Course Outcomes – Program Outcomes (COPO) Mapping

Program Outcomes (PO): B.Sc. (H) Physics

Learning Outcome-based Curriculum Framework (LOCF)

The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner

ABBREVIATIONS / NOMENCLATURE

Sno.	Nomenclature	Description	Aggregate Courses
1	PO	Program Outcome	PO1, PO2,PO3, PO4, PO5, PO6
2	CO	Course Outcome	CO1, CO2, CO3. CO4, CO5, CO6, CO7
3	CC	Core Courses	CC1, CC 2, CC 3, CC 4, CC 5, CC6, CC 7, CC 8, CC 9, CC 10, CC 11, CC-12, CC 13, CC 14
4	DSE	Discipline Specific Electives	DSE1, DSE2, DSE3, DSE4
5	GE	General Electives	GE1, GE2, GE3, GE4

Sno.	Program Outcomes (PO): B.Sc. (H) Physics	Statements
1.	PO1	Students graduating with the B.Sc. (Honours) Physics degree should be able to Acquire (i) a fundamental/systematic and coherent understanding of the academic field of basic Physics in areas like Mechanics, Electricity and Magnetism, Waves and Optics, Thermal and Statistical Physics, Quantum Mechanics, Mathematical Physics and their applications to other core subjects in Physics; (ii) a wide ranging and comprehensive experience in physics laboratory methods in experiments related to mechanics, optics, thermal physics, electricity, magnetism, digital electronics, solid state physics and modern physics. Students should acquire the ability for systematic observations, use of scientific research instruments, analysis of observational data, making suitable error estimates and scientific report writing; (iii) procedural knowledge that creates different types of professionals related to the disciplinary/subject area of Physics, including professionals engaged in research and development, teaching and government/public service; (iv) knowledge and skills in areas related to their specialization area corresponding to elective subjects within the disciplinary/subject area of Physics and current and emerging developments in the field of Physics.
2.	PO2	Demonstrate the ability to use skills in Physics and its related areas of technology for formulating and tackling Physics-related problems and identifying and applying appropriate physical principles and methodologies to solve a wide range of problems associated with Physics.
3.	PO3	Recognize the importance of mathematical modelling, simulation and computational methods, and the role of approximation and mathematical approaches to describing the physical world and beyond.
4.	PO4	Plan and execute Physics-related experiments or investigations, analyze and interpret data/information collected using appropriate methods, including the use of appropriate software such as programming languages and purpose-written packages, and report accurately the findings of the experiment/investigations while relating the conclusions/findings to relevant theories of Physics.
5.	PO5	Demonstrate relevant generic skills and global competencies such as

		(i) problem-solving skills that are required to solve different types of Physics related problems with well-defined solutions, and tackle open-ended problems that belong to the disciplinary area boundaries; (ii) investigative skills, including skills of independent investigation of Physics related issues and problems; (iii) communication skills involving the ability to listen carefully, to read texts and research papers analytically and to present complex information in a concise manner to different groups/audiences of technical or popular nature; (iv) analytical skills involving paying attention to detail and ability to construct logical arguments using correct technical language related to Physics and ability to translate them with popular language when needed; (v) ICT skills; (vi) personal skills such as the ability to work both independently and in a group.
6.	**PO6**	Demonstrate professional behavior such as (i) being objective, unbiased and truthful in all aspects of work and avoiding unethical, irrational behavior such as fabricating, falsifying or misrepresenting data or committing plagiarism; (ii) the ability to identify the potential ethical issues in work-related situations; (iii) be committed to the free development of scientific knowledge and appreciate its universal appeal for the entire humanity; (iv) appreciation of intellectual property, environmental and sustainability issues; (v) promoting safe learning and working environment.

Course Outcomes (CO): B.Sc. (H) Physics

SEMESTER 1: **CC 1:** Mathematical Physics – I			
Unique Paper Code	**Name of the Paper**	**Course Outcome: CO**	**Statement**
32221101	Mathematical Physics – I	CO1	Draw and interpret graphs of various functions.
		CO2	Solve first and second order differential equations and apply these to physics problems.
		CO3	Understand the concept of gradient of scalar field and divergence and curl of vector fields.
		CO4	Perform line, surface and volume integration and apply Green's, Stokes' and Gauss's Theorems to compute these integrals.
		CO5	Apply curvilinear coordinates to problems with spherical and cylindrical symmetries.
		CO6	Understand elementary probability theory and the properties of discrete and continuous distribution functions.
CC 2: Mechanics			
32221102	Mechanics	CO1	Understand laws of motion and their application to various dynamical situations.
		CO2	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.
		CO3	Understand translational and rotational dynamics of a system of particles.

