Department of Physics

M.Sc Physics with Specialization in Material Science

PROGRAM OUTCOMES (PO)

PO1: Advanced Knowledge and Understanding
Graduates will possess an in-depth understanding of fundamental and advanced concepts across various disciplines, enabling them to apply this knowledge to solve complex problems and conduct innovative research. This encompasses advanced mathematical techniques, theoretical and classical physics, and comprehensive understanding in fields such as condensed matter physics, statistical mechanics, and thermodynamics.

PO2: Analytical and Problem-Solving Skills
Graduates will develop strong analytical skills, allowing them to critically assess and solve problems using various methodologies. They will be adept at utilizing mathematical and computational techniques, including numerical analysis, algorithm development, and programming, to model and solve intricate problems in their respective fields.

PO3: Research Proficiency and Methodological Expertise
Graduates will be equipped with advanced research skills, including literature review, research design, data collection, analysis, and interpretation. They will be capable of conducting independent research, presenting findings, and contributing to the academic community through publications and conferences.

PO4: Experimental and Practical Skills
Graduates will demonstrate proficiency in conducting advanced experiments, utilizing modern laboratory techniques, and adhering to safety protocols. They will be skilled in error analysis, data validation, and the application of practical knowledge to verify theoretical concepts.

PO5: Computational and Numerical Proficiency
Graduates will develop expertise in computational methods and numerical techniques, enabling them to perform simulations and solve complex problems in physics, mathematics, and other related fields. This includes proficiency in programming languages and software tools relevant to their discipline.

PO6: Interdisciplinary Integration and Application
Graduates will integrate knowledge from various disciplines to address complex research questions and practical challenges. They will be able to apply concepts from fields such as genetics, bioinformatics, physiology, and immunology to interdisciplinary problems, fostering innovation and collaboration.

PO7: Communication and Presentation Skills
Graduates will enhance their communication skills, both written and verbal, to articulate complex concepts clearly and concisely. They will be proficient in presenting research findings, conducting seminars, and participating in comprehensive viva voce examinations.

PO8: Professional Development and Ethical Practices
Graduates will demonstrate professional development, ethical practices, and a commitment to lifelong learning. They will be prepared for professional roles in academia, industry, and beyond, with an understanding of the ethical implications of their work and the importance of continuous professional growth.

PO9: Cultural Sensitivity and Global Awareness
Graduates will cultivate cultural sensitivity and global awareness by engaging with diverse perspectives and traditions. They will appreciate the richness and diversity of their field, enabling them to navigate cultural differences with empathy and understanding.

PO10: Strategic Decision-Making and Management Skills
Graduates will develop strategic decision-making and management skills, enabling them to evaluate financial, organizational, and marketing strategies effectively. They will be adept at financial analysis, investment management, and applying quantitative techniques to support strategic decisions.

PO11: Adaptability to Emerging Trends and Technologies
Graduates will stay abreast of the latest trends and developments in their field, including emerging technologies and contemporary tools. They will be prepared to adapt to new advancements and incorporate innovative techniques into their research and professional practice.

PO12: Environmental and Societal Impact Awareness
Graduates will be aware of the environmental and societal impacts of their work, promoting sustainability and responsible practices. They will be equipped to contribute to conservation efforts, environmental management, and the development of solutions that address societal challenges.

Program Specific Outcomes (PSO)

Program Specific Outcomes (PSO)	Students will be able to…..	Mapped Program Outcomes (PO)
PSO 1: Advanced Mathematical Techniques	have a strong foundation in advanced mathematical methods and their applications to physics, including complex variables, special functions, and differential equations, which are crucial for solving physics problems (derived from "Mathematical Methods in Physics I & II").	PO1, PO2, PO5
PSO 2: Theoretical and Classical Physics	possess a deep understanding of classical mechanics, electrodynamics, and quantum mechanics, enabling them to analyze physical systems using Lagrangian and Hamiltonian formulations, Maxwell's equations, and quantum mechanical principles (derived from "Classical Mechanics," "Electrodynamics," and "Quantum Mechanics I & II").	PO1, PO2, PO4

