Course Outcome : B.Sc. Honours in Physics
(CBCS)

Course	Outcomes (After completion of these courses Students should be able to) ;
PHY-H-CC-T-01 : Mathematical Physics - I	CO1 :Revise the knowledge of calculus and vector calculus, probability. These basic mathematical structures are essential in solving problems in various branches of Physics. CO2: Learn the curvilinear coordinates which have applications in problems with spherical and cylindrical symmetries. CO3: Learn the basic properties of differential equations, different types of differential equations viz., 1st order, 2nd order and partial differential equations and their correspondence to physical Quantities. They will also learn how to solve the differential equations.
PHY-H-CC-P-01 : Mathematical Physics - I	CO1 :Learn the basics of PYTHON programming theoretically and practically. CO2 : Get a basic idea about the way of solving problems using PYTHON programming. CO3 : Learn the use of PYTHON programming for a few numbers of Numerical techniques.
PHY-H-CC-T-02 : Mechanics	CO1 : Understand laws of motion and their applications. He / she will learn

	the concept of conservation of energy, momentum, angular momentum to apply them to basic problems. CO2 : Understand the analogy between translational and rotational dynamics, and application of both motions simultaneously in analyzing rolling with slipping. CO3 : Write the expression for the moment of inertia about the given axis of symmetry for different uniform mass distributions. CO4 : Understand the phenomena of collisions and ideas about center of mass and laboratory frames and their correlation. CO5 : Apply Kepler's law to describe the motion of planets and satellites in circular orbit, through the study of the law of Gravitation. CO6 : Explain the phenomena of simple harmonic motion and the properties of such systems. CO7 : Describe how fictitious forces arise in a non-inertial frame, e.g., why a person sitting in a merry-go-round experiences an outward pull. CO8 : Describe special relativistic effects and their effects on the mass and energy of a moving object.
PHY-H-CC-P-02 : Mechanics	CO1 : Learn use of Vernier calipers, screw gauge and traveling microscope, and necessary

	precautions during the different experiments. CO2 : Learn basics about the errors, their propagation and recording in the final result up to correct significant digits. CO3 : Learn the linearization of data and the use of slope and intercept to determine unknown Quantities. CO4 : Way of writing of scientific laboratory reports, which may include theoretical and practical significance of the experiment performed, apparatus description, relevant theory, necessary precautions to be taken during the experiment, proper recording of observations, data analysis, estimation of the error and explanation of its sources, correct recording of the result of the experiment, and proper referencing of the material taken from other sources (books, websites, research papers, etc.)
PHY-H-CC-T-03 : Electricity and Magnetism	CO1 : Demonstrate Gauss law for the electric field, and apply it to systems of point charges as well as line, surface, and volume distributions of charges. CO2 : Explain and differentiate the vector (electric fields, Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics. CO3 : Apply Gauss's law of electrostatics to solve a variety of problems.

	CO4 : Articulate knowledge of electric current, resistance and capacitance in terms of electric field and electric potential. CO5 : Demonstrate a working understanding of capacitors. CO6 : Describe the magnetic field produced by magnetic dipoles and electric currents. CO7 : Explain Faraday-Lenz and Maxwell laws to articulate the relationship between electric and magnetic fields. CO8 : Understand the magnetic properties of materials and the phenomena of electromagnetic induction. CO9 : Describe how magnetism is produced and list examples where its effects are observed. CO10 : Apply Kirchhoff's rules to analyze AC circuits consisting of parallel and/or series combinations of voltage sources and resistors and to describe the graphical relationship of resistance, capacitor and inductor.
PHY-H-CC-P-03 : Electricity and Magnetism	CO1 : The construction, functioning and uses of different electrical bridge circuits, and electrical devices like the ballistic galvanometer. CO2 : linearization of data and the use of slope and intercept to determine unknown quantities.

	CO3 : present their experimental data in a laboratory report.
PHY-H-CC-T-04 : Waves and Optics	CO1 : Recognize and use a mathematical oscillator equation and wave equation, and derive these equations for certain systems. CO2 : Apply basic knowledge of principles and theories about the behavior of light and the physical environment to conduct experiments. CO3 : Understand the principle of superposition of waves and formation of standing waves. CO4 : Explain several phenomena we can observe in everyday life that can be explained as wave phenomena. CO5 : Use the principles of wave motion and superposition to explain the Physics of polarization, interference and diffraction. CO6 : Understand the working of selected optical instruments like biprism, interferometer, diffraction grating, and holograms.
PHY-H-CC-P-04 : Waves and Optics	CO1 : Use of spectrometers and lasers, and necessary precautions during the experiments. CO2 : Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.

