NARAJOLE RAJ COLLEGE

(NAAC Accredited 'B' Grade Govt. Aided College)
NARAJOLE: PASCHIM MEDINIPUR: WEST BENGAL: Pin-721211
E-mail: narajolerajcollege@rediffmail.com
Website: https://www.narajolerajcollege.ac.in

Programme Specific Outcomes (PSOs)

Physics (Hons.)

The students of Physics (Hons.) will acquire their theoretical, computational and experimental knowledge about the different branches of Physics like Mathematical Physics, Quantum Mechanics, Electricity & Magnetism, Waves, Optics, Electronics, Mechanics, Heat, Thermodynamics, Modern Physics, Medical Physics, Nanotechnology, Biophysics, etc. by studying this programme. They will attain the quantitative and predictive understanding of Physics in different mathematical, biological and chemical phenomena. This programme also opens up the career paths to select in many related and sub-related areas like academics, research, scientific laboratories, instrumentation and industries, etc.

After completion of the programme, the graduates will be capable of-

PSO1: Acquiring the knowledge about the different core branches of Physics like Mathematical Physics, Quantum Mechanics, Electricity & Magnetism, Waves, Optics, Electronics, Mechanics, Heat, Thermodynamics, and Modern Physics, etc.

PSO2: Developing the ability to use skills in Physics and its related domains of technology for formulating and tackling Physics-related problems.

PSO3: Acquiring their understanding skills about the different experiments of different branches of Physics by designing as well as conducting several experimental arrangements for the proper interpretation and analysis of the experimental results and drawing the conclusions by the supporting data.

PSO4: Developing several experiment related tools e.g. mathematical modelling for simple and multipart physical systems, various curve fitting, data and error analysis.

PSO5: Accumulating their knowledge and skills about the applications of numerical techniques for solving different problems of different branches of Physics, beside the theoretical and experimental skills.

PSO6: Attaining a level of proficiency and intellectually in stimulating/ computational knowledge and skill about the applications of computer programming and numerical techniques for solving different problems of Physics as well as real-world problems.

PSO7: Comprehending and cultivating an understanding of the influence of Physics and Physical Sciences on the modern society as well as different general real-world situations as well as phenomenon.

PSO8: Attaining the quantitative and predictive understanding of Physics in different mathematical, biological and chemical phenomena.

PSO9: Developing investigative skills and knowledge on different modern and budding interdisciplinary branches, such as Molecular Biology, Biophysics, Biomechanics, Nanotechnology as well as Nano-biology, etc. that helps them in their higher studies in that branches, other than core Physics.

PSO10: Demonstrating professional behaviour such as being objective, unbiased and truthful in all aspects of work and avoiding unethical, irrational behaviour such as fabricating, falsifying or misrepresenting data or committing plagiarism and the ability to identify the potential ethical issues in work-related situations.

PSO11: Developing proficiency and skill on the set up of different instruments and different electrical and electronics circuits as well as workshops skills.

PSO12: Developing communication skills involving the ability to listen carefully, to read texts and research papers analytically and to present complex information in a concise manner to different groups / audiences of technical or popular nature.

PSO13: Opening the career paths to select a career in many related and sub-related areas like academics, research, scientific laboratories, instrumentation and industries, etc.

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Programme Specific Outcomes (PSOs)

Physics (General)

The students of Physics (Gen or DSC)will acquire their theoretical and experimental basic knowledge about the different branches of Physics like Mathematical Physics, Quantum Mechanics, Electricity & Magnetism, Waves, Optics, Electronics, Mechanics, Heat, Thermodynamics, and Modern Physics, etc. by studying this programme. They willattain the quantitative and predictive understanding of Physics in different mathematical, biological and chemical phenomena.This programme also opens up the career paths to select in many related and sub-related areas like academics, scientific laboratories, instrumentation and industries etc.

After completion of the programme, the graduates will be capable of-

PSO1: Acquiring the knowledge about the different core branches of Physics like Mathematical Physics, Quantum Mechanics, Electricity& Magnetism, Waves, Optics, Electronics, Mechanics, Heat, Thermodynamics, and Modern Physics, etc.

PSO2: Developingthe ability to use skills in Physics and its related domains of technology for formulating and tackling Physics-related problems.

PSO3:Acquiring their understanding skills about the different experiments of different branches of Physics by designing as well as conductingseveral experimental arrangementsfor the proper interpretation and analysis of theexperimental results and drawing the conclusions by the supporting data.

PSO4:Accumulating their knowledge and skills about the applications of numerical techniques for solving different problems of different branches of Physics, beside thetheoretical and experimental skills.

