits	Students are known about- • Concept of analog and digital circuits. • Truth table and logic equation of AND, OR , NOT GATE and realization using diode and transistor. • NAND GATE ,NOR GATE , EX-NOR ,EX-OR and its application . • Concept of decimal ,binary ,octal and hexadecimal number and there conversion .
C.O- 7.4	Boolean algebra:	• Boolean algebra and its laws • De Morgan's Theorems and simplification of logic circuit using this theorem and Boolean algebra • Idea of min terms and max terms • Can convert a truth table into logic circuit by using sum of product method and Karnaugh map
C.O- 7.5	Data processing circuits	Students are known about- • Idea of multiplexers ,de-multiplexres ,decoder and endocoders
C.O- 7.6	Arithmetic Circuits	Students can understand- • How to solve addition using 2's compliment method • Basic idea of half and full adder ,half and full subtractors and four bit binary adder
C.O- 7.7	Sequential Circuits	Students are known about- • Idea of SR ,D,JK FLIP –FLOPS and their function ,block diagram ,logic equation and truth table • Clocked flip-flops of level and edge triggered with preset and clear operations • Race around conditions in JK FLIP FLOP • Why JK FLIP FLOP called master slave FILP FLOP

C.O- 7.8	Timers	Students are known about • Block diagram and applications of IC 555 timer • Working principle of astable and mono stable multivibrator
C.O- 7.9	Shift registers	. Students are known about- • Idea of register , • four bit serial in –serial –out ,serial –in –parallel –out ,parallel –in-serial –out ,parallel –in –parallel –out of shift registers
C.O- 7.10	Counters	Students are known about- • idea of counter, its application and classification. • Ring counter, Asynchronous counters, Decade counter, synchronous counters. • Using flip-flop these counter can represent
C.O- 7.11	Computer Organization	Students are known about- • Idea of computer organization such as- input, output device, computer memory. • Idea of RAM, ROM. Memory organization and addressing memory interfacing and memory map.
C.O- 7.12	Intel 8085 Microprocessor Architecture	Students are known about- • Idea about main features of 8085 processor and its block diagram , components, Pin-out diagram • Buses, registers, ALU memory, stack memory • Timing and control circuitry • Timing diagram of MOV and MVI
C.O- 7.13	Introduction to Assembly Language	Students are able known about- • Idea of assembly language of 1,2 and 3byte instructions
	LAB	Students can perform the following experiment • by using CRO they can measure (a) Voltage, and (b) Time period of a periodic waveform • test a Diode and Transistor using a Multimeter • design a switch (NOT gate) using a transistor • verify and design AND, OR, NOT and XOR gates using NAND gates • design a combinational logic system for a specified Truth Table • convert a Boolean expression into logic circuit and design it using logic gate ICs • Half Adder, Full Adder and 4-bit binary Adder, Adder-Subtractor using Full Adder I.C • To build JK Master-slave flip-flop using Flip-Flop ICs • To design an astable and monostablemultivibrator of given specifications using 555 Timer • using 8085 Microprocessor to write the following programme-Addition and subtraction of numbers using direct and indirect addressing mode, Multiplication and by repeated addition and division by repeated subtraction.

COURSE OUTCOME

Class: B.Sc (SEM-IV), **Course Code**: PHYH-C VIII, **Name of the Course**: Mathematical Physics- III