	CO3 : linearization of data and the use of slope and intercept to determine unknown quantities. CO4 : How to present their experimental data in a laboratory report.
PHY-H-CC-T-05 : Mathematical Physics II	CO1 : Learn about the special functions, such as the Hermite polynomial, the Legendre polynomial, the Laguerre polynomial and Bessel functions and their differential equations and their applications in various physical problems such as in quantum mechanics which they will learn in future courses in detail. CO2 : Learn the Fourier analysis of periodic functions and their applications in physical problems such as vibrating strings etc. CO3 : Acquire knowledge of methods to solve partial differential equations with the examples of important partial differential equations in Physics.
PHY-H-CC-P-05 : Mathematical Physics II	CO1 : Learn about different computational techniques used to solve physics problems.
PHY-H-CC-T-06 : Thermal Physics	CO1 : Comprehend the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations.

	CO2 : Learn about Maxwell's thermodynamic relations. CO3 : Learn the basic aspects of kinetic theory of gases, Maxwell-Boltzman distribution law, equitation of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion and Brownian motion. CO4 : Learn about the real gas equations, Van der Waal equation of state, the Joule-Thompson effect.
PHY-H-CC-P-06 : Thermal Physics	CO1 : construction and use of specific measurement instruments and apparatuses used in the thermal physics lab, including necessary precautions. CO2 : Analysis of experimental data, error estimation and writing scientific reports.
PHY-H-CC-T-07 : Digital Systems and applications	CO1 : Basic working of an oscilloscope including its different components and to employ the same to study different waveforms and to measure voltage, current, frequency and phase. CO2 : Secure first-hand idea of different components including both active and passive components to gain an insight into circuits using discrete components and also to learn about integrated circuits. CO3 : About analog systems and digital systems and their differences, fundamental logic gates,

	combinational as well as sequential and number systems. CO4 : Synthesis of Boolean functions, simplification and construction of digital circuits by employing Boolean algebra. CO5 : Sequential systems by choosing Flip-Flop as a building block-construct multivibrators, counters to provide a basic idea about memory including RAM, ROM and also about memory organization. CO6 : Microprocessor and assembly language programming with Intel μP 8085.
PHY-H-CC-P-07 : Digital Systems and applications	CO1 : Understand construction and use of CRO, and other experimental apparatuses used in the lab, including necessary precautions. CO2 : Learn about the basic components of digital electronics and circuit design.
PHY-H-SEC-T-01 : Electrical circuits and Network theory	CO1 : After the completion of the course the student will acquire necessary knowledge on multimeters, voltmeters, ammeters, electric circuit elements, dc power sources. With the knowledge of basic electronics and practical use of the measuring instruments, a student is able to troubleshoot and repair some of the electronic instruments used in our daily life.
PHY-H-CC-T/P-08 : Mathematical Physics III	CO1 : Learn about the complex numbers and their properties,

	functions of complex numbers and their properties such as analyticity, poles and residues. The students are expected to learn the residue theorem and its applications in evaluating definite integrals. CO2 : Learn about the Fourier transform, the inverse Fourier transform, their properties and their applications in physical problems. They are also expected to learn the Laplace transform, the inverse Laplace transforms, their properties and their applications in solving physical problems. CO3 : In the laboratory course, the students should apply their Python programming language to solve the following problems: (i) Solution first- and second- order ordinary differential equations with appropriate boundary conditions. (ii) Evaluation of the Gaussian integrals. (iii) Evaluation of a converging infinite series up to a desired accuracy. (iv) Evaluation of the Fourier coefficients of a given periodic function. (v) Plotting the Legendre polynomials and the Bessel functions of different orders and interpretations of the results. (vi) Least square fit of a given data to a graph.
PHY-H-CC-T-09: Elements of modern physics	CO1 : Learn main aspects of the inadequacies of classical mechanics and understand historical development of quantum mechanics and ability to discuss and interpret experiments that reveal the dual nature of matter.