PSO5: Comprehending and cultivating a basic understanding of the influence of Physics and Physical Sciences on the modern society as well as different general real-world situations as well as phenomenon.

PSO6:Attaining the quantitative and predictive understanding of Physics in different mathematical, biological and chemical phenomena.

PSO7: Demonstrating professional behaviour such as being objective, unbiased and truthful in all aspects of work and avoiding unethical, irrational behaviour such as fabricating, falsifying or misrepresenting data or committing plagiarism and the ability to identify the potential ethical issues in work-related situations.

PSO8: Developing proficiency and skill on the set up of different instruments and different electrical and electronics circuits as well as workshops skills.

PSO9:Opening the career paths to select a career in many related and sub-related areas like academics, scientific laboratories, instrumentation and industries, etc.

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Estd.-1966

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Course Outcome

Physics (Hons.)

Semester	I
Title of Course	Mathematical Physics – I (CC-1)
Paper Code	C1T (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (H) of Semester-I will acquire the knowledge about the Calculus, Vector Calculus, Orthogonal Curvilinear Coordinates, Probability, Dirac Delta Function by studying this course.

The theory paper (C1T) of this course (CC-1) provides the student with-

CO1: Physical concept and solutions of different mathematical problems on limits, continuity, average and instantaneous quantities, differentiation.

CO2: Familiarization with plotting functions, continuous, differentiable etc. functions and plotting of curves.

CO3: Physical concept and statement of Taylor and Binomial series as well as solution of mathematical problems.

CO4: Solution of problems on first order differential equations with integrating factor, homogeneous equations with constant coefficients and concept of Wronskian and general solution.

CO5: Theory and statement of existence and uniqueness theorem for initial value problems and solution of problems on particular integral.

CO6: Solution of problems on partial derivatives, exact and inexact differentials, integrating factor, with simple illustration, constrained maximization using Lagrange multipliers.

CO7: Theory of vector rotation, scalar product, vector product, scalar triple product and their interpretation in terms of area and volume respectively, scalar and vector fields as well as solution of different mathematical problems on these topics.

CO8: Theory of directional derivatives and normal derivative, gradient of a scalar field and its geometrical interpretation, divergence and curl of a vector field, Del and Laplacian operators along with solution of different mathematical problems on these topics.

CO9: Concept and theory of ordinary integrals of vectors, multiple integrals, Jacobian, line, surface and volume integrals of vector field along with solution of different mathematical problems on these topics.

CO10: Statements of Gauss' divergence theorem, Green's and Stokes Theorems and their applications in terms of different mathematical problems.

CO11: Concept of orthogonal curvilinear coordinates as well as mathematical derivation of gradient, divergence, curl and Laplacian in Cartesian, spherical polar and cylindrical polar coordinate systems.

CO12: Concept and theory on probability distribution functions, binomial, Gaussian, and Poisson distribution, with solution of different mathematical problems on these topics.

CO13: Concept of mean and variance, conditional probability, Bayes' Theorem and the idea of hypothesis testing along with solution of different mathematical problems on these topics.

CO14: Understanding the basic concept of Dirac delta function, representation as limit of a Gaussian function and rectangular function, properties of Dirac delta function along with solution of different mathematical problems on these topics.

Semester	I
Title of Course	Mathematical Physics – I (CC-1)
Paper Code	C1P (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (H) of Semester-I will acquire the practical knowledge about the Basics of Scientific Computing, Errors and Error Analysis, Plotting of Graphs with Gnuplot, Python Programming on Random Number Generation, Solution of Algebraic and Transcendental Equations by Bisection, Newton Raphson and Secant Methods, Interpolation by Newton Gregory Forward and Backward Difference Formula, Error Estimation of Linear Interpolation, Numerical Differentiation (Forward and Backward Difference Formula) and Integration (Trapezoidal and Simpson Rules), Monte Carlo Method, Solution of Ordinary Differential Equations (ODE) and First Order Differential Equation by Euler, Modified Euler and Runge-Kutta (RK) Second and Fourth Order Methods by hands on computer programming.

The lab paper (C1P) of this course (CC-1) provides the student with-

CO1: Basic concept of computer architecture and organization, memory and input/output devices.

CO2: Study of basics of scientific computing such as-binary and decimal arithmetic, floating point numbers, algorithms, sequence, selection and repetition, single and double precision arithmetic, underflow and overflow-emphasize the importance of making equations in terms of dimensionless variables, iterative methods.

CO3: Concept and analysis of truncation and round off errors, absolute and relative errors, floating point computations.