PSO 3: Experimental and Practical Skills	be proficient in conducting advanced experiments in general physics, electronics, and material science, with the ability to perform error analysis and verify results against standard values (derived from "General Physics Practicals," "Electronics Practicals," and "Advanced Elective Practicals Material Science Practicals").	PO4, PO5, PO7
PSO 4: Computational and Numerical Methods	develop skills in computational physics, including numerical techniques, algorithm development, and programming, to solve complex physical problems and conduct simulations (derived from "Computational Physics" and "Computational Physics Practicals").	PO2, PO5, PO6
PSO 5: Condensed Matter and Material Physics	have a comprehensive understanding of condensed matter systems, including crystal structures, electron behavior, phonons, and superconductivity, as well as knowledge of advanced materials and nanostructures (derived from "Condensed Matter Physics," "Science of Advanced Materials," and "Nanostructures and Materials Characterisation").	PO1, PO3, PO4

PSO 6: Statistical Mechanics and Thermodynamics	apply statistical methods to analyze classical and quantum systems, understand ensemble theory, and investigate phase transitions, providing a solid foundation in statistical mechanics and thermodynamic behavior (derived from "Statistical Mechanics").	PO1, PO2, PO6
PSO 7: Research and Analytical Skills	be equipped with research skills, including literature review, methodology design, data analysis, and presentation of findings, fostering critical thinking and problem-solving abilities essential for advanced research and professional practice (derived from "Project" and "Comprehensive Viva Voce").	PO3, PO7, PO8

Course Outcomes (CO)

Course	Course Outcome (CO)	Bloom's Taxonomy Level	Mapped PSO
Mathematical Methods in Physics – I	CO1: To equip students with a strong foundation in advanced mathematical techniques and their applications to physics.	Understand	PSO1
	CO2: Develop a deep understanding of advanced mathematical methods used in physics, such as matrices, vector calculus, tensors, and probability theory.	Understand	PSO1
	CO3: Enhance problem-solving abilities by applying mathematical techniques to physics problems.	Apply	PSO1
	CO4: Students will delve into the mathematical foundations of quantum mechanics, including concepts like Hilbert spaces, operators, wave functions, and the principles of quantum mechanics.	Analyze	PSO1
	CO5: Enable to pursue further research in theoretical physics, computational physics, or related fields.	Apply	PSO1
Classical Mechanics	CO1: Understand the fundamental concepts of the Lagrangian and the Hamiltonian methods and will be able to apply them to various problems.	Understand	PSO2
	CO2: Understand the physics of small oscillations and the concepts of canonical transformations and Poisson brackets.	Understand	PSO2
	CO3: Understand the basic ideas of central forces and rigid body dynamics.	Understand	PSO2
	CO4: Understand the Hamilton-Jacobi method and the concept of action-angle variables.	Understand	PSO2
	CO5: Learn preliminary ideas of Lagrangian formulation of relativistic mechanics.	Understand	PSO2

Electrodynamics	CO1: Develop a deep understanding of Maxwell's equations, which form the foundation of classical electromagnetism.	Understand	PSO2
	CO2: Gain proficiency in analyzing electromagnetic fields using Maxwell's equations.	Apply	PSO2
	CO3: Develop proficiency in using mathematical tools such as vector calculus and differential equations to solve problems in electrodynamics.	Apply	PSO2
	CO4: Learn about relativistic electrodynamics.	Understand	PSO2
	CO5: Analyze the behavior of light, including reflection, refraction, dispersion, and interference, using electromagnetic theory.	Analyze	PSO2
	CO6: Learn about electromagnetic induction, Faraday's law, and Lenz's law.	Understand	PSO2
Electronics	CO1: Understanding op-amp fundamentals.	Understand	PSO3
	CO2: Knowledge of IC741 specifications.	Remember	PSO3
	CO3: Op-amp circuit configurations.	Understand	PSO3
	CO4: Frequency response and stability analysis.	Analyze	PSO3
	CO5: Non-ideal op-amp effects.	Understand	PSO3
	CO6: Design and analysis of op-amp circuits.	Apply	PSO3
	CO7: Troubleshooting and debugging.	Apply	PSO3