Indexing	Name of the topic	COURSE OUTCOME
C.O-8.1	Complex Analysis	On satisfying the requirement of this course, students will have the knowledge of– • Fundamental concept of complex analysis ,graphical representation • Euler,s formula, De Moivre's theorem, Roots of Complex Numbers • Anaiyticity and Cauchy-Riemann Conditions. Examples of this function. • Integration of a function of a complex variable. • What is Cauchy's inequality? Cauchy's Integral formula • Simply and multiply connected region • Expansion of Laurent and Taylor's • Theorem of Residue. • Application in solving Definite Integrals
C.O.-8.2	Integrals Transforms	Students will be able to understand – • What is Fourier Transforms and what is Fourier Integral theorem. • Fourier transform of trigonometric, Gaussian, finite & other functions • Dirac delta function as a Fourier Integral. • Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. • About Properties of Fourier transforms . • Three dimensional Fourier transforms with examples , such as one dimensional Wave and Diffusion/Heat Flow Equations.
C.O.-8.3	Laplace Transforms	Students will be able to gain the knowledge of– • Laplace Transform of Elementary functions and its properties • What is change of Scale Theorem, Shifting Theorem. • LTs of 1st and 2nd order Derivatives and Integrals of Functions. • LTs of Dirac Delta function, Periodic Functions. • Inverse Laplace Transform . • Application of Laplace Transforms to 2nd order Differential Equations in many physical problems
	LAB	Scilab/C++ based simulations experiments based on Mathematical Physics problems

COURSE OUTCOME

Class: B.Sc (SEM-IV), **Course Code**: PHYH-C IX, **Name of the Course**: Elements of Modern Physics

Indexing	Name of the topic	COURSE OUTCOME
C.O- 9.1	Origin of quantum theory	Students are able known about- • Planck's constant and light as a collection of photons. • Blackbody Radiation • Photo-electric effect and Compton scattering. • De Broglie wavelength and matter waves.

		• Davisson-Germer experiment. • particles by wave packets. • Group and Phase velocities • Two-Slit experiment with electrons. Wave amplitude and wavefunctions.
C.O- 9.2	Foundamental of quantum theory	Students are familiar with • gamma ray microscope thought experiment • Wave-particle duality • Heisenberg uncertainty principle • WavePackets impossibility of a particle • Energy-time uncertainty principle
C.O- 9.3	Matter waves	Students are able known about- • Two slit interference experiment with photons, atoms and particles • linear superposition principle • Matter waves and wave amplitude • Schrodinger equation for non-relativistic particles • Momentum and Energy operators • stationary states • physical interpretation of a wave function • probabilities and normalization • Probability and probability current densities
C.O- 9.4	Application of Quantum Mechanics	Students are able to solve- • energy eigenvalues and eigenfunctions, normalization of one dimensional infinitely rigid box • Quantum dot as example • Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier.
C.O- 9.5	Nuclear Physics basics	Students are able known about- • Size and structure of atomic nucleus and its relation • Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle • Nature of nuclear force • Liquid Drop model: semi-empirical mass formula and binding energy Nuclear Shell Model and magic numbers.
C.O- 9.6	Radioactivity	Students are able known about- • stability of the nucleus • Law of radioactive decay • Mean life and half-life • Alpha decay, Beta decay, Gamma ray emission • spectrum and Pauli's prediction of neutrino ,energy momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus
C.O- 9.7	Nuclear Fission and fusion	Students are able known about- • mass deficit • Fission - nature of fragments and emission of neutrons. • Nuclear reactor • Fusion and thermonuclear reactions driving stellar energy
		Students are able to understand about-

C.O- 9.8	Lasers Physics	• 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
	LAB	• Measurement of Planck's constant using black body radiation and photo-detector • Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light • determine work function of material of filament of directly heated vacuum diode • determine the Planck's constant using LEDs of at least 4 different colours • determine the wavelength of H-alpha emission line of Hydrogen atom. • determine the excitation potential of mercury/Argon by Franck-Hertz experiment. • determine the absorption lines in the rotational spectrum of Iodine vapour. • determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet. • setup the Millikan oil drop apparatus and determine the charge of an electron. • To show the tunneling effect in tunnel diode using I-V characteristics. • To determine the wavelength of laser source using diffraction of single slit. • To determine (i) wavelength and (ii) angular spread of He-Ne laser using plane diffraction grating

COURSE OUTCOME

Class: B.Sc (SEM-IV), **Course Code**: PHYH-C X, **Name of the Course**: Analog Systems and Applications

Indexing	Name of the topic	COURSE OUTCOME
CO-10.1	Semiconductor Diodes	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. Current Flow Mechanism in Forward and Reverse Biased Diode.
CO-10.2	Two-terminal Devices and their Applications	(1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell.
CO-10.3	Bipolar Junction transistors	n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.