		CO4	Apply Kepler's laws to describe the motion of planets and satellite in circular orbit.
		CO5	Understand concept of Geosynchronous orbits.
		CO6	Explain the phenomenon of simple harmonic motion.
		CO7	Understand special theory of relativity - special relativistic effects and their effects on the mass and energy of a moving object.
GE1 (FOR HONOURS): Digital, Analog and Instrumentation			
32225103	Digital, Analog and Instrumentation	CO1	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.
		CO2	Characteristics and working of pn junction.
		CO3	Two terminal devices: Rectifier diodes, Zener diode, photodiode etc.
		CO4	NPN and PNP transistors: Characteristics of different configurations, biasing, stabilization and their applications.
		CO5	CE and two stage RC coupled transistor amplifier using h-parameter model of the transistor.
		CO6	Designing of different types of oscillators and their stabilities.
		CO7	Ideal and practical op-amps: Characteristics and applications.
		CO8	Timer circuits using IC 555 providing clock pulses to sequential circuits and develop multivibrators.

		CO9	Also impart understanding of working of CRO and its usage in measurements of voltage, current, frequency and phase measurement.

COPO MAPPING

	SEMESTER I : COPO MAPPING						
Papers	Program Outcome : PO						
	Course Outcome: CO	PO1	PO2	PO3	PO4	PO5	PO6
CC 1	CO1		√				
	CO2		√				
	CO3	√					
	CO4	√					
	CO5	√					
	CO6	√					
CC 2	CO1	√					
	CO2	√					
	CO3	√					
	CO4			√			
	CO5			√			
	CO6	√					
	CO7	√					
GE 1	CO1	√					
	CO2	√					
	CO3			√			
	CO4			√			
	CO5		√				
	CO6		√				
	CO7		√				
	CO8		√				
	CO9			√			

SEMESTER II: **CC 3:** Electricity and Magnetism			
Unique Paper Code	**Name of the Paper**	**Course Outcome: CO**	**Statement**
32221201	Electricity and Magnetism	CO1	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.
		CO2	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.
		CO3	Apply Gauss's law of electrostatics to solve a variety of problems.
		CO4	Calculate the magnetic forces that act on moving charges and the magnetic fields due to currents (Biot- Savart and Ampere laws)
		CO5	Understand the concepts of induction and self-induction, to solve problems using Faraday's and Lenz's laws.
		CO6	Understand the basics of electrical circuits and analyze circuits using Network Theorems.
CC 4: Waves and Optics			
32221202	Waves and Optics	CO1	Understand Simple harmonic oscillation and superposition principle.
		CO2	Understand different types of waves and their velocities: Plane, Spherical, Transverse, Longitudinal.

		CO3	Understand Concept of normal modes in transverse and longitudinal waves: their frequencies and configurations.
		CO4	Understand Interference as superposition of waves from coherent sources derived from same parent source.
		CO5	Demonstrate basic concepts of Diffraction: Superposition of wavelets diffracted from aperture, understand Fraunhoffer and Fresnel Diffraction.
GE 2 (FOR HONOURS): Embedded System – Introduction of Microcontroller			
32225204	Embedded Systems – Introduction of Microcontroller	CO1	Know the major components that constitute an embedded system.
		CO2	Understand what is a microcontroller, microcomputer embedded system.
		CO3	Describe the architecture of a 8051 microcontroller.
		CO4	Write simple programs for 8051 microcontroller in C language.
		CO5	Understand key concepts of 8051 microcontroller systems like I/O operations, interrupts, programming of timers and counters.
		CO6	Interface 8051 microcontroller with peripherals.
		CO7	Understand and explain concepts and architecture of embedded systems
		CO8	Implement small programs to solve well-defined problems on an embedded platform.
		CO9	Develop familiarity with tools used to develop an embedded environment
		CO10	Learn to use the Arduino Uno (an open source microcontroller board) in simple applications.