CO4: Theoretical concept and plotting graphs with Gnuplot including basic 2D and 3D graph plotting, plotting functions and data-files, fitting data using Gnuplot's fit function, polar and parametric plots, modifying the appearance of graphs, surface and contour plots, exporting plots.

CO5: Introduction to Python programming, constants, variables and data types, dynamical typing, operators and expressions, modules, I/O statements, iterables, compound statements, indentation in python, the if-elif-else block, for and while loops, nested compound statements, lists, tuples, dictionaries and strings, basic ideas of object oriented Python programming.

CO6: Computation of different Python programming such as sum and average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, binary search.

CO7: Computation of Python programming on Random number generation, such as area of circle, area of square, volume of sphere, value of pi (π) etc.

CO8: Computation of Python programming on solution of algebraic and transcendental equations by bisection, Newton Raphson and Secant methods such as solution of linear and quadratic equation, solving $\tan\alpha = \alpha$ etc.

CO9: Computation of Python programming on interpolation by Newton Gregory forward and backward difference formula, error estimation of linear interpolation, such as evaluation of trigonometric functions e.g. $\sin\theta$, $\cos\theta$, $\tan\theta$ etc.

CO10: Computation of Python programming on numerical differentiation (forward and backward difference formula) and integration (trapezoidal and Simpson rules), Monte Carlo method such as given position with equidistant time data to calculate velocity and acceleration and vice versa, finding the area of B-H Hysteresis loop.

CO11: Computation of Python programming for the solution of ordinary differential equations (ODE) of first order differential equation Euler, modified Euler and Runge-Kutta (RK) second and fourth order methods such as radioactive decay, current in RC, LC circuits with DC source, Newton's law of cooling, classical equations of motion, pendulum motion, coupled differential equation.

Semester	I
Title of Course	Mechanics (CC-2)
Paper Code	C2T (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (H) of Semester-I will acquire the knowledge about the Fundamentals of Dynamics, Work and Energy, Collisions, Rotational Dynamics, Elasticity, Fluid Motion, Gravitation and Central Force Motion, Oscillations, Non-Inertial Systems, Special Theory of Relativity by studying this course.

The theory paper (C2T) of this course (CC-2) provides the student with-

CO1: Understanding the basics of Newton's laws of motion and their application to various dynamical situations, idea of inertial frames and concept of Galilean invariance.

CO2: Basic concept of dynamics of a system of particles and centre of mass, procedure to evaluate centre of mass in different bodies, concept of impulse.

CO3: Physical concept of variable-mass system, motion of a rocket and motion of a projectile in uniform gravitational field.

CO4: Differentiation between conservative and non-conservative forces, kinetic energy and potential energy, stable and unstable mechanical equilibrium.

CO5: Familiarization with elastic potential energy, conceptual background of force as gradient of potential energy, methods to calculate the work done by and against a force field, work done by non-conservative forces.

CO6: Learning the concept of conservation of energy, linear momentum, angular momentum and their applications to basic problems.

CO7: Understanding the analogy between translational and rotational dynamics, angular velocity and angular acceleration, torque and application of both motions in simultaneous analysis of rolling with slipping.

CO8: Basic concept for the moment of inertia about the given axis of symmetry for different uniform mass distributions, particularly cylindrical and spherical bodies.

CO9: Understanding the phenomena of elastic and inelastic collisions and idea about centre of mass and laboratory frames and their correlation.

CO10: Understanding the principles of elasticity through the study of a few elastic constants e.g. Young's modulus and modulus of rigidity, twisting torque on a cylinder or wire.

CO11: Basic idea on simple principles of fluid flow and the equations governing fluid dynamics, Poiseuille's equation for flow of a liquid through a capillary tube.

CO12: Understanding the basics of laws of gravitation, inertial and gravitational mass, potential and field due to spherical shell and solid sphere.

CO13: Ideas of central force field, a two-body problem and reduction of it into one-body problem.

CO14: Application of Kepler's law to describe the motion of planets and satellites in circular orbit through the study of law of gravitation, concept of geosynchronous orbits and global positioning system (GPS).

CO15: Explanation of the phenomena of simple harmonic motion and the properties of systems executing such motions, e.g. kinetic energy, potential energy, the solution of the differential equation of SHM.

CO16: Building up ideas on damped oscillation, forced oscillations, transient and steady states, resonance and sharpness of resonance.

CO17: Description of non-inertial frames and fictitious forces arising in a non-inertial frame.

CO18: Concept of centrifugal force, coriolis force and their applications, ideas on the components of velocity and acceleration in cylindrical and spherical coordinate systems.

