B.Sc (H) PHYSICS

COURSE OUTCOMES

CORE COURSES

Core Course-I: Mathematical Physics-I

CO-1	Draw and interpret graphs of various functions
CO-2	Solve first and second order differential equations and apply these to physics problems
CO-3	Understand the concept of gradient of scalar field and divergence and curl of vector fields
CO-4	Perform line, surface and volume integration and apply Green's, Stokes' and Gauss's Theorems to compute these integrals
CO-5	Apply curvilinear coordinates to problems with spherical and cylindrical symmetries
CO-6	Understand elementary probability theory and the properties of discrete and continuous distribution functions
CO-7	In the laboratory course, the students will be able to design, code and test simple programs in C++ in the process of solving various problems

Core Course-II: Mechanics

CO-1	Understand laws of motion and their application to various dynamical situations
CO-2	Learn the concept of inertial reference frames and Galilean transformations. Also, the concept of conservation of energy, momentum, angular momentum and apply them to basic problems.
CO-3	Understand translational and rotational dynamics of a system of particles
CO-4	Apply Kepler's laws to describe the motion of planets and satellite in circular orbit
CO-5	Understand concept of Geosynchronous orbits
CO-6	Explain the phenomenon of simple harmonic motion
CO-7	Understand special theory of relativity - special relativistic effects and their effects on the mass and energy of a moving object
CO-8	In the laboratory course, the student shall perform experiments related to mechanics: compound pendulum, rotational dynamics (Flywheel), elastic properties (Young Modulus and Modulus of Rigidity), fluid dynamics, estimation of random errors in the observations etc.

Core Course-III: Electricity and Magnetism

CO-1	Demonstrate the application of Coulomb's law for the electric field, and also apply it to systems of point charges as well as line, surface, and volume distributions of charges

CO-2	Demonstrate an understanding of the relation between electric field and potential, exploit the potential to solve a variety of problems, and relate it to the potential energy of a charge distribution
CO-3	Apply Gauss's law of electrostatics to solve a variety of problems
CO-4	Calculate the magnetic forces that act on moving charges and the magnetic fields due to currents (Biot- Savart and Ampere laws)
CO-5	Understand the concepts of induction and self-induction, to solve problems using Faraday's and Lenz's laws
CO-6	Understand the basics of electrical circuits and analyze circuits using Network Theorems
CO-7	In the laboratory course the student will get an opportunity to verify network theorems and study different circuits such as RC circuit, LCR circuit. Also, different methods to measure low and high resistance, capacitance, self-inductance, mutual inductance, strength of a magnetic field and its variation in space will be learnt

Core Course-IV: Waves and Optics

CO-1	Understand Simple harmonic oscillation and superposition principle
CO-2	Understand different types of waves and their velocities: Plane, Spherical, Transverse, Longitudinal
CO-3	Understand Concept of normal modes in transverse and longitudinal waves: their frequencies and configurations
CO-4	Understand Interference as superposition of waves from coherent sources derived from same parent source
CO-5	Demonstrate basic concepts of Diffraction: Superposition of wavelets diffracted from aperture, understand Fraunhofer and Fresnel Diffraction
CO-6	In the laboratory course, student will gain hands-on experience of using various optical instruments and making finer measurements of wavelength of light using Newton Rings experiment, Fresnel Biprism etc. Resolving power of optical equipment can be learnt first-hand. The motion of coupled oscillators, study of Lissajous figures and behaviour of transverse, longitudinal waves can be learnt in this laboratory course

Core Course-V: Mathematical Physics-II

CO-1	Represent a periodic function by a sum of harmonics using Fourier series and their applications in physical problems such as vibrating strings etc
CO-2	Obtain power series solution of differential equation of second order with variable coefficient using Frobenius method
CO-3	Understand properties and applications of special functions like Legendre polynomials, Bessel functions and their differential equations and apply these to various physical problems such as in quantum mechanics
CO-4	Learn about gamma and beta functions and their applications
CO-5	Solve linear partial differential equations of second order with separation of variable method

CO-6	In the laboratory course, the students will learn the basics of the Scilab software/Python interpreter and apply appropriate numerical method to solve selected physics problems both using user defined and inbuilt functions from Scilab/Python. They will also learn to generate and plot Legendre polynomials and Bessel functions and verify their recurrence relation