	CO2 : Understand the theory of quantum measurements, wave packets and uncertainty principle. CO3 : Understand the central concepts of quantum mechanics: wave functions, momentum and energy operator, the Schrodinger equation, time dependent and time independent cases, probability density and the normalization techniques, skill development on problem solving e.g. one-dimensional rigid box, tunneling through potential barrier, step potential, rectangular barrier. CO4 : Understanding 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. CO5 : Ability to calculate the decay rates and lifetime of radioactive decays like alpha, beta, gamma decay. Neutrinos and its properties and role in the theory of beta decay. CO6 : Understand fission and fusion well as nuclear processes to produce nuclear energy in nuclear reactor and stellar energy in stars. CO7 : Understand various interactions of electromagnetic radiation with matter. Electron positron pair creation. CO8 : Understand 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.
PHY-H-CC-P-09: Elements of modern physics	CO1: use of specific measurement instruments and experimental apparatuses used in the modern physics lab, including necessary precautions. CO2 : review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
PHY-H-CC-T-10: Analog systems and applications	CO1 : N- and P- type semiconductors, mobility, drift velocity, fabrication of P-N junctions; forward and reverse biased junctions. CO2 : Application of PN junction for different types of rectifiers and voltage regulators. CO3 : NPN and PNP transistors and basic configurations namely common base, common emitter and common collector, and also about current and voltage gain. CO4 : Biasing and equivalent circuits, coupled amplifiers and feedback in amplifiers and oscillators. CO5 : Operational amplifiers and knowledge about different configurations namely inverting and non-inverting and applications of operational amplifiers in D to A and A to D conversions.

	CO6 : To characterize various devices namely PN junction diodes, LEDs, Zener diode, solar cells, PNP and NPN transistors. Also, construct amplifiers and oscillators using discrete components. CO7 : Demonstrate inverting and non-inverting amplifiers using op-amps.
PHY-H-CC-P-10: Analog systems and applications	CO1: construction and use of specific analogue devices and experimental apparatuses used in the lab, including necessary precautions. CO2: review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
PHY-H-SEC-T-02 : Radiation safety	CO1 : Learn the basics of atomic and nuclear physics including the nuclear reactions to understand the production of radioisotopes useful in various practical applications. CO2 : Acquaint with different types of radiations and their interaction with matter. CO3: Acquire the knowledge of radiation measurements, quantities and units; and know the different types of radiation detectors. CO4: Understand the principles involved in radiation monitoring and protection; and also get familiar with the nuclear waste and its safe handling and disposal.

	CO5: Familiar with the application of nuclear techniques in medical science, archeology, art and industry
PHY-H-CC-T-11 : Quantum mechanics and Applications	CO1: Revision of this course will enable the student to get familiar with quantum mechanics formulation. CO2: After an exposition of inadequacies of classical mechanics in explaining microscopic phenomena, quantum theory formulation will be introduced through the Schrodinger equation. CO3: The interpretation of the wave function of quantum particles and probabilistic nature of its location and subtler points of quantum phenomena will be exposed to the student. CO4: Through understanding the behavior of quantum particle encountering a potential barrier, the student will get exposed to solving non-relativistic hydrogen atom, for its spectrum and eigenfunctions. CO5: Study of influence of electric and magnetic fields on atoms will help in understanding Stark effect and Zeeman Effect respectively. CO6: This basic course will form a firm basis to understand quantum many body problems.
PHY-H-CC-T-11 : Quantum mechanics and Applications	CO1 : Better understanding of various concepts of quantum mechanics CO2 : Solving problems related to quantum mechanics using Python 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. CO3 : The experiments using PYTHON will enable the student to appreciate nuances involved in the theory.
PHY-H-CC-T-12 : Solid state physics	CO1 : A brief idea about crystalline and amorphous substances, lattice, unit cell, miller indices, reciprocal lattice, concept of Brillouin zones and diffraction of X-rays by crystalline materials. CO2 :Knowledge of lattice vibrations, phonons and in depth of understanding of Einstein and Debye theory of specific heat of solids. CO3 :Knowledge of different types of magnetism varying from diamagnetism to ferromagnetism and hysteresis loops and energy loss. CO4 : An understanding about the dielectric and ferroelectric properties of materials. Understanding the band theory of solids and to differentiate insulators, conductors and Semiconductors. CO5 : Understanding the basic idea about superconductors and their classifications. CO6: To carry out experiments based on the theory that they have learned to measure various material properties in the laboratory

