DEPARTMENT OF PHYSICS

(GENERAL)

PROGRAM OUTCOME AND COURSE OUTCOME

Broadly, Physics involves the study of everything in physical existence, from the smallest subatomic particles to the entire universe. It is one of the most fundamental scientific disciplines based on experimental observations. The acquaintance with Physics helps to realize the working principles of many of our daily appliances. This undergraduate course is designed likewise to offer to a learner a self-complete course in Physics, which let the students know and understand the principles and their applications in real life.

The entire course is designed into a Choice Based Semester System (CBCS), comprising of compulsory course, also called Core Course (CC); juxtaposed with elective subjects like Generic Elective Course (GE), Skill Enhancement Course (SEC), Discipline Specific Elective Course (DSE). The elective courses have been suitably chosen keeping in mind the degree of completeness of study at each semester. The course at each semester have been designed intricately to make the journey interesting and effective.

Program Outcomes (PO)

After completion of B.Sc. General degree with Physics students will able to:

PO1 (Conceptual Insights): Demonstrate conceptual understanding of fundamental physics principles. Collect, analyze, and interpret measurements and draw meaningful conclusions from observations of physical systems.

PO2 (Critical Thinking); Identify gaps in understanding and ask specific questions to address those gaps. Identify potential difficulties in a model or experiment by examining intermediate and end results followed by troubleshooting them.

PO3 (Problem Solving): Solve physics problems using qualitative and quantitative reasoning including sophisticated mathematical techniques.

PO4 (Computational Skills): Use fundamental physical principles to mathematically or computationally model systems

PO5 (Communication Skills): Communicate basic scientific knowledge and the scientific process to a general audience through writing or verbally communicate basic scientific knowledge and the scientific process to a general audience

PO6 (Environment and Sustainability): Understand environmental issues and gain knowledge about sustainability.

Program Specific Outcomes (PSO)

PSO1: Broad understanding of Mechanics: Conservation laws, basic Newtonian physics and general properties of matter.

PSO2: Detailed understanding of Electricity and Magnetism: Electrostatics and basic magnetostatics.

PSO3: Ideas about Statistical Mechanics, basic calorimetry, the ideal gas law, and the laws of thermodynamics.

PSO4: Basic skill of Latex for scientific writing and knowledge of renewable energy and energy harvesting.

PSO5: Knowledge about theory and applications of acoustics and elementary ideas of optical phenomena and optical instruments

PSO6: Basic training on open source electronic prototyping Arduino and theoretical insight of electrical circuits and network skills.

PSO7: Elementary ideas of basic analog and digital electronics including elementary electronic experiments.

PSO8: Overview of Modern Physics including Quantum Mechanics, Relativity, Nuclear and Particle Physics etc.

Course Outcomes (CO)

Course Name	Description
CC-1 (Semester-I) ***Classical Mechanics***	• Comprehensive understanding and application of Newton's laws of motion to describe the behavior of particles and systems of particles. • Proficiency in applying the work-energy theorem to analyze the motion of particles and systems, including the conservation of mechanical energy. • Ability to analyze the dynamics of systems of particles, including the concepts of momentum, impulse, and collisions. • Mastery of central force motion, including the gravitational force, and its application to problems involving orbits and celestial mechanics. • Development of problem-solving skills through the application of mathematical techniques such as calculus and vector analysis to classical mechanics problems. • Understanding the concepts of rotational motion, torque, angular momentum, and the relationship between linear and angular motion. • Preparation for advanced courses in classical mechanics, such as analytical mechanics, as well as applications in fields such as engineering, astrophysics, and aerospace.
CC-2 (Semester-II) ***Electricity & Magnetism***	• Understanding the fundamental principles of electrostatics, including Coulomb's law, electric fields, electric potential, and Gauss's law. • Proficiency in solving problems involving charges, conductors, insulators, and electric fields in various configurations. • Mastery of magnetism, including the behavior of magnetic fields, magnetic forces, magnetic materials, and the application of Ampère's law. • Ability to analyze electromagnetic induction phenomena, including Faraday's law of electromagnetic induction and Lenz's law. • Understanding of the principles of electrodynamics, including the behavior of moving charges in electric and magnetic fields, electromagnetic waves, and Maxwell's equations. • Application of mathematical techniques such as vector calculus and differential equations to solve problems in electricity and magnetism. • Development of critical thinking skills through the application of electromagnetic principles to real-world situations and advanced theoretical problems. • Preparation for advanced courses in electromagnetism, as well as applications in fields such as electrical engineering, telecommunications, and electromagnetic field theory.
CC-3 (Semester-III)	• Understanding of the fundamental laws of thermodynamics, including the zeroth law, the first law (conservation of energy), the second law (entropy), and the third law (absolute zero).