Core Course-VI: Thermal Physics

CO-1	Comprehend the basic concepts of thermodynamics, the first and the second law of thermodynamics
CO-2	Understand the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations
CO-3	Know about reversible and Irreversible processes
CO-4	Learn about Maxwell's relations and use them for solving many problems in Thermodynamics
CO-5	Understand the concept and behaviour of ideal and real gases
CO-6	Learn the basic aspects of kinetic theory of gases, Maxwell-Boltzmann distribution law, equitation of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion and Brownian motion
CO-7	In the laboratory course, the students are expected to do some basic experiments in thermal Physics, viz., determination of Mechanical Equivalent of Heat (J), coefficient of thermal conductivity of good and bad conductor, temperature coefficient of resistance, variation of thermo-emf of a thermocouple with temperature difference at its two junctions and calibration of a thermocouple

Core Course-VII: Digital Systems and Applications

CO-1	Course learning begins with the basic understanding of active and passive components. It then builds the concept of Integrated Chips (IC): its classification and uses
CO-2	Differentiating the Analog and Digital circuits, the concepts of number systems like Binary,BCD, Octal and hexadecimal are developed to elaborate and focus on the digital systems
CO-3	Sequential Circuits: Basic memory elements Flips-Flops, shift registers and 4-bits counters leading to the concept of RAM, ROM and memory organization
CO-4	Timer circuits using IC 555 providing clock pulses to sequential circuits and develop multivibrators
CO-5	Introduces to basic architecture of processing in an Intel 8085 microprocessor and to Assembly Language
CO-6	Also impart understanding of working of CRO and its usage in measurements of voltage, current, frequency and phase measurement

CO-7	In the laboratory students will learn to construct both combinational and sequential circuits by employing NAND as building blocks and demonstrate Adders, Subtractors, Shift Registers, and multivibrators using 555 ICs. They are also expected to use μP 8085 to demonstrate the same simple programme using assembly language and execute the programme using a μP kit

Core Course-VIII: Mathematical Physics-III

CO-1	Determine continuity, differentiability and analyticity of a complex function, find the derivative of a function and understand the properties of elementary complex functions
CO-2	Work with multi-valued functions (logarithmic, complex power, inverse trigonometric function) and determine branches of these functions
CO-3	Evaluate a contour integral using parametrization, fundamental theorem of calculus and Cauchy's integral formula. Find the Taylor series of a function and determine its radius of convergence
CO-4	Determine the Laurent series expansion of a function in different regions, find the residues and use the residue theory to evaluate a contour integral and real integral
CO-5	Understand the properties of Fourier and Laplace transforms and use these to solve boundary value problems.
CO-6	Understand the properties of Fourier and Laplace transforms and use these to solve boundary value problems
CO-7	In the laboratory course, the students will learn the basics of the Scilab software/Python interpreter and apply appropriate numerical method to solve selected physics problems both using user defined and inbuilt functions from Scilab/Python

Core Course-IX: Elements of Modern Physics

CO-1	Main aspects of the inadequacies of classical mechanics as well as understanding of the historical development of quantum mechanics
CO-2	Formulation of Schrodinger equation and the idea of probability interpretation associated with wave-functions
CO-3	The spontaneous and stimulated emission of radiation, optical pumping and population inversion. Three level and four level lasers. Ruby laser and He-Ne laser in details. Basic lasing
CO-4	The properties of nuclei like density, size, binding energy, nuclear forces and structure of atomic nucleus, liquid drop model and nuclear shell model and mass formula
CO-5	Decay rates and lifetime of radioactive decays like alpha, beta, gamma decay. Neutrino, its properties and its role in theory of beta decay
CO-6	Fission and fusion: Nuclear processes to produce nuclear energy in nuclear reactor and stellar energy in stars
CO-7	In the laboratory course, the students will get opportunity to measure Planck's constant, verify photoelectric effect, determine e/m of electron, Ionization potential of atoms, study emission and absorption line spectra. They will also find

	wavelength of Laser sources by single and Double slit experiment, wavelength and angular spread of He-Ne Laser using plane diffraction grating

Core Course-X: Analog Systems and Applications

CO-1	Characteristics and working of pn junction
CO-2	Two terminal devices: Rectifier diodes, Zener diode, photodiode etc
CO-3	NPN and PNP transistors: Characteristics of different configurations, biasing, stabilization and their applications
CO-4	CE and two stage RC coupled transistor amplifier using h-parameter model of the transistor
CO-5	Designing of different types of oscillators and their stabilities
CO-6	Ideal and practical op-amps: Characteristics and applications.
CO-7	the laboratory course, the students will be able to study characteristics of various diodes and BJT. They will be able to design amplifiers, oscillators and DACs. Also different applications using Op-Amp will be designed.