General Physics Practicals	CO1: Perform advanced experiments in general physics such as Quinck's tube method of determining Magnetic susceptibility of a paramagnetic solution, Cornu's method of determining elastic constant of a transparent material, Fresnel diffraction pattern of a single slit, Absorption bands of $KMnO_4$ using incandescent lamp, coefficient of viscosity of the given liquid by oscillating disc method, Young's modulus of the material of a bar by flexural vibrations, Michelson interferometer determine the wavelength of light, absorption spectrum of iodine vapour and a standard spectrum, charge of an electron using Millikan oil drop experiment, Stefan's constant of radiation from a hot body, etc.	Apply	PSO3
	CO2: Verify the result with the standard values available.	Evaluate	PSO3
	CO3: Do error analysis and check whether the result falls within the desired error limit.	Evaluate	PSO3
Mathematical Methods in Physics – II	CO1: Learn preliminary ideas in complex variable theory and apply important theories in it (Cauchy integral theorem, integral formula, and residue theorem) to evaluate definite integrals.	Understand	PSO1
	CO2: Understand the basic concepts of Laplace and Fourier transforms.	Understand	PSO1
	CO3: Learn special functions (gamma, beta, Bessel, Legendre, Hermite, and Laguerre functions) and their properties like generating function, recurrence relation, orthogonality condition, and Rodrigues formula.	Understand	PSO1
	CO4: Solve partial differential equations using variable separable methods and while in non-homogeneous cases using the Green function.	Apply	PSO1
Quantum Mechanics – I	CO1: Develop a comprehensive understanding of the fundamental principles and concepts of quantum mechanics.	Understand	PSO2

	CO2: Understand the fundamental concepts of the Dirac formalism.	Understand	PSO2
	CO3: Understand how quantum systems evolve in time.	Understand	PSO2
	CO4: Understand the basics of the quantum theory of angular momentum.	Understand	PSO2
Statistical Mechanics	CO1: Apply statistical methods to analyze classical ideal gas systems and accurately enumerate microstates.	Apply	PSO6
	CO2: Understand and apply the concepts of ensemble theory, including phase space and Liouville's theorem.	Understand	PSO6
	CO3: Analyze systems in the canonical ensemble, including their equilibrium with a heat reservoir, and interpret the physical significance of statistical quantities.	Analyze	PSO6
	CO4: Apply quantum mechanical formulations to study quantum systems and analyze statistics of various ensembles.	Apply	PSO6
	CO5: Analyze the thermodynamic behavior of ideal gases in different ensembles, such as quantum-microcanonical, ideal Bose, and ideal Fermi gases.	Analyze	PSO6
	CO6: Analyze phase transitions, including the different phases, thermodynamic potentials, and the application of the Clapeyron equation.	Analyze	PSO6
Condensed Matter Physics	CO1: Understanding of condensed matter systems: Students will develop a solid understanding of condensed matter systems, which encompass a wide range of materials such as solids, liquids, and complex structures.	Understand	PSO5
	CO2: Knowledge of crystal structures and symmetry.	Remember	PSO5
	CO3: Electron behavior in solids.	Understand	PSO5

