Semester	Paper	Course	Course Outcome (CO)
1st	MDC-1/MDC Minor-1: BASIC PHYSICS-I (Theory)	**(A) Mathematical Physics: [20 Lecture Periods (LP)]** ***1. Preliminaries:*** SI system of units, dimensional analysis. Plotting of functions (both cartesian and polar), Limits, Intuitive ideas about continuity and differentiability of a function. Taylor series of one variable and binomial series (statements only); Maxima and minima for functions of one variable. Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. [5 LP] ***2. Ordinary Differential Equations*:** First order linear differential equations and integrating factor. Linear second order homogeneous equations with constant coefficients. Simple harmonic motion as an example. [2 LP] ***3. Vectors:*** Dot, cross, scalar triple and vector triple products of cartesian vectors. Vector differentiation. Scalar and vector fields --- gradient, divergence, curl and Laplacian (for Cartesian coordinates), solenoidal and irrotational vector field. Statement of Divergence theorem and Stokes' theorem; application to simple cases. [7 LP] ***4. Curvilinear coordinates*:** Plane polar, spherical polar and cylindrical polar coordinates: their unit vectors, role of unit vectors as basis vectors. Surface and volume element (from geometry). Line, surface and volume integrals. Form of the gradient operator in curvilinear coordinates. Velocity and acceleration of point particle in Cartesian, plane polar, spherical polar, cylindrical polar coordinates. [6 LP]	Students will learn basics of SI system of units, dimensional analysis, plotting of functions, Limits, continuity and differentiability of a function, Taylor series, Partial derivatives, exact and inexact differentials and other mathematical topics that will help understand physics throughout the lessons and develop problem solving skills. Students will learn to solve first and second-order homogeneous and inhomogeneous differential equations with constant coefficients, with application in damped Harmonic oscillators and other areas of physics. Students will learn in detail the vector algebra, scaler and vector products, vectors identities, and vector calculus, curvilinear coordinates with applications in all areas of physics.
		(B) Classical Mechanics: [30 Lecture Periods] ***1. Review of Newton's Laws*:** Concepts of Inertial frames; force and mass. Galilean transformations and Galilean invariance; Newton's laws of motion, principle of conservation of linear momentum, Simple problems involving motion under resistive forces. Rotational motion: Angular velocity, angular acceleration, angular momentum, torque, principle of conservation of angular momentum. [6 LP] ***2. Work Kinetic Energy Theorem:*** Conservative Forces: Force as the gradient of a scalar field. Concept of potential and potential energy. Other equivalent definitions of a conservative force. Conservation of energy. Qualitative study of one-dimensional motion from potential energy curves. Stable and unstable equilibrium. [4 LP] ***3. Dynamics of a system of particles*:** The problem of solving equation of motion; Actionreaction kind of forces and the two body problem; Reduced mass & centre of mass; Properties of the centre of mass; Effect of torque; Linear momentum, angular momentum & total energy of a system of particles. [4 LP]	At the end of the discussion, students will be able to understand the meaning of Newton's laws and their applicability in diverse physical phenomena. Also, they will understand the dynamics of system of particles in realistic scenarios. Moreover, they will have a clear understanding on the conservation laws. Also, students will learn central force field, law of force in central force field, Kepler's Laws, Newton's Law of Gravitation, and Satellite in circular orbit and its applications, as well as two important topics: Two body collision and scattering and Mechanics of Continuum.