COPO MAPPING

	SEMESTER II: COPO MAPPING						
Papers	Program Outcome: PO						
	Course Outcome: CO	PO1	PO2	PO3	PO4	PO5	PO6
CC 3	CO1	√					
	CO2	√					
	CO3	√					
	CO4		√				
	CO5			√			
	CO6			√			
CC 4	CO1	√					
	CO2	√					
	CO3	√					
	CO4			√			
	CO5			√			
GE2	CO1	√					
	CO2	√					
	CO3	√					
	CO4			√			
	CO5		√				
	CO6		√				
	CO7		√				
	CO8			√			
	CO9				√		
	CO10		√				

SEMESTER III:			
CC 5: Mathematical Physics – II			
Unique Paper Code	**Name of the Paper**	**Course Outcome: CO**	**Statement**
32221301	Mathematical Physics – II	CO1	Represent a periodic function by a sum of harmonics using Fourier series and their applications in physical problems such as vibrating strings etc.
		CO2	Obtain power series solution of differential equation of second order with variable coefficient using Frobenius method.
		CO3	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.
		CO4	Learn about gamma and beta functions and their applications.
		CO5	Solve linear partial differential equations of second order with separation of variable method.
CC 6: Thermal Physics			
32221302	Thermal Physics	CO1	Comprehend the basic concepts of thermodynamics, the first and the second law of thermodynamics.
		CO2	Understand the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations.
		CO3	Know about reversible and Irreversible processes.
		CO4	Learn about Maxwell's relations and use them for solving many problems in Thermodynamics.
		CO5	Understand the concept and behavior of ideal and real gases.
		CO6	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.
CC 7: Digital Systems and Applications			
32221303	Digital Systems and Applications	CO1	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.

		CO2	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.
		CO3	Sequential Circuits: Basic memory elements Flips-Flops, shift registers and 4-bits counters leading to the concept of RAM, ROM and memory organization.
		CO4	Timer circuits using IC 555 providing clock pulses to sequential circuits and develop multivibrators.
		CO5	Introduces to basic architecture of processing in an Intel 8085 microprocessor and to Assembly Language.
		CO6	Also impart understanding of working of CRO and its usage in measurements of voltage, current, frequency and phase measurement.
GE 3 (FOR HONOURS): Communication System			
32225312	Communication System	CO1	Understand of fundamentals of electronic communication system and electromagnetic communication spectrum with an idea of frequency allocation for radio communication system in India.
		CO2	Gain an insight on the use of different modulation and demodulation techniques used in analog communication
		CO3	Learn the generation and detection of a signal through pulse and digital modulation techniques and multiplexing.
		CO4	Gain an in-depth understanding of different concepts used in a satellite communication system.
		CO5	Study the concept of Mobile radio propagation, cellular system design and understand mobile technologies like GSM and CDMA.
		CO6	Understand evolution of mobile communication generations 2G, 3G, and 4G with their characteristics and limitations.

COPO MAPPING

	SEMESTER III: COPO MAPPING						
Papers	Program Outcome : PO						
	Course Outcome: CO	PO1	PO2	PO3	PO4	PO5	PO6
CC 5	CO1	√					
	CO2	√					
	CO3	√					
	CO4		√				
	CO5		√				
CC 6	CO1	√					
	CO2	√					
	CO3	√					
	CO4		√				
	CO5			√			
	CO6	√					
CC 7	CO1		√				
	CO2		√				
	CO3			√			
	CO4				√		
	CO5		√				
	CO6		√				
GE 3	CO1		√				
	CO2		√				
	CO3			√			
	CO4			√			
	CO5		√				
	CO6		√				

SEMESTER IV: **CC 8:** Mathematical Physics – III			
Unique Paper Code	**Name of the Paper**	**Course Outcome: CO**	**Statement**
32221401	Mathematical Physics – III	CO1	Determine continuity, differentiability and analyticity of a complex function, find the derivative of a function and understand the properties of elementary complex functions.
		CO2	Work with multi-valued functions (logarithmic, complex power, inverse trigonometric function) and determine branches of these functions.
		CO3	Evaluate a contour integral using parametrization, fundamental theorem of calculus and Cauchy's integral formula.
		CO4	Find the Taylor series of a function and determine its radius of convergence.
		CO5	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.
		CO6	Understand the properties of Fourier and Laplace transforms and use these to solve boundary value problems.
CC 9: Elements of Modern Physics			
32221402	Elements of Modern Physics	CO1	Main aspects of the inadequacies of classical mechanics as well as understanding of the historical development of quantum mechanics.
		CO2	Formulation of Schrodinger equation and the idea of probability

