# B.Sc. (Hons.) PHYSICS COURSE OUTCOMES

**CORE COURSES**

Core Course-I: Mathematical Physics-I

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| **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

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| 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

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| **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

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| **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

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| **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

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| **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: Analog Systems and Applications

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| **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-VIII: Mathematical Physics-III

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| **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

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| **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 |
| **CO-8** | 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: Digital Systems and Applications

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| **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-XI: Quantum Mechanics and Applications

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| **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 Eigen functions |
| **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

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| **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

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| **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

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| **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: Classical Dynamics

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| **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-2: Nuclear and particle Physics

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| **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: Nano Material and Application

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| **CO-1** | Understand the elementary concepts of Nanoscience |
| **CO-2** | Understand the electrical transport mechanisms in nanostructures |
| **CO-3** | Understand the applications of quantum mechanics in nanoscienc |
| **CO-4** | Understand the fabrication and characterization techniques of nanomaterials |
| **CO-5** | Enumerate the different applications of nanotechnology |

**DSE-4: PROJECT**

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| **CO-1** | Understand research methodology |
| **CO-2** | Understand and formulate a research\project |
| **CO-3** | Design and implement a research project |
| **CO-4** | Identify and enumerate the scope and limitations of a research project |

**GENERIC ELECTIVE-1 &2**

**Mechanic and Properties of Matter, Oscillation and Waves, Thermal Physics, Electricity and Magnetism, Electronics**

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| **CO-1** | Understand the basic ideas of frames of reference and the principles of conservation of energy and momentum and apply it to many physical situation. |
| **CO-2** | Understand the basic ideas of oscillations and waves |
| **CO-3** | Understand the basic ideas of modern physics |
| **CO-4** | Understand the basic ideas of static and current electricity |
| **CO-5** | Understand the concepts of magnetism |
| **CO-6** | Understand the fundamentals of electronics and can apply it to different electronic device. |
| **CO-7** | Understand the fundamentals of thermodynamics |
| **CO-8** | Differentiate between different harmonic motion. |

**GENERIC ELECTIVE-3 &4**

**Optics, Special Theory of Relativity, Atomic Physics, Quantum Mechanics and Nuclear Physics**

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| **CO-1** | Describe the basic properties of a nucleus explaining the binding energy curve. |
| **CO-2** | Understand the basic ideas of cosmic rays and elementary particles |
| **CO-3** | Understand the particle properties of electromagnetic radiation |
| **CO-4** | Understand and apply the Schrödinger equation to simple physical systems |
| **CO-5** | Apply the principles of wave mechanics to the Hydrogen atom |
| **CO-6** | Understand the fundamentals of Fermat’s principles and geometrical optics |
| **CO-7** | Understand the fundamental ideas of special relativity. |
| **CO-8** | Describe the different types of nuclear reactions and their applications |
| **CO-9** | Understand the basic principles of elementary particle physics |