		4. Central force: Newton's Law of Gravitation; Kepler's Laws; Conservation of angular momentum, Gauss's law for Gravitation (integral form); Gravitational potential and intensity due to uniform spherical shell, solid sphere of uniform density and infinite flat sheet. Differential equation for the path in a central force field. Motion under an inverse square force, calculation of orbits. [8 LP] ***6. Scattering:*** Two body collision and scattering [2 LP] ***7. Mechanics of Continuum:*** Kinematics of Moving Fluids: Idea of compressible and incompressible fluids, Equation of continuity; streamline and turbulent flow, Reynold's number. Stokes' law from dimensional analysis; Euler's Equation and the special case of fluid statics. Simple applications (e.g., Pascal's law and Archimedes principle). Bernoulli's Theorem. [6 LP]	
	MDC-1/MDC Minor-1: BASIC PHYSICS-I (Practical)	**List of Practical** 1. Measurement of the diameter of a wire using screw gauge a number of times and to determine the mean, median, mode & standard deviation for study of random error in observation. 2. Measurement of a suitable vertical height using Sextant. 3. Determination of the Moment of Inertia of a metallic cylinder/rectangular rod about an axis passing through its centre of gravity 4. Determination of modulus of rigidity of the material of a suspension wire by dynamical method. 5. To determine the coefficient of viscosity of water by Poiseuille's method.	At the end of these experiments students will develop skill to study various physical/mechanical/general properties and their inter connections experimentally.
2nd	**MDC-2/MDC Minor-2: BASIC PHYSICS - II (Theory)**	**(A) Basic Electricity and Magnetism [22 LP]** ***1. Electrostatics:*** Coulomb's law, Electric field, Electric field lines. Superposition Principle. Electric flux. Idea of charge density (linear, surface, volume) and continuous charge distributions. Gauss' Law (in integral form) with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Introduction to electrostatic potential, Equipotential surfaces. Calculation of potential for linear, surface and volume charge distributions: simple cases (e.g.: uniform line charge, disc, spherical shell, sphere etc). Potential and field due to a physical dipole; Torque, force and Potential Energy of an electric dipole in a uniform electric field. Electrostatic energy of a system of charges, a charged sphere. Conductors in an electrostatic Field. Mechanical force on the surface of a charged conductor. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Capacitance for parallel-plate, cylindrical, spherical capacitors (without	Students will learn Coulomb's law in detail with electric field, potential and Gauss's law for different charged surfaces. They learn properties of conductors and its applications. They learn dielectrics and their behaviour and applications. Students will learn Lorentz force, Biot-Savart law, and their applications for different problems to find magnetic fields. They learn Ampere's circuital law and its applications to simple cases, as well as Torque and force on magnetic dipole in a uniform magnetic field.

		dielectrics). Energy stored in the Electrostatic field. [11 LP] ***2. Lorentz force:*** Force on a moving charge in simultaneous electric and magnetic fields, force on a current carrying conductor in a magnetic field. Trajectory of charged particles in uniform electric field, crossed uniform electric and magnetic fields. Basic principle of cyclotron. [3 LP] ***3. Magnetostatics:*** Concept of current density (linear, surface, volume). Equation of continuity. Biot and Savart's law, magnetic field due to a straight conductor, circular coil, Helmholtz coil, solenoid. Ampere's circuital law with applications (Infinite long wire, infinite solenoid, infinite current sheet). Magnetic field due to a small current loop - concept of magnetic dipole. Torque and force on magnetic dipole in a uniform magnetic field. [8 LP]	
		(B) Introduction to Thermodynamics [28 LP] ***1. Kinetic theory:*** Macroscopic and microscopic description of matter, Postulates of molecular kinetic theory of an ideal gas, Relation between microscopic and macroscopic state variables, Maxwell's velocity distribution, Concept of pressure and temperature. [3 LP] ***2. Zeroth and First Law of Thermodynamics:*** Extensive and intensive thermodynamic variables. Thermodynamic equilibrium, zero-th law of Thermodynamics & concept of temperature. Concept of work & heat, State Functions, internal energy and first law of Thermodynamics, its differential form, first law & various processes. Applications of first law: General relation between C_P and C_V, work done during isothermal and adiabatic processes, compressibility and expansion coefficient. [9 LP] ***3. Second Law of Thermodynamics:*** Reversible and irreversible process with examples. Interconversion of work and heat. Heat engines. Carnot's cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, Kelvin-Planck and Clausius statements for the second law and their equivalence. Carnot's Theorem. Applications of second law of Thermodynamics: Thermodynamic scale of temperature and its equivalence to perfect gas scale. [10 LP] ***4. Entropy:*** Concept of Entropy, Clausius theorem. Clausius inequality, Second law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of increase of Entropy. Entropy changes in reversible and irreversible processes with examples. Entropy of the universe. Principle of increase of Entropy. Temperature-Entropy diagrams for different cycles. Third law of Thermodynamics. Unattainability of absolute zero. [6 LP]	At the end of this topic, students will learn about Maxwell's law of distribution of velocities and learn to solve various problems. The course makes the students able to understand the basic physics of heat and temperature and their relationship with energy, and work. The students also learn how different laws of thermodynamics are used. Importantly, students will learn the second law of thermodynamics and its application to various processes. They will also learn the concept of Entropy and third law of thermodynamics.