CO-10.4	Amplifiers	Transistor Biasing and Stabilization Circuits. Fixed Bias and 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. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers.
CO-10.5	Coupled Amplifier	Two stage RC-coupled amplifier and its frequency response.
CO-10.6	Feedback in Amplifiers:	Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.
CO-10.7	Sinusoidal Oscillators	Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.
CO-10.8	Operational Amplifiers (Black Box approach)	Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground.
CO-10.9	Applications of Op-Amps	(1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator.
CO-10.10	Conversion	Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation)
	LAB	• To study V-I characteristics of PN junction diode, and Light emitting diode. • To study the V-I characteristics of a Zener diode and its use as voltage regulator. • Study of V-I & power curves of solar cells, and find maximum power point & efficiency. • To study the characteristics of a Bipolar Junction Transistor in CE configuration. • To study the various biasing configurations of BJT for normal class A operation. • To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias. • To study the frequency response of voltage gain of a RC-coupled transistor amplifier. • Wien bridge oscillator for given frequency using an op-amp. • design a digital to analog converter (DAC) of given specifications and analog to digital convertor (ADC) IC • design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain • design inverting an non inverting amplifier using Op-amp (741,351) and study its frequency response

		• To add two dc voltages using Op-amp in inverting and non-inverting mode • To design a precision Differential amplifier of given I/O specification using Op-amp • To investigate the use of an op-amp as an Integrator and a differentiator.

COURSE OUTCOME

Class: B.Sc (SEM-V), **Course Code**: PHYH-C XI, **Name of the Course**: Quantum Mechanics and applications

Indexing	Name of the topic	COURSE OUTCOME
C.O- 11.1	Time dependent Schrodinger equation	Students are able known about- •Time dependent Schrodinger equation and dynamical evolution of a quantum state. •Properties of Wave Function Students are able known about- •Probability and probability current densities • Conditions for Physical Acceptability of Wave Functions • Normalization • Linearity and Superposition Principles • Eigenvalues and Eigenfunctions • Position, momentum and Energy operators •commutator of position and momentum operators • Expectation values of position and momentum • Wave Function of a Free Particle
C.O- 11.2	General discussion of bound states in an arbitrary potential	Students are able known about- • Hamiltonian, stationary states and energy eigenvalues • expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions • General solution of the time dependent Schrodinger equation • Application to spread of Gaussian wave-packet for a free particle • wave packets • Fourier transforms • Position-momentum uncertainty principle
C.O- 11.3	Quantum theory of hydrogen-like atoms	Students are able known about- • continuity of wave function • boundary condition and emergence of discrete energy levels • square well potential and its solution • Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method • Hermite polynomials • zero point energy & uncertainty principle
		Students are able known about- • time independent Schrodinger equation in spherical polar Coordinates • separation of variables for second order partial differential equation

C.O- 11.4	Atoms in Electric & Magnetic Fields	• angular momentum operator & quantum numbers • Radial wavefunctions from Frobenius method • shapes of the probability densities for ground & first excited states • Orbital angular momentum quantum numbers l and m; s, p, d,..shells
C.O- 11.5	Zeeman Effect	Students are able known about- • Electron angular momentum • Space quantization • Electron Spin and Spin Angular Momentum • Larmor's Theorem • Spin Magnetic Moment • Stern-Gerlach Experiment • Zeeman Effect (Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.)
C.O- 11.6	Atoms in External Magnetic Fields	Students are able known about- • Normal and Anomalous Zeeman Effect • Paschen Back and Stark Effect
C.O- 11.7	Many electron atoms	Students are able to understand about- • Pauli's Exclusion Principle. • Symmetric & Antisymmetric Wave Functions • Fine structure and Spin orbit coupling. • Spectral Notations for Atomic States • Total angular momentum. • Vector Model(Spin-orbit coupling in atoms- L-S and J-J couplings) • Hund's Rule • Term symbols • Spectra of Hydrogen and Alkali Atoms
	LAB	Use C/C++/Scilab for solving the following problems based on Quantum Mechanics