Core Course-XI: Quantum Mechanics and Applications

CO-1	Methods to solve time-dependent and time-independent Schrodinger equation
CO-2	Quantum mechanics of simple harmonic oscillator
CO-3	Non-relativistic hydrogen atom: spectrum and eigenfunctions
CO-4	Angular momentum: Orbital angular momentum and spin angular momentum
CO-5	Bosons and fermions - symmetric and anti-symmetric wave functions
CO-6	Application to atomic systems
CO-7	In the laboratory course, with the exposure in computational programming in the computer lab, the student will be in a position to solve Schrodinger equation for ground state energy and wave functions of various simple quantum mechanical one-dimensional and three-dimensional potentials

Core Course-XII: Solid State Physics

CO-1	Elucidate the concept of lattice, crystals and symmetry operations
CO-2	Understand the elementary lattice dynamics and its influence on the properties of materials.
CO-3	Describe the main features of the physics of electrons in solids: origin of energy bands, and their influence electronic behavior
CO-4	Explain the origin of dia-, para-, and ferro-magnetic properties of solids
CO-5	Explain the origin of the dielectric properties exhibited by solids and the concept of polarizability
CO-6	Understand the basics of phase transitions and the preliminary concept and experiments related to superconductivity in solid.
CO-7	In the laboratory students will carry out experiments based on the theory that they have learned to measure the magnetic susceptibility, dielectric constant, trace hysteresis loop. They will also employ to four probe methods to measure electrical conductivity and the hall set up to determine the hall coefficient of a semiconductor

Core Course-XIII: Electromagnetic Theory

CO-1	Apply Maxwell's equations to deduce wave equation, electromagnetic field energy, momentum and angular momentum density
CO-2	Understand electromagnetic wave propagation in unbounded media: Vacuum, dielectric medium, conducting medium, plasma
CO-3	Understand electromagnetic wave propagation in bounded media: reflection and transmission coefficients at plane interface in bounded media.
CO-4	Understand polarization of Electromagnetic Waves: Linear, Circular and Elliptical Polarization. Production as well as detection of waves in laboratory
CO-5	Learn the features of planar optical wave guide
CO-6	Understand the fundamentals of propagation of electromagnetic waves through optical fibres.
CO-7	In the laboratory course, the student get an opportunity to perform experiments with Polarimeter, Babinet Compensator, Ultrasonic grating, simple dipole antenna. Also, to study phenomena of interference, refraction, diffraction and polarization.

Core Course-XIV: Statistical Mechanics

CO-1	Understand the concepts of microstate, microstate, phase space, thermodynamic probability and partition function
CO-2	Understand the use of Thermodynamic probability and Partition function for calculation of thermodynamic variables for physical system (Ideal gas, finite level system)
CO-3	Difference between the classical and quantum statistics
CO-4	Understand the properties and Laws associated with thermal radiation
CO-5	Apply the Fermi- Dirac distribution to model problems such as electrons in solids and white dwarf stars
CO-6	Apply the Bose-Einstein distribution to model problems such as blackbody radiation and Helium gas
CO-7	In the laboratory course, with the exposure in computer programming and computational techniques, the student will be in a position to perform numerical simulations for solving the problems based on Statistical Mechanics

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)

DSE-1: Advanced Mathematical Physics-I

CO-1	Understand algebraic structures in n-dimension and basic properties of the linear vector spaces
CO-2	Represent Linear Transformations as matrices and understand basic properties of matrices
CO-3	Apply vector spaces and matrices in the quantum world

CO-4	Learn basic properties of Cartesian and general tensors with physical examples such as moment of inertia tensor, energy momentum tensor, stress tensor, strain tensor etc.
CO-5	Learn how to express the mathematical equations for the Laws of Physics in their co-variant forms
CO-6	In the laboratory course, the students are expected to solve the problems using the Scilab/C++/Python computer language: Eigenvalues and Eigenvectors of given matrix, determination of wave functions for stationary states as eigenfunctions, eigen energy values of Hermitian differential operators, Lagrangian formulation in classical dynamics etc.