PHY-H-CC-P-12 : Solid state physics	CO1: Learning of the measurement of the magnetic susceptibility, dielectric constant, trace hysteresis loop. They will also employ four probe methods to measure electrical conductivity and the hal set up to determine the hall coefficient of a semiconductor. CO2: Operation of measuring instruments and experimental apparatuses used in the solid-state physics lab, including necessary precautions.
PHY-H-DSE-T-01 : Classical dynamics	CO1: Revision of the knowledge of the Newtonian, the Lagrangian and the Hamiltonian formulations of classical mechanics and their applications in appropriate physical problems. Learning about the small oscillation related problems. CO2: Recapitulating and learning of the special theory of relativity- postulates of the special theory of relativity, Lorentz transformations on space-time and other four vectors, four-vector notations, space-time invariant length, length contraction, time dilation, mass-energy relation, Doppler effect, light cone and its significance, problems involving energy- momentum conservations. CO3 : Learning of the basics of fluid dynamics, streamline and turbulent flow, Reynolds's number, coefficient of viscosity and Poiseuille's equation. CO4 : Review of the retarded potentials, potentials due to a moving charge, Lienard Wiechert potentials, electric and magnetic fields due to a moving charge, power radiated, Larmor's formula and its relativistic generalization.

PHY-H-DSE-T-02 : Nuclear and particle physics	CO1 : Learn the ground state properties of a nucleus – the constituents and their properties, mass number and atomic number, relation between the mass number and the radius and the mass number, average density, range of force, saturation property, stability curve, the concepts of packing fraction and binding energy, binding energy per nucleon vs. mass number graph, explanation of fusion and fission from the nature of the binding energy graph. CO2 : Know about the nuclear models and their roles in explaining the ground state properties of the nucleus –(i) the liquid drop model, its justification so far as the nuclear properties are concerned, the semi-empirical mass formula, (ii) the shell model, evidence of shell structure, magic numbers, predictions of ground state spin and parity, theoretical deduction of the shell structure, consistency of the shell structure with the Pauli exclusion principles. CO3 :Learn about the process of radioactivity, the radioactive decay law, the emission of alpha, beta and gamma rays, the properties of the constituents of these rays and the mechanisms of the emissions of these rays, outlines of Gamow's theory of alpha decay and Pauli's theory of beta decay with the neutrino hypothesis, the electron capture, the fine structure of alpha particle spectrum, the Geiger-Nuttall law, the radioactive series. CO4: Learn the basic aspects of nuclear reactions, the Q-value of such reaction and its derivation from conservation laws, The reaction cross-sections, the types of nuclear reactions, direct and compound nuclear reactions, Rutherford scattering by Coulomb potential.

	CO5 : Learn some basic aspects of interaction of nuclear radiation with matter- interaction of gamma ray by photoelectric effect, Compton scattering and pair production, energy loss due to ionization, Cerenkov radiation. CO6 : Learn about the detectors of nuclear radiations- the Geiger-Mueller counter, the scintillation counter, the photo-multiplier tube, the solid state and semiconductor detectors. CO7 : The students are expected to learn about the principles and basic constructions of particle accelerators such as the Van-de-Graff generator, cyclotron, betatron and synchrotron. They should know about the accelerator facilities in India. CO8 : Gain knowledge on the basic aspects of particle Physics – the fundamental interactions, elementary and composite particles, the classifications of particles: leptons, hadrons (baryons and mesons), quarks, gauge bosons. The students should know about the quantum numbers of particles: energy, linear momentum, angular momentum, isospin, electric charge, colour charge, strangeness, lepton numbers, baryon number and the conservation laws associated with them.
PHY-H-CC-T-13 : Electromagnetic theory	CO1 : An understanding of the Maxwell's equations, role of displacement current, gauge transformations, scalar and vector potentials, Coulomb and Lorentz gauge, boundary conditions at the interface between different media. CO2 : Appling Maxwell's equations to deduce wave equation, electromagnetic field energy, momentum and angular momentum density.