Thermal Physics	• Proficiency in applying thermodynamic principles to analyze and solve problems related to heat, work, energy transfer, and thermodynamic processes. • Mastery of thermodynamic potentials such as internal energy, enthalpy, Helmholtz free energy, and Gibbs free energy, and their significance in determining system behavior and equilibrium conditions. • Ability to apply the kinetic theory of gases to describe the macroscopic properties of gases in terms of microscopic motion of molecules, including concepts like pressure, temperature, and kinetic energy. • Understanding of the theory of radiation, including blackbody radiation, Planck's radiation law, Stefan-Boltzmann law, and Wien's displacement law, and their implications for thermal physics and quantum mechanics. • Application of mathematical techniques such as statistical mechanics, probability theory, and differential equations to analyze thermal systems and radiation phenomena. • Development of critical thinking skills through the application of thermal physics principles to real-world scenarios and advanced theoretical problems. • Preparation for advanced courses in statistical mechanics, quantum mechanics, and fields such as thermal engineering, materials science, and astrophysics. • Understanding the principles of statistical mechanics as applied to systems with many particles. • Proficiency in applying statistical methods to describe the behavior of large ensembles of particles, including classical and quantum systems. • Mastery of probability theory and statistical distributions relevant to statistical mechanics, such as the Maxwell-Boltzmann, Fermi-Dirac, and Bose-Einstein distributions. • Ability to derive and interpret macroscopic thermodynamic properties from statistical mechanics, including entropy, free energy, and specific heat capacities. • Understanding of phase transitions and critical phenomena, and their description within the framework of statistical mechanics. • Proficiency in applying statistical mechanics to study real-world systems such as gases, liquids, solids, and phase transitions.
SEC-A-1 (Semester-III/V) ***Scientific Writing***	• Proficiency in using LaTeX to typeset scientific documents, including research papers, reports, theses, and presentations. • Mastery of LaTeX syntax and commands for formatting text, equations, figures, tables, and references in accordance with scientific writing standards. • Understanding of document structure and organization, including title pages, abstracts, sections, subsections, and bibliographies. • Knowledge of LaTeX packages and templates commonly used in scientific writing to enhance document appearance and functionality.

	• Ability to create and customize mathematical expressions, equations, and symbols using LaTeX's powerful math typesetting capabilities. • Familiarity with bibliography management tools such as Bib TeX or Bib LaTeX for generating citations and bibliographies in various citation styles (e.g., APA, MLA, IEEE). • Skill in collaborative writing and version control using LaTeX in conjunction with platforms like Overleaf or Git. • Awareness of best practices for writing and presenting scientific content, including clarity, conciseness, coherence, and adherence to academic conventions. • Experience with troubleshooting and debugging LaTeX documents to resolve formatting issues and errors effectively. • Confidence in producing high-quality scientific documents suitable for publication, academic submission, or professional communication using LaTeX.
SEC-A-2 (Semester-III/V) ***Renewable Energy***	• Understanding the principles and technologies behind renewable energy sources such as solar, wind, hydroelectric, geothermal, and biomass. • Proficiency in analyzing the environmental, economic, and social impacts of renewable energy deployment. • Mastery of energy harvesting techniques, including piezoelectric, thermoelectric, and electromagnetic methods, for converting ambient energy into usable electrical power. • Ability to evaluate the efficiency, scalability, and feasibility of different renewable energy and energy harvesting technologies. • Understanding of energy storage systems such as batteries, supercapacitors, and pumped hydro for storing renewable energy and managing intermittent energy sources. • Proficiency in designing and implementing renewable energy systems and energy harvesting devices for specific applications and environments. • Application of mathematical modeling, simulation, and optimization techniques to assess the performance and viability of renewable energy and energy harvesting systems. • Development of critical thinking skills through the analysis of case studies, research papers, and real-world examples in the field of renewable energy and energy harvesting. • Preparation for careers in renewable energy engineering, sustainable development, energy policy, and related fields, as well as further study in advanced topics such as renewable energy integration, smart grids, and energy management systems.
CC-4 (Semester-IV) ***Waves and Optics***	• Understanding the fundamental principles of wave motion, including wave equations, wave properties (such as amplitude, frequency, and wavelength), and wave interference.