			interpretation associated with wave-functions.
		CO3	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.
		CO4	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	Decay rates and lifetime of radioactive decays like alpha, beta, gamma decay. Neutrino, its properties and its role in theory of beta decay.
		CO6	Fission and fusion: Nuclear processes to produce nuclear energy in nuclear reactor and stellar energy in stars.
CC 10: Analog Systems and Applications			
32221403	Analog Systems and Applications	CO1	Characteristics and working of pn junction.
		CO2	Two terminal devices: Rectifier diodes, Zener diode, photodiode etc.
		CO3	NPN and PNP transistors: Characteristics of different configurations, biasing, stabilization and their applications.
		CO4	CE and two stage RC coupled transistor amplifier using h-parameter model of the transistor.
		CO5	Designing of different types of oscillators and their stabilities.
		CO6	Ideal and practical op-amps: Characteristics and applications.
GE 4 (FOR HONOURS): Astronomy and Astrophysics			
32225418	Astronomy and Astrophysics	CO1	Different types of telescopes, diurnal and yearly motion of astronomical objects, and astronomical coordinate systems and their transformations.
		CO2	Brightness scale for stars, types of stars, their structure and evolution on HR diagram.

		CO3	Components of Solar System and its evolution.
		CO4	The large scale structure of the Universe and its history.
		CO5	Distribution of chemical compounds in the interstellar medium and astrophysical conditions necessary for the emergence and existence of life.

COPO MAPPING

	SEMESTER IV: COPO MAPPING						
Papers	Program Outcome : PO						
	Course Outcome: CO	PO1	PO2	PO3	PO4	PO5	PO6
CC 8	CO1		√				
	CO2		√				
	CO3		√				
	CO4		√				
	CO5		√				
	CO6		√				
CC 9	CO1	√					
	CO2	√					
	CO3	√					
	CO4	√					
	CO5	√					
	CO6	√					
CC 10	CO1		√				
	CO2		√				
	CO3		√				
	CO4		√				
	CO5		√				
	CO6		√				
GE 4	CO1		√				
	CO2		√				
	CO3		√				
	CO4		√				
	CO5		√				

SEMESTER V:

CC 11: Quantum Mechanics and Applications

Unique Paper Code	Name of the Paper	Course Outcome: CO	Statement
32221501	Quantum Mechanics and Applications	CO1	Methods to solve time-dependent and time-independent Schrodinger equation.
		CO2	Quantum mechanics of simple harmonic oscillator.
		CO3	Non-relativistic hydrogen atom: spectrum and eigenfunctions.
		CO4	Angular momentum: Orbital angular momentum and spin angular momentum.
		CO5	Bosons and fermions - symmetric and anti-symmetric wave functions.
		CO6	Application to atomic systems.
CC 12: Solid State Physics			
32221502	Solid State Physics	CO1	Elucidate the concept of lattice, crystals and symmetry operations.
		CO2	Understand the elementary lattice dynamics and its influence on the properties of materials.
		CO3	Describe the main features of the physics of electrons in solids: origin of energy bands, and their influence electronic behavior.
		CO4	Explain the origin of dia-, para-, and ferro-magnetic properties of solids.
		CO5	Explain the origin of the dielectric properties exhibited by solids and the concept of polarizability.
		CO6	Understand the basics of phase transitions and the preliminary concept and experiments related to superconductivity in solid.
DSE 1 (FOR HONOURS): Nuclear and Particle Physics			

32227504	Nuclear and Particle Physics	CO1	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.
		CO2	To appreciate the formulations and contrasts between different nuclear models such as Liquid drop model, Fermi gas model and Shell Model and evidences in support.
		CO3	Knowledge of radioactivity and decay laws. A detailed analysis, comparison and energy kinematics of alpha, beta and gamma decays.
		CO4	Familiarization with different types of nuclear reactions, Q- values, compound and direct reactions.
		CO5	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.
		CO6	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.
		CO7	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 2 (FOR HONOURS): Advanced Mathematical Physics - I			
32227502	Advanced Mathematical Physics - I	CO1	Understand algebraic structures in n-dimension and basic properties of the linear vector spaces.