	CO3 : Analyzing the phenomena of wave propagation in the unbounded, bounded, vacuum, dielectric, guided and unguided media. CO4 : Understanding the laws of reflection and refraction and to calculate the reflection and transmission coefficients at plane interface in bounded media. CO5 : Understanding the linear, circular and elliptical polarization of em waves. Production as well as detection of waves in the laboratory. CO6 : Understanding propagation of em waves in anisotropic media, uniaxial and biaxial crystals phase retardation plates and their uses. CO7 : Understanding the concept of optical rotation, theories of optical rotation and their experimental rotation, calculation of angle rotation and specific rotation. CO8 : Understanding the features of planar optical waveguide and obtaining the Electric field components, Eigenvalue equations, phase and group velocities in a dielectric waveguide. CO9 : Understanding the fundamentals of propagation of electromagnetic waves through optical fibers and calculating numerical apertures for step and graded indices and transmission losses.
PHY-H-CC-P-13 : Electromagnetic theory	CO1 : Construction and use of specific measurement instruments and experimental apparatuses used in the lab, with necessary precautions.

	CO2 : review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
PHY-H-CC-T-14: Statistical Mechanics	CO1 : Understanding of the concepts of microstate, macrostate, ensemble, phase space, thermodynamic probability and partition function. CO2 : Understanding of the combinatoric studies of particles with their distinguishably or indistinguishably nature and conditions which lead to the three different distribution laws e.g. Maxwell-Boltzmann distribution, Bose-Einstein distribution and Fermi-Dirac distribution laws of particles and their derivation. CO3 : Comprehending and articulating the connection as well as dichotomy between classical statistical mechanics and quantum statistical mechanics. CO4 : Learning of application of the classical statistical mechanics to derive the law of equipartition of energy and specific heat. CO5 : Understanding of the Gibbs paradox, equipartition of energy and concept of negative temperature in a two level system. CO6 : Learning to derive classical radiation laws of black body radiation. Wiens law, Rayleigh Jeans law, ultraviolet catastrophe. Saha ionization formula. CO7: Learning to calculate the macroscopic properties of degenerate photon gas using BE distribution law, understand Bose-Einstein condensation law and liquid Helium. derivation of Plank's law Understanding of the

	concept of Fermi energy and Fermi level, calculate the macroscopic properties of completely and strongly degenerate Fermi gas, electronic contribution to specific heat of metals. CO8: Understanding of the application of F-D statistical distribution law to derive thermodynamic functions of a degenerate Fermi gas, electron gas in metals and their properties. CO9 : Calculating the electron degeneracy pressure and ability to understand the Chandrasekhar mass limit, stability of white dwarfs against gravitational collapse.
PHY-H-CC-P-14: Statistical Mechanics	CO1 : Use of numerical simulations for solving the problems based on Statistical Mechanics.
PHY-H-DSE-T-03 : Communication electronics	CO1 : Electromagnetic spectra and different frequency bands. Modulation, different types of modulation and about super heterodyne receivers. CO2: Concept of sampling, sampling theorem and multiplexing. CO3 : Digital transmission, encoding and decoding. CO4 : Satellite communication including uplinking and downlinking. CO5 : Mobile communication/telephony and concepts of cell telephony. 2G, 3G, 4G and 5G (Quantitative). CO6 :Apply the theory that they have learned in the theory class to gain hands on

	experience in building modulation and demodulation circuits; Transmitters and Receivers for AM and FM. Also to construct TDM, PAM, PWM, PPM and ASK, PSK and FSK modulator and verify their results.
PHY-H-DSE-P-03 : Communication electronics	CO1: Learn in depth concept modulation and how it is practically done in communication systems. CO2 : Get the practical idea about different way pulse modulation techniques.
PHY-H-DSE-T/P-04 : Dissertation	CO1 : Exposure to research methodology CO2 : Picking up skills relevant to dissertation/project CO3 : Development of creative ability and intellectual initiative CO4 : Developing the ability for scientific writing CO5 : Becoming conversant with ethical practices in acknowledging other sources, avoiding

Course Outcome : B.Sc. Physics (Generic Elective Courses)
(CBCS)

Course	Outcomes (After completion of these courses Students should be able to);
PHY-H-GE-T-01 : Mechanics	CO1 :Understand laws of motion and their applications. He / she will learn the concept of conservation of energy,

	momentum, angular momentum to apply them to basic problems. CO2: Understand the analogy between translational and rotational dynamics, and application of both motions simultaneously in analyzing rolling with slipping. CO3 : Write the expression for the moment of inertia about the given axis of symmetry for different uniform mass distributions. CO4 : Understand the phenomena of collisions and ideas about center of mass and laboratory frames and their correlation. CO5 : Apply Kepler's law to describe the motion of planets and satellites in circular orbit, through the study of the law of Gravitation. CO6 : Explain the phenomena of simple harmonic motion and the properties of such systems. CO7 : Describe how fictitious forces arise in a non-inertial frame, e.g., why a person sitting in a merry-go-round experiences an outward pull. CO8 : Describe special relativistic effects and their effects on the mass and energy of a moving object.
PHY-H-GE-P-01 : Mechanics	CO1 : Learn use of Vernier calipers, screw gauge and traveling microscope, and necessary precautions during the different experiments.