COURSE OUTCOME

Class: B.Sc (SEM-V), Course Code: PHYH-C XII, Name of the Course: Solid State Physics

Indexing	Name of the topic	COURSE OUTCOME
CO-12.1	Crystal Structure: Solids	Students are able to know about • Amorphous and crystalline materials • Lattice, basis, unit cell and crystal structure • Miller indices, reciprocal lattice na Brillouin zone • X-ray diffraction, Braggs law • Atomic and geometrical structure factor
CO-12.2	Elementary Lattice Dynamics	Students are familier with the following • lattice vibration and phonons • linear mono atomic and diatomic chains • acoustical and Optical Phonons • description of the Phonon Spectrum in Solids • Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids.

		T^3law
CO-12.3	Magnetic Properties of Matter	Students are able to know about • Dia-, Para-, Ferri- and Ferromagnetic Materials • Classical Langevin theory of Dia and Para magnetic domain • Quantum Mechanical Treatment of Paramagnetism • Curie'slaw, • Weiss's Theory of Ferromagnetism and Ferromagnetic Domains.. • Hysteresis and Energy Loss.
CO-12.4	Dielectric Properties of Materials	Students are enriched with the followings • Local Electric Field at an Atom • Electric Susceptibility. Polarizability • Clausius Mosotti Equation • Theory of electric polarization • Normal and Anomalous Dispersion • Normal and Anomalous Dispersion • Langevin-Debye equation • Plasma oscillation, plasma frequency, plasmons and TO modes.
CO-12.5	Ferroelectric Properties of Materials	Students are know about • Ferroelectric Properties of Materials: Structural phase transition • Piezoelectric effect • Pyroelectric effect • Ferroelectric effect • Electrostrictive effect • Curie-Weiss Law • Ferroelectric domains • PE hysteresis loop
CO-12.6	Elementary band theory	Students are able to know about band theory • Kronig Penny model • Band Gap. • Conductor, Semiconductor (P and N type) and insulator. • Conductivity of Semiconductor, mobility, • Hall Effect. Measurement of conductivity (04 probe • method) & Hall coefficient.
CO-12.7	Superconductivity: Experimental Results	Familiar with the followings • Experimental results of Superconductivity • Critical Temperature • Critical magnetic field • Meissner effect • Type I and type II Superconductors • London's Equation and Penetration Depth • Isotope effect • Idea of BCS theory

	LAB	The following experiment can perform by the students • Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method) • Magnetic susceptibility of Solids (Guoy method). • determine the Coupling Coefficient of a Piezoelectric crystal • measure the Dielectric Constant of a dielectric Materials with frequency • To determine the band gap using a thermistor • determine the refractive index of a dielectric layer using SPR • study the PE Hysteresis loop of a Ferroelectric Crystal • draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis • To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 oC) and to determine its band gap. • determine the Hall coefficient of a semiconductor sample

COURSE OUTCOME

Class: B.Sc (SEM-VI), **Course Code**: PHYH-C XIII, **Name of the Course**: Electromagnetic Theory

Indexing	Name of the topic	COURSE OUTCOME
C.O -13.1	Maxwell Equations	Students can understand about the following • Maxwell's equations • Displacement Current, 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
C.O- 13.2	EM Wave Propagation in Unbounded Media	Students are able to know about • 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, wave impedance. • Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.
C.O- 13.3	EM Wave in Bounded Media	Students can understand about • 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 • Brewster's law • Reflection & Transmission coefficients. • Total internal reflection, evanescent waves. Metallic reflection (normal Incidence)

