Course Outcomes – Program Outcomes (COPO) Mapping

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

Undergraduate Curriculum Framework (UGCF)

National Education Policy (NEP)

The Preamble of the Undergraduate Curriculum Framework-2022 underlines the historical perspective, philosophical basis, and contemporary realities of higher education as enshrined in the National Education Policy 2020 and endeavours to synchronize these cornerstones while charting the road ahead for the state of higher education.

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	DSC	Core Courses	DSC1, DSC2, DSC3, DSC4, DSC5, DSC6, DSC7, DSC8, DSC9, DSC10, DSC11, DSC12
4	GE	General Electives	GE3 , GE4

Sno.	Program Outcomes (PO): B.Sc. (H) Physics	Statements
1.	**PO1**	The student will acquire comprehensive knowledge and understanding of the fundamental concepts, theoretical principles and processes in the main and allied branches of physics. The core papers will provide in-depth understanding of the subject. A wide choice of elective courses offered to the student will provide specialized understanding rooted in the core and interdisciplinary areas.

2.	**PO2**	Comprehensive hands-on/ laboratory exercises will impart analytical, computational and instrumentation skills. The students will be able to demonstrate mature skills for the collation, evaluation, analysis and presentation of information, ideas, concepts as well as quantitative and/or qualitative data.
3.	**PO3**	The course provides an opportunity to students to hone their research and innovation skills through internship/apprenticeship/ project/community outreach/dissertation/Academic Project/Entrepreneurship. It will enable the students to demonstrate mature skills in literature survey, information management skills, data analysis and research ethics.
4.	**PO4**	The students will develop awareness and appreciation for the significant role played by physics in current societal and global issues. They will be able to address and contribute to such issues through the skills and knowledge acquired during the programme. They will be able identify/mobilize appropriate resources required for a project, and managing a project through to completion, while observing responsible and ethical scientific conduct, safety and laboratory hygiene regulations and practices.
5.	**PO5**	Various DSCs, DSEs, SECs, GEs and AECs have been designed to enhance student's ability to write methodical, logical and precise reports. The courses will, in addition, guide the student to communicate effectively through oral/poster presentations, writing laboratory/ project reports and dissertations. Several IT based papers in DSCs, DSEs, SECs and AECs will enable students to develop expertise in general and subject specific computational skills.
6.	**PO6**	The programme will develop the ability to apply the underlying concepts and principles of physics and allied fields beyond the classrooms to real life applications, innovation and creativity. A student will be able to distinguish between relevant and irrelevant facts and information, discriminate between objective and biased information, apply logic to arrive at definitive conclusions, find out if conclusions are based upon sufficient evidence, derive correct quantitative results, make rational evaluations, and arrive at qualitative judgments according to established rules.

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

SEMESTER I: DSC 1: Mathematical Physics I			
Unique Paper Code	**Name of the Paper**	**Course Outcome: CO**	**Statement**
2222011101	Mathematical Physics I	CO1	Draw and interpret graphs of various elementary functions and their combinations.
		CO2	Understand the vector quantities as entities with Cartesian components which satisfy appropriate rules of transformation under rotation of the axes.
		CO3	Use index notation to write the product of vectors in compact form easily applicable in computational work.
		CO4	Solve first and second order differential equations and apply these to physics problems.
		CO5	Understand the functions of more than one variable and concept of partial derivatives.
		CO6	Understand the concept of scalar field, vector field and gradient of scalar fields.
		CO7	Understand the properties of discrete and continuous distribution functions.
DSC 2: Mechanics			
2222011102	Mechanics	CO1	Learn the Galilean invariance of Newton's laws of motion.
		CO2	Understand translational and rotational dynamics of a system of particles.
		CO3	Apply Kepler's laws to describe the motion of planets and satellite in circular orbit.
		CO4	Understand Einstein's postulates of special relativity.

		CO5	Apply Lorentz transformations to describe simultaneity, time dilation and length contraction.
DSC 3: Waves and Oscillations			
2222011103	Waves and Oscillations	CO1	Understand travelling and standing waves, stretched strings.
		CO2	Understand simple harmonic motion.
		CO3	Understand superposition of N collinear harmonic oscillations.
		CO4	Understand superposition of two perpendicular harmonic oscillations.
		CO5	Understand free, damped and forced oscillations.
		CO6	Understand coupled oscillators and normal modes of oscillations.