	CO4: Phonons and lattice vibrations.	Understand	PSO5
	CO5: Magnetic properties of materials.	Understand	PSO5
	CO6: Superconductivity and low-temperature physics.	Understand	PSO5
	CO7: Advanced topics and current research.	Evaluate	PSO5
Electronics Practicals	CO1: Perform advanced experiments in electronics with IC 741, IC 555, etc.	Apply	PSO3
	CO2: Verify the result with the theoretical value.	Evaluate	PSO3
	CO3: Do error analysis for all the experiments.	Evaluate	PSO3
Quantum Mechanics – II	CO1: Understand the different stationary state approximation methods and be able to apply them to various quantum systems.	Understand	PSO2
	CO2: Understand the basics of time-dependent perturbation theory and its application to semi-classical theory of atom-radiation interaction.	Understand	PSO2
	CO3: Understand the theory of identical particles and its application to helium.	Understand	PSO2
	CO4: Understand the idea of Born approximation and the method of partial waves.	Understand	PSO2
	CO5: Introduce the basic concepts of relativistic quantum mechanics.	Understand	PSO2
Computational Physics	CO1: Understand the basic idea of numerical techniques used in physics to solve problems.	Understand	PSO4
	CO2: Solve problems which cannot be solved analytically due to underlying complexity, with the help of computers.	Apply	PSO4
	CO3: Develop algorithms themselves for every method described in the course.	Create	PSO4

Atomic and Molecular Physics	CO1: Apply quantum mechanics to analyze atomic structure and spectra, including the treatment of hydrogen atom and alkali metal vapors.	Apply	PSO5
	CO2: Understand the principles and analyze the spectra of Zeeman effect, Paschen–Back effect, and Stark effect.	Analyze	PSO5
	CO3: Analyze rotational and vibrational spectra of diatomic molecules, including the effects of isotopic substitution and the selection rules for infrared spectroscopy.	Analyze	PSO5
	CO4: Apply the principles of Raman spectroscopy to analyze molecular polarizability, vibrational Raman spectra, and nonlinear Raman effects.	Apply	PSO5
	CO5: Understand and apply the principles of spin resonance spectroscopy, including nuclear magnetic resonance (NMR) and electron spin resonance (ESR), and analyze chemical shift and hyperfine structure.	Analyze	PSO5
	CO6: Understand the principles and applications of Mossbauer spectroscopy, including recoilless emission and absorption, isomer shift, and quadrupole interaction.	Understand	PSO5
Solid State Physics for Materials (Elective – 1)	CO1: Develop a thorough understanding of crystal structures, including concepts such as unit cells, lattice types, and Miller indices.	Understand	PSO5
	CO2: Learn about band theory and its implications for the electronic properties of materials.	Understand	PSO5
	CO3: Understand the role of phonons in determining the thermal properties of materials.	Understand	PSO5

	CO4: Analyze heat transfer mechanisms and thermal behavior in different materials.	Analyze	PSO5
	CO5: Gain an understanding of magnetic properties and their origins in materials.	Understand	PSO5
	CO6: Analyze different types of magnetism, such as paramagnetism, ferromagnetism, and antiferromagnetism, and explain magnetic ordering and hysteresis.	Analyze	PSO5
Advanced Elective Practicals Material Science	CO1: Perform resistivity measurements of single crystals using the four-probe method and determine the energy gap of the material.	Apply	PSO3
	CO2: Compare the temperature-dependent capacitance of ceramic and polymer capacitors and analyze the dielectric constant following Curie-Weiss law.	Analyze	PSO3
	CO3: Use the Hall effect setup to determine the Hall coefficient, mobility of charge carriers, and carrier concentration.	Apply	PSO3
	CO4: Observe and measure the Zeeman effect to understand the shift of atomic energy levels in an external magnetic field.	Analyze	PSO3
	CO5: Conduct experiments to determine the Seebeck coefficient of copper and constantan as a function of temperature and study the para to ferroelectric transition in barium titanate to determine the Curie temperature.	Apply	PSO3
	CO6: Apply experimental techniques to measure the Young's modulus of a metal, investigate the electrical conductivity-temperature relationship of NaCl/KCl, and measure the absolute Seebeck coefficient of n-type and p-type Bismuth telluride.	Apply	PSO3