CO19: Demonstration of special theory of relativity (STR) through Michelson-Morley experiment and postulates of STR.

CO20: Ideas of length contraction, time dilation, effects of STR on the mass and energy of a moving object.

CO21: Understanding the concept of massless particles, mass-energy equivalence, description of relativistic Doppler effect.

CO22: Familiarization with the ideas of relativistic kinematics and transformation of energy and momentum.

Semester	I
Title of Course	Mechanics (CC-2)
Paper Code	C2P (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (H) of Semester-I will acquire the practical knowledge about the Slide Callipers, Screw Gauge and Travelling Microscope, Random Errors, Sextant, Motion of a Spring, Moment of Inertia of a Flywheel, Digital Timing Technique, Capillary Flow Method, Optical Lever Method, Bar Pendulum, Kater's Pendulum, Elastic Constants by Searle's Method, Maxwell's Needle Method by hands on practical experiments.

The lab paper (C2P) of this course (CC-2) provides the student with-

CO1: Study of necessary theory, working formula and experimental measurement of length (or diameter) using slide callipers, screw gauge and travelling microscope.

CO2: Study of necessary theory, working formula and experimental observation of random errors originating in different measurements and their analysis.

CO3: Study of necessary theory, working formula and experimental determination of the height of a building using a sextant.

CO4: Study of necessary theory, working formula and experimental observation for the motion of a spring and calculation of its spring constant, acceleration due to gravity (g) and modulus of rigidity of the material.

CO5: Study of necessary theory, working formula and experimental determination the moment of inertia of a flywheel.

CO6: Study of necessary theory, working formula and experimental determination of acceleration due to gravity (g) and velocity for a freely falling body using digital timing technique.

CO7: Study of necessary theory, working formula and experimental determination of the coefficient of viscosity of water by capillary flow or Poiseuille's method.

CO8: Study of necessary theory, working formula and experimental determination of the Young's modulus of a wire by optical lever method.

CO9: Study of necessary theory, working formula and experimental determination of the modulus of rigidity of a wire by Maxwell's needle.

CO10: Study of necessary theory, working formula and experimental determination of the elastic constants of a wire by Searle's method.

CO11: Study of necessary theory, working formula and experimental determination the value of acceleration due to gravity (g) using Bar Pendulum.

CO12: Study of necessary theory, working formula and experimental determination the value of acceleration due to gravity (g) using Kater's Pendulum.

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Semester	II
Title of Course	Electricity and Magnetism (CC-3)
Paper Code	C3T (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (H) of Semester-II will acquire the knowledge about the Electric Field and Electric Potential, Dielectric Properties of Matter, Magnetic Field, Magnetic Properties of Matter, Electromagnetic Induction, Electrical Circuits, Network Theorems by studying this course.

The theory paper (C3T) of this course (CC-3) provides the student with-

CO1: Demonstration of Gauss' Law and Coulomb's Law for the electric field and application to systems of point charges as well as line, surface and volume distributions of charges.

CO2: Explanation and differentiation of the vector (electric fields from Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics.

CO3: Application of Gauss' Law of electrostatics to solve a variety of problems.

CO4: Basic knowledge of electric current, resistance and capacitance in terms of electric field and electric potential, idea about electrostatic energy and calculation.

CO5: Concept of electric fields in matter, polarization and polarization charges, dielectric materials.

CO6: Demonstration of working and understanding of capacitors of various shapes filled with dielectrics.

CO7: Concept of displacement vector D, applications of Gauss' law in dielectric materials.

CO8: Demonstration of Biot Savart Law for current carrying elements and its application to systems of straight wire and current loops.

CO9: Concept of Ampere's Circuital Law and its application to (a) infinite straight wire, (b) infinite planar surface current and (c) solenoids.

CO10: Concept of magnetic dipoles, magnetic vector potential and magnetic forces.

CO11: Understanding the magnetic properties of materials and magnetic susceptibility, magnetic permeability, magnetic hysteresis.

CO12: Concept of electromagnetic induction by Faraday's Law and Lenz Law, self inductance and mutual inductance.

CO13: Description of magnetic energy stored, introduction to Maxwell's Equations.

CO14: Applications of Kirchhoff's rules to analyze AC circuits consisting of parallel and/or series combinations of voltage sources and resistors and to describe the graphical relationship of resistance (R), capacitor (C) and inductor (L).

CO15: Concept of complex reactance and impedances of various AC circuits.

CO16: Idea of constant-current and constant-voltage sources, electrical networks.

CO17: Concept of various network theorems such as superposition, Thevenin, Norton, reciprocity, maximum power transfer theorems etc.