	MDC-2/MDC Minor-2: BASIC PHYSICS – II (Practical)	**List of Practical** 1. Conversion of an ammeter to voltmeter and vice versa. 2. Determination of an unknown low resistance using Carey-Foster's Bridge. 3. Measurement of current by potentiometer. 4. Measurement of pressure coefficient of expansion of air by Jolly's apparatus. 5. Measurement of coefficient of thermal expansion of a metallic rod by optical lever arrangement.	At the end of these experiments, students will develop skill to study various electrical properties of different instruments. Also, they will develop sufficient skill to perform experiments related to different thermal properties of matter.
	SEC-1: INTRODUCTION TO COMPUTER PROGRAMMING AND GRAPH PLOTTING (PRACTICAL)	***1. Introduction to Graph Plotting (2D only, using GNUPLOT)*** (a) **Plotting 2D graphs:** both functions and data files. Changing plot range and plot styles: the options- with points (w p), with dots (w d), with lines (w l), with linespoints (w lp), linetype (lt), linewidth (lw). Using the set command for samples, xrange, yrange, xlabel, ylabel, title etc. The using option. ***2. Introduction to programming in python*** (Version 3.x): (a) Introduction • Using the python interpreter as a calculator • Variable and data types (int, float, complex, list, tuple, set, string, the type() function) • Basic mathematical operations • Compound statements in python – Conditionals (if, elseif, else) – Loops (for, while) – User defined functions def: (return statement, default values for arguments, keyword arguments), lambda function. • Importing modules with math and cmath as examples • Using help and dir command to use the inbuilt manual • Python scripts, I/O operations (including opening and writing to files) The python data types • List: defining lists, reading and changing elements from lists, slicing, list comprehension. – built in functions involving lists: range(), len(), sum(), min(), max() – list methods: append(), extend(), count(), index(), sort(), insert(), pop(), remove(), reverse() • Tuples: Contrast and compare with lists, packing/unpacking using tuples (including a,b=b,a to swap variables) • Strings: defining strings, the use of single, double or triple quotes as string delimiters, len(), indexing, slicing, string concatenation, some string methods: split(), join(), find(), count(), replace()	At the end of this lesson, students will develop graph plotting skills using scientific tool GNUPLOT. Also, they will acquire skills to write programming in python (an open source computational/programming language) and apply it in diverse fields of Physics and other areas.

Program Outcomes (PO)

The theoretical and experimental topics covered in the course outcome (CO) document, aim to equip students with skills, knowledge, mathematical proficiency, and critical thinking. It focuses on the application of theoretical and experimental knowledges across interdisciplinary and diverse fields, preparing students to excel in academia, industry, and other real-life arenas.

The experimental lab helps students to develop skills and competencies for future experimental research and development (R&D), as well as to tackle real-world challenges.

GNUPLOT, Python programming, and LaTeX have profound impacts on students aiming to pursue careers in academia, industry, research, engineering, and self-employment. These skills (with open-source scientific software) are essential for data visualization and analysis in the highly demanding field of data science, scripting, critical data analysis, and algorithm development. Python programming enhances software development capabilities, while LaTeX equips students with scientific document preparation skills, mathematical typesetting, and collaborative writing abilities. Together, these tools empower students to excel in various technical and scientific domains.