C.O.-13.4	Polarization of Electromagnetic Waves	Students are able to know about • Description of Linear, Circular and Elliptical Polarization.Propagation of E.M. Waves in Anisotropic Media • Symmetric Nature of Dielectric Tensor. Fresnel's Formula • Uniaxial and Biaxial Crystals, light Propagation in Uniaxial Crystal • Double Refraction, Polarization by Double Refraction, Nicol Prism • Ordinary & extraordinary refractive indices • Production & detection of Plane Circularly and Elliptically Polarized Light • Phase Retardation Plates: Quarter-Wave and Half-Wave Plates • Babinet Compensator and its Uses • Analysis of Polarized Light
C.O-13.5	Rotatory Polarization	Students can understand about • Optical Rotation • Biot's Laws for Rotatory Polarization • Fresnel's Theory of optical rotation, Calculation of angle of rotation • Experimental verification of Fresnel's theory, Specific rotation, Laurent's half-shade polarimeter
C.O-13.6	Wave Guides	Students are able to know about • Planar optical wave guides, Planar dielectric wave guide • Condition of continuity at interface • Phase shift on total reflection • Eigenvalue equations • Phase and group velocity of guided waves • Field energy and Power transmission
C.O- 13.7	Optical Fibres	Students can understand about the following • Numerical Aperture • Step and Graded Indices • Single and Multiple Mode Fibres
	LAB	Students can perform the following experiments • verify the law of Malus for plane polarized light • determine the specific rotation of sugar solution using Polarimeter • analyze elliptically polarized Light by using a Babinet's compensator • To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating • To study the reflection, refraction of microwaves • determine the refractive index of liquid by total internal reflection using Wollaston's air-film • determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece • study the polarization of light by reflection and determine the polarizing angle for air-glass interface. • verify the Stefan`s law of radiation and to determine Stefan's constant. • determine the Boltzmann constant using V-I characteristics of PN junction diode

COURSE OUTCOME

Class: B.Sc (SEM-VI), **Course Code**: PHYH C XIV, **Name of the Course**: Statistical Mechanics

Indexing	Name of the topic	COURSE OUTCOME
C.O.-14.1	Classical Statistics	On completion of this course a student should be able to – • Understand the elementary concepts of Macrostate & Microstate, Ensemble, Phase Space, Entropy . • Idea of Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas. • Expression of Classical Entropy, Gibbs Paradox, Sackur Tetrode equation. • Idea about Law of Equipartition of Energy • Thermodynamic Functions of a Two-Energy Levels System. • Idea of negative Temperature.
C.O.-14.2	Classical Theory of Radiation	Students are able to understand - • Properties of Thermal Radiation ,Blackbody Radiation. • Pure temperature dependence. • Kirchhoff's law, Stefan-Boltzmann law and its Thermodynamic proof. • Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. • Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe.
C.O.-14.3	Quantum Theory of Radiation	Students will be able to understand - • Spectral Distribution of Black Body Radiation. • Planck's Quantum Postulates and Blackbody Radiation . • Experimental Verification of (i) Wien's Distribution Law, (ii) Rayleigh-Jeans Law, (iii) Stefan-Boltzmann Law, (iv) Wien's Displacement law from Planck's law.
C.O.-14.4	Bose-Einstein Statistics	Students will be able to understand - • B-E distribution law, Bose Gas. • Idea of Bose Einstein condensation. • Radiation as a photon gas and Thermodynamic functions of photon gas. • Bose derivation of Planck's law.
C.O.-14.5	Fermi-Dirac Statistics	Students will be able to understand - • Fermi-Dirac Distribution Law • Thermodynamic functions of Fermi Gas, Fermi Energy. • Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas. • White Dwarf Stars. • Idea about Chandrasekhar Mass Limit
	LAB	Use C/C++/Scilab/other numerical simulations for solving the problems based on Statistical Mechanics

COURSE OUTCOME

Class: B.Sc (SEM-III), **Course Code**: PHYH SEC- I, **Name of the Course**: Renewable energy and energy hravesting

Indexing	Name of the topic	COURSE OUTCOME
SEC-1.1	Fossil fuels and Alternate Sources of energy	Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity
SEC-1.2	Solar energy	Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.
SEC-1.3	Wind Energy harvesting	Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.
SEC-1.4	Ocean Energy	Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.
SEC-1.5	Tide characteristics and Statistics	Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.
SEC-1.6	Geothermal Energy:	Geothermal Resources, Geothermal Technologies.
SEC-1.7	Hydro Energy	Hydropower resources, hydropower technologies, environmental impact of hydro powersources.