Nuclear and Particle Physics	CO1: Knowledge of the basic properties of the nucleus and the nuclear force.	Understand	PSO5
	CO2: Understanding of major models of the nucleus and the theory behind the nuclear decay process.	Understand	PSO5
	CO3: Exploring the physics of nuclear reactions.	Analyze	PSO5
	CO4: Study of the interaction between elementary particles and the conservation laws in particle physics.	Understand	PSO5
	CO5: Impart some idea about nuclear astrophysics and the practical applications of nuclear physics.	Understand	PSO5
Science of Advanced Materials	CO1: Understanding advanced materials.	Understand	PSO5
	CO2: Knowledge of material synthesis and characterization.	Remember	PSO5
	CO3: Exploration of material properties.	Analyze	PSO5
	CO4: Applications of advanced materials.	Apply	PSO5
	CO5: Material design and engineering.	Create	PSO5
	CO6: Environmental and sustainability considerations.	Evaluate	PSO5
	CO7: Research and critical thinking skills.	Analyze	PSO5

Nanostructures and Materials Characterisation	CO1: Develop a comprehensive understanding of nanostructures and nanomaterials, including their synthesis methods, properties, and unique characteristics at the nanoscale.	Understand	PSO5
	CO2: Explain the principles behind size-dependent properties and phenomena observed in nanomaterials.	Understand	PSO5
	CO3: Become familiar with a range of characterization techniques used to investigate nanomaterials.	Understand	PSO5
	CO4: Gain knowledge of techniques used to assess the mechanical, electrical, thermal, and optical properties of nanomaterials.	Understand	PSO5
	CO5: Analyze surface properties, such as surface roughness, surface energy, and surface functionalization.	Analyze	PSO5
	CO6: Learn about XRD, TGA, DTA, etc.	Understand	PSO5
Computational Physics Practicals	CO1: Develop algorithm/flowchart for all the experiments.	Create	PSO4
	CO2: Develop code in the Python programming language.	Create	PSO4
	CO3: Edit the code wherever it is required to implement for more complicated situations.	Apply	PSO4
	CO4: Do plotting with the matplotlib package where it is required.	Apply	PSO4
	CO5: Confirm the numerical results obtained with analytical results wherever it is possible.	Evaluate	PSO4
Project	CO1: Research Skills: Develop advanced research skills, including the ability to identify relevant literature, formulate research questions, design methodologies, gather data, analyze information, and draw meaningful conclusions.	Create	PSO7

	CO2: Critical Thinking: Encourage students to think critically and analytically, evaluating various perspectives and evidence to arrive at well-reasoned conclusions.	Evaluate	PSO7
	CO3: Problem-Solving: Identify and address complex problems related to their field of study, applying their knowledge and research findings to propose effective solutions.	Analyze	PSO7
	CO4: Domain Knowledge: Deepen the student's understanding of their specific area of study or specialization within the postgraduate program.	Understand	PSO7
	CO5: Communication Skills: Improve their ability to communicate research findings and ideas effectively, both in written and oral formats, demonstrating clarity and coherence.	Apply	PSO7
	CO6: Project Management: Gain experience in planning, organizing, and executing a significant project, including time management and resource allocation.	Apply	PSO7
	CO7: Ethical Considerations: Be aware of and adhere to ethical principles in conducting research and handling sensitive data.	Understand	PSO7
	CO8: Innovation and Creativity: Demonstrate innovation and creativity in their approach to problem-solving and research, depending on the nature of the project.	Create	PSO7
	CO9: Presentation and Defense: Present their project findings confidently and defend their work during project evaluations or viva voce (oral defense) sessions.	Evaluate	PSO7
	CO10: Contribution to the Field: Make a meaningful contribution to the existing knowledge or practices within the field of study.	Create	PSO7
Comprehensive Viva Voce	CO1: Evaluate Mastery of Subject Matter: Determine whether the student has a deep understanding of the subject matter related to their field of study.	Evaluate	PSO7

	CO2: Critical Thinking and Problem-Solving: Challenge the student to think critically, analyze information, and apply their knowledge to solve complex problems.	Analyze	PSO7
	CO3: Communication Skills: Present their ideas and findings effectively, demonstrating their ability to communicate complex concepts clearly and concisely.	Apply	PSO7
	CO4: Research Skills: Focus on the student's research project, including the research methodology, findings, and implications.	Analyze	PSO7