Name of the Programme: B.Sc. Physics (CBCS)

Programme Outcomes (PO)

After completing the Three Year Undergraduate Programme in Physics, Students are expected to achieve the following Programme Outcomes:

PO1: Knowledge and Comprehension

PO2: Analytical Skills

PO3: Experimental Skills

PO4: Critical Thinking

PO5: Problem-Solving Skills

PO6: Computational Proficiency

PO7: Research and Inquiry Skills

PO8: Communication and Presentation Skills

PO9: Ethics and Values

PO10: Interdisciplinary and Multidisciplinary Learning:

PO11: Lifelong learners

PO12: Employability

Programme Specific Outcomes (PSO)

After completing the programme, the students will be able to gain the following programme specific outcomes-

PSO1: Advanced Problem Solving

PSO2: Specialized Knowledge in Key Areas

PSO3: Practical Laboratory Experience

Course Outcomes (CO)

B.Sc. 1st Semester

Course Title: MATHEMATICAL PHYSICS-I
Course Code: PHYSICS-CI

On completion of this Course, the students will be able to –

CO1 Understand fundamental concepts in calculus, including limits, continuity, differentiation, and the intuitive ideas of functions, as well as the properties of vectors and vector operations

CO2 Apply calculus techniques to solve differential equations, including first and second-order equations, and to perform operations on functions of more than one variable, such as partial differentiation and constrained maximization

CO3 Analyze and interpret vector calculus concepts, such as directional derivatives, gradient, divergence, and curl of vector fields, and apply vector calculus identities

CO4 Evaluate vector fields over lines, surfaces, and volumes, apply Gauss' divergence theorem, Green's theorem, and Stokes's theorem, and understand their applications

CO5 Understand probability concepts, including independent and dependent events, probability distribution functions, conditional probability, Bayes' theorem, and hypothesis testing, as well as the definition and properties of the Dirac delta function.

Course Title: MECHANICS-I
Course Code: PHYSICS-CII

At the end of this course, the student will be able to:

CO1 Understand classical mechanics, including Newton's laws of motion, conservation principles (such as momentum and angular momentum), and the behavior of particles and systems under various forces.

CO2 Apply the principles of conservation of energy, momentum, and angular momentum to analyze and solve problems involving complex physical systems, including collisions, rotations, and oscillations.

CO3 Understand special relativity, including the Lorentz transformations, time dilation, length contraction, and relativistic kinematics, enabling them to analyze phenomena at high velocities and understand the implications of Einstein's theory.

CO4 Analyze motion in different reference frames, including inertial and non-inertial frames, and understand the concept of fictitious forces.

C05 Analyzed fluid motion, including understanding Poiseuille's equation and its application to fluid flow in capillary tubes, as well as understanding elasticity and the relation between elastic constants.

B.Sc. 2nd Semester

Course Title: Electricity and Magnetism

Course Code: PHYSICS-CIII

At the end of this course, the student will be able to:

CO1 Understand electrostatics and magnetostatics, including the behavior of electric and magnetic fields, their sources, and the principles governing their interactions with charges and currents.

CO2 Apply fundamental laws such as Gauss's Law, Ampere's Law, and Biot-Savart's Law to calculate electric and magnetic fields generated by various charge and current distributions, including those with symmetrical geometries.

CO3 Understand the principles behind capacitance, inductance, and magnetic properties of materials, enabling them to design and analyze circuits and devices effectively.

CO4 Apply Maxwell's equations to analyze and solve problems involving electromagnetic phenomena.

CO5 Analyze and design complex electrical circuits, including AC components and reactive elements, utilizing Kirchhoff's laws, network theorems, and impedance concepts, such as Thevenin's and Norton's theorems.

Course Title: WAVES AND OPTICS

Course Code: PHYSICS-CIV

At the end of this course, the students will be able to:

CO1 Understand various wave phenomena, including superposition, interference, diffraction, and wave optics, through both theoretical knowledge and practical applications.

CO2 Analyze and interpret wave behavior, such as the formation of Lissajous figures, the calculation of wave velocities, and the determination of diffraction patterns.

CO3 Apply mathematical concepts, including differential equations, integral theorems, and Fourier analysis, to model and analyze complex wave systems accurately.

CO4 Apply their knowledge and understanding of wave principles to assess and interpret complex phenomena, such as diffraction patterns and interference fringes.

CO5 Apply the knowledge of optical instruments and collecting data from the setups like Michelson interferometer and Fraunhofer diffraction and interpreting the resulting experimental outcomes, they will apply theoretical predictions to real-world scenarios.