SEC-1.8	PiezoelectricEnergy harvesting	Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power
SEC-1.9	Electromagnetic Energy Harvesting	Linear generators, physics mathematical models, recent applications
SEC-1.10	Carboncaptured technologies	cell, batteries, power consumption
SEC-1.11	Contemporary issues	Environmental issues and Renewable sources of energy, sustainability.
	Demonstration and Experiments	• Solar and wind energy • Using of piezoelectric materials • Using of thermo electric energy

COURSE OUTCOME

Class: B.Sc. (Sem-IV), **Course Code:** PHYH-SEC-2, **Name of the Course:** Electrical Circuits and Network Skills.

Indexing	Name of the topic	COURSE OUTCOME
SEC-2.1	Electricity Principles and Circuits.	Students are able to know about • Ohm's Law, Series , Parallel combination. • DC, AC circuits, Power Factors.
SEC-2.2	Electrical Drawing	Students are able to know about • Drawing symbols, Schematics, Ladder Diagrams. • Control Circuits, Power Circuits.
SEC-2.3	Generators and Motors	Students are able to know about • AC/DC Generators. • Inductance, Cpacitance,

		Impedence, Transformers. • Single phase, Three phase, DC motors.
SEC-2.4	Solid state Devices	Students are able to know about • Resistors, Capacitors, Inductors, Diodes and Rectifiers.
SEC-2.5	Electrical Protection	Students are able to know about • Relays, Fuses, Circuit breakers, Grounding, Surge protections.
SEC-2.6	Electric Wiring	Students are able to know about • Different types of conductors and cables. • Star and delta connections. • Voltage drop and losses. • Solid and stranded cables etc.

COURSE OUTCOME

Class: B.Sc (SEM-IV), **Course Code**: PHYH SEC- 2, **Name of the Course**: Computational Physics skill

Indexing	Name of the topic	COURSE OUTCOME
SEC-2.1	**Introduction**	• Importance of computers in Physics, paradigm for solving physics problems for solution. • Usess of linux as an Editor. Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates • Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal
SEC-2.2	**Scientific Programming**	• Some fundamental Linux Commands (Internal and External commands) • Development of FORTRAN, Basic elements of FORTRAN • Character Set, Constants and their types,Variables and their types, Keywords, Variable Declaration and concept of instruction and program. • Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, • Relational, Logical, Character and Assignment Expressions. Fortran

		Statements: I/O Statements(unformatted/formatted), Executable and Non-Executable Statements, • Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic
SEC-2.3	**Control Statements**	• Types of Logic (Sequential, Selection, Repetition) • Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements) • Looping Statements (DO-CONTINUE, DO-ENDDO, DO- WHILE, Implied and Nested DO Loops) • Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) • Subscripted Variables (Arrays:Types of Arrays DIMENSION Statement, Reading and Writing Arrays) Functions and Subroutines • (Arithmetic Statement Function, Function Subprogram and Subroutine) • RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.
SEC-2.4	**Programming**	• Exercises on syntax on usage of FORTRAN • Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editorto write sources codes in FORTRAN. • To print out all natural even/ odd numbers between given limits. • To find maximum, minimum and range of a given set of numbers. • Calculating Euler number using exp(x) series evaluated at x=1
SEC-2.5	**Scientific word processing**	• Introduction to LaTeX • preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style,Symbols from other languages. • Equation representation: Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment • Generating table of contents,bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors.
SEC-2.6	**Visualization**	• Introduction to graphical analysis and its limitations. • Introduction to Gnuplot. • Importance of visualization of computational and computational data,basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file • physics with Gnuplot (equations,building functions, user defined variables and functions), Understanding data with Gnuplot
		various physics problems like, • To compile a frequency distribution and evaluate mean, standard deviation etc. • To evaluate sum of finite series and the area under a curve. • To find the product of two matrices • To find a set of prime numbers and Fibonacci series. • To write program to open a file and generate data for plotting using