	CO2 : Learn basics about the errors, their propagation and recording in the final result to correct significant digits. CO3 : Learn the linearization of data and the use of slope and intercept to determine unknown Quantities. CO4 : Way of writing of scientific laboratory reports, which may include theoretical and practical significance of the experiment performed, apparatus description, relevant theory, necessary precautions to be taken during the experiment, proper recording of observations, data analysis, estimation of the error and explanation of its sources, correct recording of the result of the experiment, and proper referencing of the material taken from other sources (books, websites, research papers, etc.)
PHY-H-GE-T-02 : Waves and Optics	CO1 : Recognize and use a mathematical oscillator equation and wave equation, and derive these equations for certain systems. CO2 : Apply basic knowledge of principles and theories about the behavior of light and the physical environment to conduct experiments. CO3 : Understand the principle of superposition of waves and formation of standing waves. CO4 : Explain several phenomena we can observe in everyday life that can be explained as wave phenomena.

	CO5 : Use the principles of wave motion and superposition to explain the Physics of polarisation, interference and diffraction. CO6 : Understand the working of selected optical instruments like biprism, interferometer, diffraction grating, and holograms.
PHY-H-GE-P-02: Waves and Optics	CO1 : Use of spectrometer and lasers, and necessary precautions during the experiments. CO2 : Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors. CO3 : linearization of data and the use of slope and intercept to determine unknown quantities. CO4 :How to present their experimental data in a laboratory report.

Course Outcome B.Sc. Physics (General)
(CBCS)

Course	Outcomes (After completion of these courses Students should be able to);
PHY-G-CC-T-01 : Mechanics	CO1 : Understand laws of motion and their applications. He / she will learn the concept of conservation of energy, momentum, angular momentum to apply them to basic problems. CO2 : Understand the analogy between translational and rotational dynamics, and application of both motions simultaneously in analyzing rolling with slipping. CO3 : Write the expression for the moment of inertia about the given axis of symmetry for different uniform mass distributions. CO4 : Understand the phenomena of collisions and ideas about center of mass and laboratory frames and their correlation. CO5 : Apply Kepler's law to describe the motion of planets and satellites in circular orbit, through the study of the law of Gravitation. CO6 : Explain the phenomena of simple harmonic motion and the properties of such systems. CO7: Describe how fictitious forces arise in a non-inertial frame, e.g., why a person sitting in a merry-go-round experiences an outward pull.

	CO8 : Describe special relativistic effects and their effects on the mass and energy of a moving object.
PHY-G-CC-P-01 : Mechanics	CO1 : Learn use of Vernier calipers, screw gauge and traveling microscope, and necessary precautions during the different experiments. CO2 : Learn basics about the errors, their propagation and recording in final result up to correct significant digits. CO3 : Learn the linearization of data and the use of slope and intercept to determine unknown Quantities. CO4 : Way of writing of scientific laboratory reports, which may include theoretical and practical significance of the experiment performed, apparatus description, relevant theory, necessary precautions to be taken during the experiment, proper recording of observations, data analysis, estimation of the error and explanation of its sources, correct recording of the result of the experiment, and proper referencing of the material taken from other sources (books, websites, research papers, etc.)
PHY-G-CC-T-02 : Digital Systems and applications	CO1 : Basic working of an oscilloscope including its different components and to employ the same to study different waveforms and to measure voltage, current, frequency and phase.