		CO2	Represent Linear Transformations as matrices and understand basic properties of matrices.
		CO3	Apply vector spaces and matrices in the quantum world.
		CO4	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.
		CO5	Learn how to express the mathematical equations for the Laws of Physics in their covariant forms.

COPO MAPPING

	SEMESTER V: COPO MAPPING						
Papers	Program Outcome : PO						
	Course Outcome: CO	PO1	PO2	PO3	PO4	PO5	PO6
CC 11	CO1	√					
	CO2	√					
	CO3	√					
	CO4	√					
	CO5	√					
	CO6	√					
CC 12	CO1	√					
	CO2	√					
	CO3	√					
	CO4	√					
	CO5	√					
	CO6	√					
DSE 1	CO1	√					
	CO2	√					
	CO3	√					
	CO4	√					
	CO5		√				
	CO6		√				
	CO7			√			
DSE 2	CO1	√					
	CO2	√					
	CO3		√				
	CO4		√				
	CO5	√					

SEMESTER VI:

CC-13: Electromagnetic Theory

Unique Paper Code	Name of the Paper	Course Outcome: CO	Statement
32221601	Electromagnetic Theory	CO1	Apply Maxwell's equations to deduce wave equation, electromagnetic field energy, momentum and angular momentum density.
		CO2	Understand electromagnetic wave propagation in unbounded media: Vacuum, dielectric medium, conducting medium, plasma.
		CO3	Understand electromagnetic wave propagation in bounded media: reflection and transmission coefficients at the plane interface in bounded media.
		CO4	Understand polarization of Electromagnetic Waves: Linear, Circular, and Elliptical Polarization. Production as well as detection of waves in the laboratory.
		CO5	Learn the features of a planar optical waveguide.
		CO6	Understand the fundamentals of propagation of electromagnetic waves through optical fibers.
CC 14: Statistical Mechanics			
32221602	Statistical Mechanics	CO1	Understand the concepts of microstate, macrostate, phase space, thermodynamic probability and partition function.
		CO2	Understand the use of Thermodynamic probability and Partition function forcalculation of thermodynamic variables for physical system (Ideal gas, finite level system).
		CO3	Difference between the classical and quantum statistics.

		CO4	Understand the properties and Laws associated with thermal radiation.
		CO5	Apply the Fermi- Dirac distribution to model problems such as electrons in solids and white dwarf stars.
		CO6	Apply the Bose-Einstein distribution to model problems such as blackbody radiation and Helium gas.
DSE 3 (FOR HONOURS): Communication Systems			
32227613	Communication Systems	CO1	Understand of fundamentals of electronic communication system and electromagnetic communication spectrum with an idea of frequency allocation for radio communication system in India.
		CO2	Gain an insight on the use of different modulation and demodulation techniques used in analog communication.
		CO3	Learn the generation and detection of a signal through pulse and digital modulation techniques and multiplexing.
		CO4	Gain an in-depth understanding of different concepts used in a satellite communication system.
		CO5	Study the concept of Mobile radio propagation, cellular system design and understand mobile technologies like GSM and CDMA.
		CO6	Understand evolution of mobile communication generations 2G, 3G, and 4G with their characteristics and limitations.
DSE 4 (FOR HONOURS): Classical Dynamics			
32227626	Classical Dynamics	CO1	Understand the physical principle behind the derivation of Lagrange and Hamilton equations, and the advantages of these formulations.
		CO2	Understand small amplitude oscillations.
		CO3	Understand the intricacies of motion of particle in central force field. Critical thinking and problem-solving skills.
		CO4	Recapitulate and learn the special theory of relativity extending to Four – vectors.

		CO5	Learn the basics of fluid dynamics, streamline and turbulent flow, Reynolds's number, coefficient of viscosity and Poiseuille's equation.

COPO MAPPING

	SEMESTER VI: COPO MAPPING						
Papers	Program Outcome : PO						
	Course Outcome: CO	PO1	PO2	PO3	PO4	PO5	PO6
CC 13	CO1	√					
	CO2	√					
	CO3	√					
	CO4	√					
	CO5		√				
	CO6		√				
CC 14	CO1	√					
	CO2	√					
	CO3	√					
	CO4	√					
	CO5	√					
	CO6	√					
DSE 3	CO1	√					
	CO2	√					
	CO3	√					
	CO4		√				
	CO5		√				
	CO6		√				
DSE 4	CO1		√				
	CO2	√					
	CO3	√					
	CO4	√					
	CO5	√					