COPO MAPPING

	SEMESTER I : COPO MAPPING						
Papers	Program Outcome : PO						
	Course Outcome: CO	PO1	PO2	PO3	PO4	PO5	PO6
DSC 1	CO1		√				
	CO2	√					
	CO3	√					
	CO4			√			
	CO5	√					
	CO6	√					
	CO7	√					
DSC 2	CO1	√					
	CO2	√					
	CO3	√					
	CO4	√					
	CO5	√					
DSC 3	CO1	√					
	CO2	√					
	CO3	√					
	CO4	√					

	CO5	√					
	CO6	√					

SEMESTER II:

DSC 4: Mathematical Physics II

Unique Paper Code	Name of the Paper	Course Outcome: CO	Statement
2222011201	Mathematical Physics II	CO1	Understand the concept of divergence and curl of vector fields.
		CO2	Perform line, surface and volume integration and apply Green's, Stokes' and Gauss's theorems to compute these integrals. The students will be also enabled to apply these to physics problems.
		CO3	Use curvilinear coordinates to problems with spherical and cylindrical symmetries.
		CO4	Represent a periodic function by a sum of harmonics using Fourier series.
DSC 5: Electricity and Magnetism			
2222011202	Electricity and Magnetism	CO1	Apply Coulomb's law to line, surface, and volume distributions of charges.
		CO2	Apply Gauss's law of electrostatics to distribution of charges.
		CO3	Solve boundary value problems using method of images.
		CO4	Comprehend the genesis of multipole effects in arbitrary distribution of charges.
		CO5	Understand the effects of electric polarization and concepts of bound charges in dielectric materials.

		CO6	Understand and calculate the vector potential and magnetic field of arbitrary current distribution.
		CO7	Understand the concept of bound currents and ferromagnetism in magnetic materials.
DSC 6: Electrical Circuit Analysis			
2222011203	Electrical Circuit Analysis	CO1	Understand the basic concepts, basic laws and methods of analysis of DC and AC networks and their difference.
		CO2	Solve complex electric circuits using network theorems.
		CO3	Discuss resonance in series and parallel circuits and also the importance of initial conditions and their evaluation.
		CO4	Evaluate the performance of two port networks.

COPO MAPPING

	SEMESTER II: COPO MAPPING						
Papers	Program Outcome: PO						
	Course Outcome: CO	PO1	PO2	PO3	PO4	PO5	PO6
DSC 4	CO1	√					
	CO2		√				
	CO3	√					
	CO4	√					
DSC 5	CO1	√					
	CO2	√					
	CO3	√					
	CO4	√					
	CO5	√					
	CO6	√					
	CO7	√					
DSC 6	CO1	√					
	CO2	√					
	CO3	√					
	CO4	√					

SEMESTER III:

DSC 7: Mathematical Physics III

Unique Paper Code	Name of the Paper	Course Outcome: CO	Statement
2222012301	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 parameterization, 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 transforms and use these to solve boundary value problems.
		CO7	Solve linear partial differential equations of second order with separation of variable method.

DSC 8: Thermal Physics

2222012302	Thermal Physics	CO1	Comprehend the basic concepts of thermodynamics, the first and the second law of thermodynamics.
		CO2	Understand the concept of reversibility, irreversibility and entropy.
		CO3	Understand various thermodynamic potentials and their physical significance with respect to different thermodynamic systems and processes.
		CO4	Deduce Maxwell's thermodynamical relations and use them for solving various problems in Thermodynamics.
		CO5	Understand the concept and behaviour of ideal and real gases.
		CO6	Apply the basic concept of kinetic theory of gases in deriving Maxwell-Boltzman distribution law and its applications.
		CO7	Understand mean free path and molecular collisions in viscosity, thermal conductivity, diffusion and Brownian motion.
DSC 9: Light and Matter			
2222012303	Light and Matter	CO1	Appreciate the dual nature of light which is part of the electromagnetic spectrum and the dual nature of matter simultaneously.
		CO2	Understand the phenomena of interference and diffraction exhibited by light and matter, their nuances and details.
		CO3	Delve in to the depth of understanding wave optics with its various kinds of interference and diffraction exhibited by light.
		CO4	Demonstrate basic concepts of diffraction: Superposition of wavelets diffracted from aperture, understand Fraunhofer and Fresnel diffraction.

		CO5	Learn about the application of matter waves in latest technological developments of electron microscope e.g. SEM and TEM used widely for characterization in several fields of physics such as material science, nanotechnology etc.
GE 3: INTRODUCTION TO ELECTRONICS			
2224002001	Introduction to electronics	CO1	This paper aims to describe the concepts of basic electronics in real-life. In this course, students will receive an introduction to the principle, performance and applications of basic electronic components.
		CO2	The students will gain an insight on the existence of analog and digital signals and their necessity. Specifically they would know the difference between active and passive electronic components including filters.
		CO3	Students will learn about diodes and its uses in rectification (analog) and switching properties thereof (digital). They will gain an insight into working principle of Photodiodes, Solar Cells, LED and Zener Diode as Voltage Regulator.
		CO4	They will gain an understanding of construction and working principle of bipolar junction transistors (BJTs). Specifically, they would understand the fundamentals of amplification.
		CO5	Students will be able to seamlessly understand and work on different numbers systems including binary, octal, hexadecimal besides decimal.
		CO6	They will learn about the existence of digital gates besides their need in electronic decision making thus laying the foundation for basic artificial intelligence.
		CO7	Students will learn the fundamentals of operation amplifier and their regular application including those used to sum, subtract and compare two or more signals.
		CO8	They will gain an in-depth understanding of working of Cathode Ray Oscilloscope which effectively acts as an electronic stethoscope for

			analysis of electronic signal in any laboratory.
		CO9	This paper will essentially connect the text book knowledge with the most common electronic components available that influence design of technology in a real world.