	• Proficiency in analyzing and solving problems related to various types of waves, including mechanical waves (such as sound waves) and electromagnetic waves (such as light waves). • Mastery of optical phenomena, including reflection, refraction, diffraction, and polarization, and their applications in optics. • Ability to apply wave optics principles to analyze and design optical systems, such as lenses, mirrors, and optical fibers. • Understanding of wave behavior in different mediums and interfaces, including the relationship between wave velocity, frequency, and wavelength. • Proficiency in using mathematical techniques such as calculus and differential equations to describe wave motion and optics phenomena. • Application of experimental methods and laboratory techniques to investigate wave and optics phenomena, including data collection, analysis, and interpretation. • Development of critical thinking skills through the analysis of real-world applications of waves and optics in fields such as imaging, telecommunications, and medical diagnostics. • Preparation for further study or careers in fields such as physics, engineering, photonics, and optical technology, as well as interdisciplinary areas such as bio photonics and quantum optics.
SEC-B-1 (Semester-IV/VI) ***Arduino***	• Understanding the basics of microcontroller programming using Arduino. • Proficiency in writing and debugging code in the Arduino IDE (Integrated Development Environment). • Ability to interface various sensors, actuators, and peripheral devices with Arduino. • Skill in designing and implementing projects that integrate Arduino with other hardware components to solve real-world problems. • Knowledge of common communication protocols such as I2C, SPI, and UART for data exchange between Arduino and external devices. • Competence in utilizing Arduino libraries and resources to expedite development and enhance functionality. • Experience with troubleshooting and debugging Arduino-based systems to identify and resolve issues effectively. • Creativity in designing innovative solutions and applications using Arduino for automation, robotics, IoT (Internet of Things), and other domains. • Awareness of best practices for power management, circuit design, and hardware integration to optimize performance and reliability. • Collaboration and teamwork skills developed through group projects and peer learning activities involving Arduino-based development.
SEC-B-2 (Semester-IV/VI)	The course outcome for topics including DC generator, transformer, AC motor, measurement, and faults may include:

Electrical Circuit & Network Skill	• Understanding the principles and operation of DC generators, transformers, and AC motors. • Ability to analyze and calculate parameters such as voltage, current, power, and efficiency in DC generators, transformers, and AC motors. • Proficiency in measuring electrical quantities accurately using appropriate instruments and techniques. • Knowledge of common faults and failures in electrical systems, including generators, transformers, and motors, and methods for their detection, diagnosis, and rectification. • Skills in troubleshooting electrical systems and implementing preventive maintenance measures to ensure optimal performance and reliability. • Ability to interpret electrical diagrams, schematics, and specifications related to generators, transformers, motors, and associated measurement devices. • Application of theoretical concepts to practical scenarios through laboratory experiments, simulations, and real-world case studies. • Awareness of safety protocols and regulations applicable to electrical equipment and installations to minimize risks and ensure compliance with industry standards.
DSE-A-1 (Semester-V) ***Analog Electronics***	• Understanding the principles of circuits and networks, including basic circuit analysis techniques, circuit laws, and network theorems. • Proficiency in analyzing and designing circuits using semiconductor devices such as diodes, bipolar junction transistors (BJTs), and field-effect transistors (FETs). • Mastery of regulated power supply circuits, including voltage regulators and current sources, and their applications in powering electronic systems. • Ability to analyze and design field-effect transistor (FET) circuits, including amplifiers, switches, and voltage-controlled oscillators. • Understanding the principles of feedback amplifiers and operational amplifiers (OP-AMPs), including ideal op-amp characteristics, inverting and non-inverting amplifier configurations, and frequency response. • Proficiency in analyzing and designing sinusoidal oscillators, including RC, LC, and crystal oscillators, and their applications in signal generation and frequency synthesis. • Application of mathematical techniques such as circuit analysis, differential equations, and Laplace transforms to analyze and design analog electronic circuits. • Development of practical skills through laboratory experiments and projects involving the construction, testing, and troubleshooting of analog electronic circuits. • Preparation for advanced courses in analog and mixed-signal integrated circuit design, as well as careers in fields such as electronics engineering, telecommunications, and instrumentation.