	CO2 : Secure first-hand idea of different components including both active and passive components to gain an insight into circuits using discrete components and also to learn about integrated circuits. CO3 : About analog systems and digital systems and their differences, fundamental logic gates, combinational as well as sequential and number systems. CO4 : Synthesis of Boolean functions, simplification and construction of digital circuits by employing Boolean algebra. CO5 : Sequential systems by choosing Flip-Flop as a building bock-construct multivibrators, counters to provide a basic idea about memory including RAM, ROM and also about memory organization. CO6 : Microprocessor and assembly language programming with Intel μP 8085.
PHY-G-CC-P-02 : Digital Systems and Applications	CO1 : Understand construction and use of CRO, and other experimental apparatuses used in the lab, including necessary precautions. CO2 : Learn about the basic components of digital electronics and circuit design.
PHY-G-SEC-T-01 : Electrical circuits and Network theory	After the completion of the course the student will acquire necessary knowledge on

	multimeters, voltmeters, ammeters, electric circuit elements, dc power sources. With the knowledge of basic electronics and practical use of the measuring instruments, a student is able to troubleshoot and repair some of the electronic instruments used in our daily life.
PHY-G-CC-T-03 : Analog systems and applications	CO1 : N- and P- type semiconductors, mobility, drift velocity, fabrication of P-N junctions; forward and reverse biased junctions. CO2 : Application of PN junction for different type of rectifiers and voltage regulators. CO3 : NPN and PNP transistors and basic configurations namely common base, common emitter and common collector, and also about current and voltage gain. CO4 : Biasing and equivalent circuits, coupled amplifiers and feedback in amplifiers and oscillators. CO5 : Operational amplifiers and knowledge about different configurations namely inverting and non-inverting and applications of operational amplifiers in D to A and A to D conversions. CO6 : To characterize various devices namely PN junction diodes, LEDs, Zener diode, solar cells, PNP and NPN transistors. Also, construct amplifiers and oscillators using discrete components.

	CO7 : Demonstrate inverting and non-inverting amplifiers using op-amps.
PHY-G-CC-P-03 : Analog systems and Applications	CO1: construction and use of specific analogue devices and experimental apparatuses used in the lab, including necessary precautions. CO2: review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
PHY-G-SEC-T-02 : Radiation safety	CO1 : Learn the basics of atomic and nuclear physics including the nuclear reactions to understand the production of radioisotopes useful in various practical applications. CO2 : Acquaint with different types of radiations and their interaction with matter. CO3: Acquire the knowledge of radiation measurements, quantities and units; and know the different types of radiation detectors. CO4: Understand the principles involved in radiation monitoring and protection; and also get familiar with the nuclear waste and, it's safe handling and disposal. CO5: Familiar with the application of nuclear techniques in medical science, archeology, art and industry

PHY-G-CC-T-04 : Solid state physics	CO1 : A brief idea about crystalline and amorphous substances, lattice, unit cell, miller indices, reciprocal lattice, concept of Brillouin zones and diffraction of X-rays by crystalline materials. CO2 :Knowledge of lattice vibrations, phonons and in depth of understanding of Einstein and Debye theory of specific heat of solids. CO3 :Knowledge of different types of magnetism varying from diamagnetism to ferromagnetism and hysteresis loops and energy loss. CO4 : An understanding about the dielectric and ferroelectric properties of materials. Understanding the band theory of solids and to differentiate insulators, conductors and Semiconductors. CO5 : Understanding the basic idea about superconductors and their classifications. CO6: To carry out experiments based on the theory that they have learned to measure various material properties in the laboratory
PHY-G-CC-P-04 : Solid State Physics	CO1: Learning of the measurement of the magnetic susceptibility, dielectric constant, trace hysteresis loop. They will also employ four probe methods to measure electrical conductivity and the hal set up to determine the hall coefficient of a semiconductor. CO2: Operation of measuring instruments and experimental apparatuses used in the

	solid-state physics lab, including necessary precautions.
PHY-G-DSE-T-02 : Nuclear and particle physics	CO1 : Learn the ground state properties of a nucleus – the constituents and their properties, mass number and atomic number, relation between the mass number and the radius and the mass number, average density, range of force, saturation property, stability curve, the concepts of packing fraction and binding energy, binding energy per nucleon vs. mass number graph, explanation of fusion and fission from the nature of the binding energy graph. CO2 : Know about the nuclear models and their roles in explaining the ground state properties of the nucleus –(i) the liquid drop model, its justification so far as the nuclear properties are concerned, the semi-empirical mass formula, (ii) the shell model, evidence of shell structure, magic numbers, predictions of ground state spin and parity, theoretical deduction of the shell structure, consistency of the shell structure with the Pauli exclusion principles. CO3 :Learn about the process of radioactivity, the radioactive decay law, the emission of alpha, beta and gamma rays, the properties of the constituents of these rays and the mechanisms of the emissions of these rays, outlines of Gamow's theory of alpha decay and Pauli's theory of beta decay with the neutrino hypothesis, the electron capture, the fine structure of alpha particle spectrum, the Geiger-Nuttall law, the radioactive series. CO4: Learn the basic aspects of nuclear reactions, the Q-value of such reaction and its derivation from conservation laws, The reaction cross-sections, the types of nuclear