COPO MAPPING

	SEMESTER III: COPO MAPPING						
Papers	Program Outcome : PO						
	Course Outcome: CO	PO1	PO2	PO3	PO4	PO5	PO6
DSC 7	CO1	√					
	CO2	√					
	CO3	√					
	CO4	√					
	CO5	√					
	CO6	√					
	CO7	√					
DSC 8	CO1	√					
	CO2	√					
	CO3	√					
	CO4	√					
	CO5	√					
	CO6	√					
	CO7	√					
DSC 9	CO1	√					
	CO2	√					
	CO3	√					
	CO4	√					
	CO5		√				
GE 3	CO1		√				
	CO2	√					
	CO3	√					
	CO4		√				
	CO5	√					
	CO6	√					
	CO7		√				
	CO8		√				
	CO9		√				

SEMESTER IV:

DSC 10: Modern Physics

Unique Paper Code	Name of the Paper	Course Outcome: CO	Statement
2222012401	Modern Physics	CO1	Main aspects of the inadequacies of classical mechanics as well as understanding of the historical development of quantum mechanics. Heisenberg's Uncertainty principle and its applications, photoelectric effect and Compton scattering.
		CO2	The Schrodinger equation in 1-dimension, wave function, probability and probability current densities, normalization, conditions for physical acceptability of wave functions, position and momentum operators and their expectation values, Commutator of position and momentum operators.
		CO3	Time independent Schrodinger equation, derivation by separation of variables, wave packets, particle in a box problem, energy levels. Reflection and transmission across a step and rectangular potential barrier.
		CO4	Modification in Bohr's quantum model: Sommerfeld theory of elliptical orbits.
		CO5	Hydrogen atom energy levels and spectra emission and absorption spectra.
		CO6	X-rays: their production and spectra: continuous and characteristic X-rays, Moseley Law.
		CO7	Lasers and their working principle, spontaneous and stimulated emissions and absorption,

			Einstein's A and B coefficients, Metastable states, components of a laser and lasing action in He-Ne lasers and free electron laser.
		CO8	Basic properties of nuclei, nuclear binding energy, semi-empirical mass formula, nuclear force and meson theory. Radioactivity.
		CO9	Types of Accelerators, Van-de Graaff generator linear accelerator, cyclotron.
DSC 11: Solid State Physics			
2222011402	Solid State Physics	CO1	Elucidate the concept of lattice, crystals and symmetry operations.
		CO2	Understand elementary lattice dynamics and its influence on the properties of materials.
		CO3	Describe the origin of energy bands, and their influence on electronic behaviour.
		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 superconductivity.
DSC 12: Analog Electronics			
2222011403	Analog Electronics	CO1	To learn about diodes and its uses in rectification.
		CO2	To gain an insight into working principle of photodiodes, solar cells, LED and zener diode as voltage regulator.
		CO3	To gain an understanding of construction and working principle of bipolar junction transistors (BJTs), characteristics of different configurations, biasing and analysis of transistor amplifier.
		CO4	To be able to design and understand use of different types of oscillators.

		CO5	To learn the fundamentals of operation amplifiers and understand their operations to compare, add, or subtract two or more signals and to differentiate or integrate signals etc.
GE 4: Quantum Mechanics			
2224002006	Quantum Mechanics	CO1	Learn the methods to solve time-dependent and time-independent Schrödinger equation.
		CO2	Characteristics of an acceptable wave function for any sub atomic particle in various potentials.
		CO3	Applications of the Schrodinger equation to different cases of potentials namely infinite and finite potential well, step potential, rectangular potential barrier, harmonic oscillator potential.
		CO4	Solve the Schrodinger equation in 3-D.
		CO5	Understand the spectrum and eigen functions for hydrogen atom.

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	SEMESTER IV: COPO MAPPING						
Papers	Program Outcome : PO						
	Course Outcome: CO	PO1	PO2	PO3	PO4	PO5	PO6
DSC 10	CO1	√					
	CO2	√					
	CO3	√					
	CO4	√					
	CO5	√					
	CO6	√					
	CO7	√					
	CO8	√					
	CO9	√					
DSC 11	CO1	√					
	CO2	√					
	CO3	√					
	CO4	√					

	CO5	√					
	CO6	√					
DSC 12	CO1	√					
	CO2		√				
	CO3		√				
	CO4		√				
	CO5	√					
GE 4	CO1	√					
	CO2	√					
	CO3	√					
	CO4	√					
	CO5	√					