DSE-A-2 (Semester-V) ***Modern Physics***	• Understanding the fundamentals of nuclear structure and properties based on various nuclear models such as the liquid drop model and the nuclear shell model. • Proficiency in analyzing and interpreting nuclear decay processes, including alpha decay, beta decay, gamma decay, and electron capture. • Knowledge of radioactive decay kinetics and decay modes, including half-life, decay constant, and branching ratios. • Ability to calculate and predict nuclear reaction rates and cross-sections for different types of nuclear reactions, such as fusion, fission, and scattering. • Familiarity with the principles and operation of particle accelerators, including linear accelerators, cyclotrons, synchrotrons, and colliders. • Understanding the role of particle accelerators in studying nuclear and particle physics phenomena, such as high-energy collisions and particle interactions. • Proficiency in analyzing experimental data from nuclear and particle physics experiments, including techniques for data collection, analysis, and interpretation. • Knowledge of fundamental particles and their interactions, including leptons, quarks, and gauge bosons, as described by the Standard Model of particle physics. • Awareness of current research topics and advancements in nuclear and particle physics, including applications in fields such as nuclear energy, medical imaging, and cosmology. • Ability to communicate effectively about nuclear and particle physics concepts, theories, and experimental results through written reports, presentations, and discussions.
DSE-B-1 (Semester-VI) ***Digital Electronics***	• Understanding the fundamentals of integrated circuits (ICs), including their classification, fabrication process, and application in digital systems. • Proficiency in working with different number systems, including binary, decimal, octal, and hexadecimal, and their conversion techniques. • Mastery of digital logic circuits, including combinational logic circuits (such as logic gates and multiplexers) and sequential logic circuits (such as flip-flops and shift registers). • Ability to design and analyze digital circuits using Boolean algebra, Karnaugh maps, and truth tables. • Understanding of data processing techniques in digital systems, including arithmetic operations, logic operations, and data manipulation. • Proficiency in designing and analyzing sequential circuits, including finite state machines, counters, and sequential logic circuits with feedback. • Mastery of registers and counters, including their types, operation, and application in digital systems for data storage and counting.

	• Application of digital electronics principles to solve practical problems and design digital systems for various applications. • Development of practical skills through laboratory experiments and projects involving the construction, testing, and troubleshooting of digital circuits. • Preparation for advanced courses in digital system design, computer architecture, embedded systems, and digital signal processing, as well as careers in fields such as digital design engineering, hardware engineering, and embedded systems development.
DSE-B-2 (Semester-VI) ***Nuclear & Particle Physics***	• Understanding the fundamentals of nuclear structure and properties based on various nuclear models such as the liquid drop model and the nuclear shell model. • Proficiency in analyzing and interpreting nuclear decay processes, including alpha decay, beta decay, gamma decay, and electron capture. • Knowledge of radioactive decay kinetics and decay modes, including half-life, decay constant, and branching ratios. • Ability to calculate and predict nuclear reaction rates and cross-sections for different types of nuclear reactions, such as fusion, fission, and scattering. • Familiarity with the principles and operation of particle accelerators, including linear accelerators, cyclotrons, synchrotrons, and colliders. • Understanding the role of particle accelerators in studying nuclear and particle physics phenomena, such as high-energy collisions and particle interactions. • Proficiency in analyzing experimental data from nuclear and particle physics experiments, including techniques for data collection, analysis, and interpretation. • Knowledge of fundamental particles and their interactions, including leptons, quarks, and gauge bosons, as described by the Standard Model of particle physics. • Awareness of current research topics and advancements in nuclear and particle physics, including applications in fields such as nuclear energy, medical imaging, and cosmology. • Ability to communicate effectively about nuclear and particle physics concepts, theories, and experimental results through written reports, presentations, and discussions.