B.Sc. 3rd Semester

Course Title: MATHEMATICAL PHYSICS – II
Course Code: PHYSICS-CV

At the end of this course, the students will be able to:

CO1 Understand the fundamental principles of the Fourier series, including the orthogonality of sine and cosine functions, and apply them to expand periodic functions into a series of sine and cosine functions.

CO2 Apply the complex representation of Fourier series to expand functions with arbitrary periods, and develop the ability to expand non-periodic functions over a given interval.

CO3 Understand special functions such as Legendre polynomials and Bessel functions, including their properties, orthogonality, and recurrence relations.

CO4 Understand Frobenius's method for solving second-order linear differential equations with singular points.

CO5 Apply the concept of separation variable of the method of differential equation to solve Laplace's equation, the wave equation, and the diffusion equation in various physical contexts, including problems of rectangular, cylindrical, and spherical symmetry.

Course Title: Thermal Physics
Course Code: PHYSICS-CVI

At the end of this course, the students will be able to:

CO1 Understand fundamental thermodynamic laws, including the zeroth, first, and second laws, along with concepts such as thermodynamic equilibrium, work, heat, and entropy.

CO2 Apply concepts such as state functions, thermodynamic potentials, and Maxwell's relations to solve problems related to heat engines, refrigerators, and gas behavior.

CO3 Understand the concept of entropy and its role in reversible and irreversible processes, as well as the properties and applications of thermodynamic potentials such as internal energy, enthalpy, Helmholtz free energy, and Gibbs free energy.

CO4 Apply the principles of the kinetic theory of gases to understand the distribution of velocities, collision phenomena, mean free path, and transport properties of gases, including viscosity, thermal conductivity, and diffusion.

CO5 Analyze the behavior of real gases, including deviations from ideal gas behavior, the Virial equation, critical constants, Van der Waals equation of state, and experimental methods such as Joule's experiment and the Joule-Thomson effect, enhancing their understanding of gas behavior under various conditions.

Course Title: Digital Systems and Applications
Course Code: PHYSICS-CVII

At the end of this course, the students will be able to:

CO1 Understand CRO, ICs, digital circuits, and arithmetic circuits.

CO2 Analyze digital circuits using Boolean algebra and logic gates, including data processing circuits, arithmetic circuits, and sequential circuits.

CO3 Understand about input/output devices, memory organization, interfacing, and computer
architecture.

CO4 Understand 8085 microprocessor architecture, including its main features, block diagram, components, pin-out diagram, buses, registers, ALU, memory, stack memory, timing and control circuitry, instruction cycle, and timing diagram.

CO5 Apply knowledge of 1-byte, 2-byte, and 3-byte instructions to effectively program microprocessors, understanding their specific applications and implications in programming tasks.

B.Sc. 4th Semester

Course Title: Mathematical Physics-III
Course Code: PHYSICS-CVIII

At the end of this course, the students will be able to:

CO1 Recall the fundamental concepts of complex numbers, including Euler's formula, De Moivre's theorem, and graphical representation.

CO2 Understand the principles of complex analysis, including the significance of analytic functions, poles, branch points, and singularities. Comprehend the conditions for analyticity such as the Cauchy-Riemann equations, and grasp the concepts of Laurent and Taylor expansions.

CO3 Apply complex analysis techniques to solve problems involving the integration of functions of complex variables, utilizing Cauchy's Inequality and Cauchy's Integral formula. Apply the Residue Theorem to evaluate contour integrals and solve definite integrals.

CO4 Analyze the properties and applications of Fourier transforms, including their behavior under translation, scaling, and complex conjugation. Analyze the solutions of differential equations using Laplace transforms.

CO5 Create solutions to complex problems in physics and engineering by applying integral transform techniques, such as Fourier and Laplace transforms, to analyze and solve differential equations governing various physical phenomena.

Course Title: Elements of Modern Physics
Course Code: PHYSICS-CIX

At the end of this course, the students will be able to:

CO1 Understand fundamental principles in quantum mechanics, including Planck's quantum theory, wave-particle duality, the photoelectric effect, Compton scattering, De Broglie wavelength, and the Davisson-Germer experiment enabling them to explain the wave-like and particle-like behavior of matter and radiation.

CO2 Applying the Schrödinger equation, wave functions, probability densities, and quantum
mechanical scattering, students will be able to analyze and interpret physical systems,
such as one-dimensional potential barriers and quantum dots, illustrating phenomena
like tunneling and quantum mechanical scattering.

CO3 Understand the structure of the atomic nucleus, including the role of nuclear forces and the principles underlying models such as the Liquid Drop Model and Nuclear Shell Model.