	reactions, direct and compound nuclear reactions, Rutherford scattering by Coulomb potential. CO5 : Learn some basic aspects of interaction of nuclear radiation with matter- interaction of gamma ray by photoelectric effect, Compton scattering and pair production, energy loss due to ionization, Cerenkov radiation. CO6 : Learn about the detectors of nuclear radiations- the Geiger-Mueller counter, the scintillation counter, the photo-multiplier tube, the solid state and semiconductor detectors. CO7 : The students are expected to learn about the principles and basic constructions of particle accelerators such as the Van-de-Graff generator, cyclotron, betatron and synchrotron. They should know about the accelerator facilities in India. CO8 : Gain knowledge on the basic aspects of particle Physics – the fundamental interactions, elementary and composite particles, the classifications of particles: leptons, hadrons (baryons and mesons), quarks, gauge bosons. The students should know about the quantum numbers of particles: energy, linear momentum, angular momentum, isospin, electric charge, colour charge, strangeness, lepton numbers, baryon number and the conservation laws associated with them.
PHY-G-SEC-T-01: Electrical circuits and Network Skills	After the completion of the course the student will acquire necessary knowledge on multimeters, voltmeters, ammeters, electric circuit elements, dc power sources.

	With the knowledge of basic electronics and practical use of the measuring instruments, a student is able to troubleshoot and repair some of the electronic instruments used in our daily life.
PHY-G-SEC-T-03 : Basic Instrumentation Skill	CO-1: Imparting the knowledge of basic measurement and use multimeter. CO-2: To gain practical knowledge of the use of electronic voltmeters. CO-3: Imparting the basic knowledge of CRO. CO-4: To gain practical knowledge of digital instruments and digital multimeter.
PHY-G-SEC-T-04 : Renewable Energy and Energy Harvesting	CO1: The students are expected to learn not only the theories of the renewable sources of energy, but also to have hands-on experiences on them wherever possible. Some of the renewable sources of energy which should be studied here are: (i) off-shore wind energy, (ii) tidal energy, (iii) solar energy, (iv) biogas energy and (v) hydroelectricity. CO2: All these energy sources should be studied in detail. CO3 : Learn about piezoelectricity, carbon-captured technologies like cells, batteries. CO4 : The students should observe practical demonstrations of (i) training modules of solar energy, wind energy etc., (ii) Conversion of vibration into voltage using piezoelectric materials, (iv) conversion of thermal energy into voltage using thermoelectric modules.
PHY-G-DSE-T-01 : Electricity and Magnetism	

	CO1 : Demonstrate Gauss law for the electric field, and apply it to systems of point charges as well as line, surface, and volume distributions of charges. CO2 : Explain and differentiate the vector (electric fields, Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics. CO3 : Apply Gauss's law of electrostatics to solve a variety of problems. CO4 : Articulate knowledge of electric current, resistance and capacitance in terms of electric field and electric potential. CO5 : Demonstrate a working understanding of capacitors. CO6 : Describe the magnetic field produced by magnetic dipoles and electric currents. CO7 : Explain Faraday-Lenz and Maxwell laws to articulate the relationship between electric and magnetic fields. CO8 : Understand the magnetic properties of materials and the phenomena of electromagnetic Induction. CO9 : Describe how magnetism is produced and list examples where its effects are observed.

	10) Apply Kirchhoff's rules to analyze AC circuits consisting of parallel and/or series combinations of voltage sources and resistors and to describe the graphical relationship of resistance, capacitor and inductor.
PHY-G-DSE-P-01 : Electricity and Magnetism	CO1 : The construction, functioning and uses of different electrical bridge circuits, and electrical devices like the ballistic galvanometer. CO2 : linearization of data and the use of slope and intercept to determine unknown quantities. CO3 : How to present their experimental data in a laboratory report.