	Exercises	Gnuplot. • Plotting trajectory of a projectile projected horizontally. • Plotting trajectory of a projectile projected making an angle with the horizontally. • Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Savingit as an eps file and as a pdf file. • To find the roots of a quadratic equation. • Motion of a projectile using simulation and plot the output for visualization. • Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs forvisualization. • Motion of particle in a central force field and plot the output

COURSE OUTCOME

Class: B.Sc (SEM-V), Course Code: PHYH DSE-1, **Name of the Course**: Advanced Mathematical Physics

Indexing	Name of the topic	COURSE OUTCOME
DSE -1.1	**Linear Vector Spaces**	Students are able to know about • Abstract Systems. Binary Operations and Relations • Introduction to Groups and Fields. Vector Spaces and Subspaces. Linear Independence and Dependence of Vectors. Basis and Dimensions of a Vector Space. Change of basis. • Homomorphism and Isomorphism of Vector Spaces. Linear Transformations. Algebra of Linear Transformations. • Non-singular Transformations.Representation of Linear Transformations by Matrices.
DSE -1.2	**Matrices**	Students are able to know about • Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar and Unit Matrices. Upper-Triangular and Lower-Triangular 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. Inner Product.
DSE -1.3	**Eigen-values and Eigenvectors**	Students are able to know about • Cayley- Hamiliton Theorem • Diagonalization of Matrices • Solutions of Coupled Linear Ordinary Differential Equations. Functions of a Matrix.
DSE -1.4	**Cartesian Tensors**	Students are able to know about • Transformation of Co-ordinates. Einstein's Summation Convention. Relation between Direction Cosines. • Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors.Contraction. Quotient Law of Tensors. Symmetric and Anti- symmetric

		Tensors. • Invariant Tensors :Kronecker and Alternating Tensors. Association of Antisymmetric Tensor of Order Two and Vectors.
DSE -1.5	**Vector Algebra and Calculus using Cartesian Tensors :**	Students are able to know about • Scalar and Vector Products, Scalar and Vector Triple Products. Differentiation. Gradient, Divergence and Curl of Tensor Fields. • Vector Identities
DSE -1.6	**Tensorial Formulation of Analytical Solid Geometry**	Students are able to know about • Equation of a Line. Angle Between Lines. Projection of a Line on another Line. Condition for Two Lines to be Coplanar. Foot of the Perpendicular from a Point on a Line. • Rotation Tensor (No Derivation). Isotropic Tensors. Tensorial Character of Physical Quantities. Moment of Inertia Tensor. • Stress and Strain Tensors : Symmetric Nature. Elasticity Tensor. Generalized Hooke's Law.
DSE -1.7	**General Tensors**	Students are able to know about • Transformation of Co-ordinates. Minkowski Space. Contravariant & Covariant Vectors. Contravariant, Covariant and Mixed Tensors. • Kronecker Delta and Permutation Tensors. Algebra of Tensors. Sum, Difference & Product of Two Tensors. • Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Metric Tensor.

COURSE OUTCOME

Class: B.Sc (SEM-V), Course Code: PHYH DSE-2, **Name of the Course**: Classical Dynamics

Indexing	Name of the topic	COURSE OUTCOME
DSE -2.1	Classical Mechanics of Point Particles	Students are able to know about • Recapitulation of Newtonian Mechanics • Application to the motion of a charge particle in external electric and magnetic fields. • Generalized coordinates and velocities, Hamilton's principle, Lagrangian and the Euler-Lagrange equations, one-dimensional examples of the Euler-Lagrange equations- one-dimensional Simple Harmonic Oscillations and falling body in uniform gravity • Hamilton's equations of motion.
DSE -2.2	Small Amplitude Oscillations	Students are able to know about • Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum. • Normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs.