DSE-2: Nuclear and particle Physics

CO-1	To be able to understand the basic properties of nuclei as well as knowledge of experimental determination of the same, the concept of binding energy, its various dependent parameters, N-Z curves and their significance
CO-2	Liquid drop model, Fermi gas model and Shell Model and evidences in support.
CO-3	Knowledge of radioactivity and decay laws. A detailed analysis, comparison and energy kinematics of alpha, beta and gamma decays
CO-4	Familiarization with different types of nuclear reactions, Q- values, compound an direct reactions
CO-5	To know about energy losses due to ionizing radiations, energy losses of electrons, gamma ray interactions through matter and neutron interaction with matter. Through the section on accelerators students will acquire knowledge about Accelerator facilities in India along with a comparative study of a range of detectors and accelerators which are building blocks of modern day science.
CO-6	It will acquaint students with the nature and magnitude of different forces, particle interactions, families of sub- atomic particles with the different conservation laws, concept of quark model.
CO-7	The acquired knowledge can be applied in the areas of nuclear medicine, medical physics, archaeology, geology and other interdisciplinary fields of Physics and Chemistry. It will enhance the special skills required for these fields.

DSE-3: Classical Dynamics

CO-1	Understand the physical principle behind the derivation of Lagrange and Hamilton equations, and the advantages of these formulations
CO-2	Understand small amplitude oscillations
CO-3	Understand the intricacies of motion of particle in central force field. Critical thinking and problem-solving skills
CO-4	Recapitulate and learn the special theory of relativity extending to Four – vectors
CO-5	Learn the basics of fluid dynamics, streamline and turbulent flow, Reynolds's number, coefficient of viscosity and Poiseuille's equation

DSE-4: Advanced M.P-II

CO-1	Understand variational principle and its applications: Geodesics in two and three dimensions, Euler Lagrange Equation and simple problems in one and two dimensions
CO-2	Acquire basic concept of Hamiltonian, Hamilton's principle and Hamiltonian equation of motion, Poisson and Lagrange brackets
CO-3	Learn elementary group theory: definition and properties of groups, subgroups, Homomorphism, isomorphism, normal and conjugate groups, representation of groups, Reducible and Irreducible groups
CO-4	Learn the theory of probability: Random variables and probability distributions, Expectation values and variance

SKILL ENHANCEMENT ELECTIVE COURSES (SEC)

SEC-1: Weather forecasting

CO-1	Acquire basic knowledge of the elements of the atmosphere, its composition at various heights, variation of pressure and temperature with height
CO-2	Learn basic techniques to measure temperature and its relation with cyclones and anti-cyclones
CO-3	Knowledge of simple techniques to measure wind speed and its directions, humidity and rainfall
CO-4	Understanding of absorption, emission and scattering of radiations in atmosphere; Radiation laws
CO-5	Knowledge of global wind systems, jet streams, local thunderstorms, tropical cyclones, tornadoes and hurricanes
CO-6	Knowledge of climate and its classification. Understanding various causes of climate change like global warming, air pollution, aerosols, ozone depletion, acid rain.
CO-7	Develop skills needed for weather forecasting, mathematical simulations, weather forecasting methods, types of weather forecasting, role of satellite observations in weather forecasting, weather maps etc. Uncertainties in predicting weather based on statistical analysis
CO-8	Develop ability to do weather forecasts using input data
CO-9	In the laboratory course, students should be able to learn: Principle of the working of a weather Station, Study of Synoptic charts and weather reports, Processing and analysis of weather data, Reading of Pressure charts, Surface charts, Wind charts and their analysis

SEC-2: Radiation Safety

CO-1	Awareness and understanding the hazards of radiation and the safety measures to guard against these hazards
CO-2	Learning the basic aspects of the atomic and nuclear Physics, specially the radiations that originate from the atom and the nucleus
CO-3	Having a comprehensive knowledge about the nature of interaction of matter with radiations like gamma, beta, alpha rays, neutrons etc. and radiation shielding by appropriate materials
CO-4	Knowing about the units of radiations and their safety limits, the devises to detect and measure radiation.
CO-5	Learning radiation safety management, biological effects of ionizing radiation, operational limits and basics of radiation hazards evaluation and control, radiation protection standards, 'International Commission on Radiological Protection' (ICRP) its principles, justification, optimization, limitation, introduction of safety and risk management of radiation. nuclear waste and disposal management, brief idea about Accelerator driven Sub-Critical System' (ADS) for waste management.

CO-6	Learning about the devices which apply radiations in medical sciences, such as MRI, PET
CO-7	Understanding and performing experiments like Study the background radiation levels using Radiation detectors, Determination of gamma ray linear and mass absorption coefficient of a given material for radiation shielding application
CO-8	The acquired knowledge can be applied in the areas of nuclear medicine, medical physics, archaeology, geology and other interdisciplinary fields of Physics and Chemistry. It will enhance the special skills required for these fields.