CO4 Analyze the concepts of radioactivity, decay processes, and energy-momentum conservation principles, facilitating their understanding of nuclear stability, decay modes, and the characteristics of nuclear reactions. write in short

CO5 Recall the key principles involved in the operation of lasers, including Einstein's coefficients, metastable states, and population inversion.

Course Title: Analog Systems and Applications
Course Code: PHYSICS-CX

At the end of this course, the students will be able to:

CO1 Understand semiconductor diodes, including P-N junction formation, energy level diagrams, and current flow mechanisms in forward and reverse-biased states.

CO2 Apply their understanding of rectifier diodes and Zener diodes to design and analyze
power supply and regulation circuits.

CO3 Understand the principles and structures of LEDs, photodiodes, and solar cells.

CO4 Analyze the characteristics of bipolar junction transistors (BJTs) in various configurations (CB, CE, CC) to understand their operational differences and applications.

CO5 Apply their knowledge of transistor biasing, stabilization circuits, and amplifier configurations to design both single-stage and multistage amplifiers.

B.Sc. 5th Semester

Course Title: Quantum Mechanics and Applications
Course Code: PHYSICS-CXI

At the end of this course, the students will be able to:

CO1 Understand the fundamentals of the time-dependent Schrödinger equation and its role in describing the dynamical evolution of quantum states.

CO2 Understand the principles of normalization, linearity, and superposition, as well as the operators associated with position, momentum, and energy.

CO3 Understand bound states in arbitrary potentials, focusing on the continuity of wave functions, boundary conditions, and the emergence of discrete energy levels.

CO4 Analyze the shapes of probability densities associated with different atomic states and recognize their implications for electron shells and spectral notations.

CO5 Understand the behavior of many electron atoms, including Pauli's exclusion principle, fine structure, spin-orbit coupling, and Hund's rule, gaining a deeper understanding of atomic structure and spectroscopic phenomena.

Course Title: Solid State Physics
Course Code: PHYSICS-CXII

At the end of this course, the students will be able to:

CO1 Understand the difference between amorphous and crystalline materials, as well as understand lattice translation vectors, unit cells, Miller indices, and reciprocal lattices.

CO2 Analyze the behavior of linear monoatomic and diatomic chains through the study of lattice vibrations and phonons.

CO3 Understand the distinction between acoustical and optical phonons, and gain insight into Dulong and Petit's Law, as well as the theories of specific heat by Einstein and Debye.

CO4 Understand the characteristics of dia-, para-, ferri-, and ferromagnetic materials, including classical and quantum mechanical treatments.

CO5 Analyze classical theories of electric polarizability and understand concepts such as normal and anomalous dispersion

Course Title: Classic Dynamics
Course Code: PHYSICS DSE-I

At the end of this course, the students will be able to:

CO1 Apply the principles of Newtonian mechanics, Hamilton's principle, Lagrangian dynamics, and Hamiltonian mechanics to analyze the motion of point particles in external electric and magnetic fields, as well as systems involving small amplitude oscillations.

CO2 Analyze the phenomena such as time dilation, length contraction, and the twin paradox, as well as understand the concept of four vectors and their applications to relativistic kinematics and dynamics through the study of the postulates of special relativity, Lorentz transformations, and Minkowski spacetime

CO3 Analyze phenomena such as the Doppler effect, two-body decay of unstable particles, and the conservation of four-momentum in relativistic interactions.

CO4 Understand the principles of fluid dynamics, including density, pressure, continuity
equation, and mass conservation.

CO5 Apply theoretical concepts to practical situations, such as analyzing motion in external fields, understanding relativistic effects in particle interactions, and solving fluid dynamics problems in engineering and physics.

Course Title: Astronomy and Astrophysics
Course Code: PHYSICS DSE-II

At the end of this course, the students will be able to:

CO1 Understand astronomical quantities including distances, masses, timescales, and brightness measurements, as well as the concepts of radiant flux and luminosity, alongside the measurement techniques employed in astronomy to ascertain these parameters.

CO2 Understand the basic parameters of stars, including distance determination, brightness, temperature, and mass determination.

CO3 Understand the principles behind optical telescopes, including different types of reflecting telescopes, telescope mountings, and detectors used in conjunction with telescopes.

CO4 Understand the gravitational principles in astrophysics, including the virial theorem and the comparison between Newtonian and Einsteinian gravitation.

CO5 Understand solar magneto-hydrodynamics, helioseismology, the structure and properties of the Milky Way galaxy, galaxy morphology and classification, and cosmological concepts such as the cosmic distance ladder, Hubble's law, and the role of dark matter in galaxy clusters.