DSE -2.3	Special Theory of Relativity	Students are able to know about • Postulates of Special Theory of Relativity • Lorentz Transformations. • Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction and twin paradox • Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a four-vector perspective. Concept of four-force. • Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle.
DSE -2.4	Fluid Dynamics	Students are able to know about • Density ρ and pressure P in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow. • Poiseuille's equation for flow of a liquid through a pipe, Navier-Stokes equation, qualitative description of turbulence, Reynolds number.

COURSE OUTCOME

Class: B.Sc (SEM-V), Course Code: PHYH DSE- 3, **Name of the Course**: Nuclear and Particle Physics

Indexing	Name of the topic	COURSE OUTCOME
DSE -3.1	**General Properties of Nuclei**	Students are able to know about • Constituents of nucleus and their Intrinsic properties • Quantitive facts about mass, radii, charge density (matter density), binding energy, average binding energy • variation of mass numberwith binding energy • main features of binding energy versus mass number curve, N/A plot • angular momentum • parity • magnetic moment and electric moments and • nuclear excites states
DSE -3.2	**Nuclear Models**	This section gives a broad idea about • Approach of Liquid drop model • Semi empirical mass formula and significance of is various terms • condition of nuclear stability • Fermi gas moel • evidence for nuclear shell structure • nuclear magic number • assumption of shell model • concept of mean field • concept of nuclear force
		Students can able to know about

DSE -3.3	**Radioactivity decay**	• basics of α-decay processes, theory of α- emission, Gamow factor,Geiger Nuttall law, α-decay spectroscopy • β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis • Gamma decay: Gamma rays emission & kinematics, internal conversion
DSE -3.4	**Nuclear Reactions**	Students can able to know about • Types of nuclear Reactions • Laws of Conservation for nuclear reaction • kinematics of reactions, Q-value, reaction rate, reaction cross section • Concept of compound and direct Reaction • resonance reaction, Coulomb scattering (Rutherford scattering)
DSE -3.5	**Interaction of Nuclear Radiation with matter**	Students are familiar with the followings • Energy loss due to ionization (Bethe- Block formula) energy loss of electrons • Cerenkov radiation • Interaction of Gamma ray through matter • photoelectric effect • Compton scattering • pair production • interaction of neutron with matter.
DSE -3.6	**Detector for Nuclear Radiations**	Students can able to know about • Gas detectors • estimation of electric field, mobility of particle, for ionization chamber and GM Counter • Basic principle of Scintillation Detectors and construction of photomultiplietube (PMT) • Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility) • neutron detector.
DSE -3.7	**Particle Accelerators**	They can know about • Accelerator facility available in India • Van-de Graaff generator (Tandem accelerator) • Linear accelerator • Cyclotron • Synchrotrons.
DSE -3.8	**Particle physics**	Students can able to know about • basic features of Particle interactions, types of particles and its families • 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

COURSE OUTCOME

Class: B.Sc. (Sem-VI), **Course Code:** PHYH-DSE-4, **Name of the Course:** Astronomy and Astrophysics

Indexing	Name of the topic	COURSE OUTCOME

DSE-4.1	Astronomical Scales	Students are able to know about • Astronomical Distances, Times, Scales, Coordinate systems. • Brightness, Luminocity, Magnitudes, H-R Diagrams. • Parallax method.
DSE-4.2	Astronomical Techniques	Students are able to know about • Optical Telescopes, Resolving Power and Magnifications. • Gravitation in Astrophysics. • Thermodynamic Equilibrium.
DSE-4.3	The Sun	Students are able to know about • Solar Family. • Solar structures, its origin. • Stellar Spectra.
DSE-4.4	The Milky Way	Students are able to know about • Properties of Milky Way. • Rotation of Milky Way. • Star Clusters of Milky Way.
DSE-4.5	Galaxies	Students are able to know about • Different types of galaxy. • Hubble’s Classification.
DSE-4.6	Large scale structures and expanding universe	Students are able to know about • Cosmic Distance Ladder. • Hubble’s Law. • Cluster of galaxies.