B.Sc. 6th Semester

Course Title: Electromagnetic Theory
Course Code: PHYSICS-CXIII

At the end of this course, the students will be able to:

CO1 Understand Maxwell's equations and their applications in electromagnetism, including concepts such as displacement current, vector and scalar potentials, and electromagnetic wave propagation.

CO2 Analyze electromagnetic wave propagation in unbounded and bounded media, including understanding wave impedance, reflection, refraction, and polarization phenomena.

CO3 Understand the principles of polarization of electromagnetic waves, including linear, circular, and elliptical polarization, as well as the propagation of light in anisotropic media and the use of optical elements such as polarizers and phase retardation plate

CO4 Apply the principles of optical devices and techniques, including waveguides and optical fibers, their operating principles, and their applications in modern optical communication systems.

CO5 Apply the principles of electromagnetic wave theory to solve practical problems related to wave propagation, polarization, and optical devices, thereby enhancing their problem-solving and analytical skills in the field of electromagnetism and optics.

Course Title: Statistical Mechanics
Course Code: PHYSICS-CXIV

At the end of this course, the students will be able to:

CO1 Understand statistical mechanics principles, including macrostate and microstate concepts, phase space, entropy, and thermodynamic probability, and their applications in describing the behavior of systems with a large number of particles.

CO2 Understand the classical and quantum theories of radiation, including the properties of thermal radiation, blackbody radiation, Planck's quantum postulates, Bose-Einstein statistics, and Fermi-Dirac statistics, and their applications in describing the behavior of radiation in various physical systems.

CO3 Analyze the thermodynamic functions, such as partition functions, entropy expressions, and thermodynamic functions of ideal gases, strongly degenerate Bose gases, and completely and strongly degenerate Fermi gases, and their applications in understanding the thermodynamic properties of different physical systems.

CO4 Apply statistical mechanics principles to analyze and describe physical systems, such as Bose-Einstein condensation, properties of liquid helium, electron gas in metals, specific heat of metals, and relativistic Fermi gas, and their applications in understanding phenomena in condensed matter physics, astrophysics, and other fields.

CO5 Understand classical and quantum concepts in statistical mechanics and radiation theory to analyze complex physical systems, such as the derivation of Planck's law from quantum principles and the application of statistical mechanics to describe the behavior of radiation and matter in equilibrium and non-equilibrium conditions.

Course Title: Nuclear and Particle Physics

Course Code: PHYSICS DSE-III

At the end of this course, the students will be able to:

CO1 Understand the general properties of nuclei, including their constituents, intrinsic properties, binding energy, nuclear excitation states, and the main features of the binding energy versus mass number curve.

CO2 Remember various nuclear models, including the liquid drop model and Fermi gas model, and understand the significance of terms in the semi-empirical mass formula, conditions for nuclear stability, evidence for nuclear shell structure, and the concept of mean-field and residual interaction.

CO3 Understand alpha, beta, and gamma decay processes, including the theory behind each decay mode, energy kinematics, and decay spectroscopy, as well as the concepts of Q-value, Geiger-Nuttall law, and internal conversion.

CO4 Understand various types of nuclear reactions, conservation laws, kinematics, reaction rates, cross-sections, and concepts such as compound and direct reactions, resonance reactions, and Coulomb scattering.

CO5 Understand particle physics concepts, including particle interactions, conservation laws, particle families, symmetries, and the quark model as well they will also gain knowledge about particle accelerators, their facilities available in India, and their role in advancing research in nuclear and particle physics.

Course Title: Nano Materials and Applications
Course Code: PHYSICS DSE-IV

At the end of this course, the students will be able to:

CO1 Understand nanoscale systems, including the various length scales in physics, different types of nanostructures (1D, 2D, and 3D), and the band structure and density of states of materials at the nanoscale.

CO2 Understand synthesis of nanostructure materials through both top-down and bottom-up approaches, utilizing various methods such as photolithography, ball milling, vapor deposition techniques (PVD and CVD), sol-gel, and hydrothermal synthesis.

CO3 Analyze the characterization of nanostructures using advanced techniques such as X-ray diffraction, optical microscopy, scanning electron microscopy (SEM), transmission electron microscopy (TEM), atomic force microscopy (AFM), and scanning tunneling microscopy (STM).

CO4 Comprehend the optical properties of nanostructures, including Coulomb interactions, dielectric constants, quasi-particles, excitons, and radiative processes.

CO5 Understand the applications of nanoparticles, quantum dots, nanowires, and thin films in photonic devices, single electron transfer devices, CNT-based transistors, magnetic data storage, MEMS, and NEMS.

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