CO18: Applications of these theorems in electronics, electrical circuit analysis and electrical machines.

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Semester	II
Title of Course	Electricity and Magnetism (CC-3)
Paper Code	C3P (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (H) of Semester-II will acquire the practical knowledge about the Multimeter for the Measurement of Resistances, AC and DC Voltages, DC Current, Capacitances and Checking of Electrical Fuses, Characteristics of a Series RC Circuit, Potentiometer, Carey Foster's Bridge, Thomson's Method, Solenoid, Applications of Thevenin, Norton, Superposition, Maximum Power Transfer Theorems, Anderson's Bridge, Series and Parallel LCR Circuits by hands on practical experiments.

The lab paper (C3P) of this course (CC-3) provides the student with-

CO1: Study of necessary theory, working formula and experimental observation to use a multimeter for the measurement of (a) resistances, (b) AC and DC voltages, (c) DC current, (d) capacitances and (e) checking of electrical fuses.

CO2: Study of necessary theory, working formula and experimental measurement to study the characteristics of a series RC Circuit.

CO3: Study of necessary theory, working formula and experimental determination of an unknown low resistance using a potentiometer.

CO4: Study of necessary theory, working formula and experimental determination of an unknown low resistance using Carey Foster's bridge.

CO5: Study of necessary theory, working formula and experimental determination of the resistance of a galvanometer using Thomson's method.

CO6: Study of necessary theory, working formula and experimental measurement of field strength B and its variation in a solenoid.

CO7: Study of necessary theory, working formula and experimental verification of the Thevenin and Norton theorems.

CO8: Study of necessary theory, working formula and experimental verification of the superposition and maximum power transfer theorems.

CO9: Study of necessary theory, working formula and experimental determination of the self-inductance of a coil by Anderson's bridge.

CO10: Study of necessary theory, working formula and experimental measurement to study the response curve of a series LCR circuit and determination of its (a) resonant frequency, (b) impedance at resonance, (c) quality factor Q and (d) band width.

CO11: Study of necessary theory, working formula and experimental measurement to study the response curve of a parallel LCR circuit and determination of its (a) anti-resonant frequency and (b) quality factor Q.

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Semester	II
Title of Course	Waves and Optics (CC-4)
Paper Code	C4T (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (H) of Semester-II will acquire the knowledge about the Superposition of Collinear Harmonic Oscillations and Perpendicular Harmonic Oscillations, Wave Motion, Velocity of Waves, Superposition of Two Harmonic Waves, Wave Optics, Interference, Interferometer, Diffraction and Holography by studying this course.

The theory paper (C4T) of this course (CC-4) provides the student with-

CO1: Understanding the theory of superposition principle of collinear harmonic oscillations and solutions of harmonic oscillations with equal and different frequencies and phases.

CO2: Demonstration of Lissajous Figure both graphically and analytically and calculation of the resulting pattern with equal and unequal frequencies.

CO3: Physical concept of plane wave, spherical wave, longitudinal and transverse wave and expression for the fundamental frequency of the longitudinal waves.

CO4: Expression for the differential equation of a plane progressive wave, longitudinal wave and transverse wave and calculation of wave velocity, pressure and intensity.

CO5: Learning the concept of water waves, ripple and gravity waves.

CO6: Brief discussion about the formation of stationary waves for the transverse vibration of a stretched string under tension and fixed at the two ends.

CO7: Expression for the velocity of longitudinal waves created in a fluid in a pipe.

CO8: Understanding the phenomena of Newton's formula for velocity of sound and Laplace's Correction.

CO9: Explanation of the amplitudes of the different frequencies of a uniformly stretched string with two ends when free and fixed, calculation of the total energy of vibrating string.

CO10: Understanding the phenomena of group velocity and phase velocity, relationship between them.

CO11: Analysis of the motion of a plucked string and stretched string, deduction of the general expression for its displacement and derivation of the characteristic frequency to show that its vibration obeys the Young's law.

CO12: Description of Melde's experiment for transverse and longitudinal vibrations, concept about open and closed pipes and superposition of N harmonic waves.

CO13: Ideas of electromagnetic nature of light, wave front of light, definition and properties of wave front, demonstration of Huygens' Principle, concept of temporal spatial coherence.

CO14: Demonstration of the Young's experiment for interference of light, calculation of fringe width.

CO15: Explanation of the formation of interference fringes by Fresnel's biprism and Lloyd's mirror experiment.

CO16: Explanation of the Stokes' treatment for phase changes on reflection, interference pattern in parallel and wedge shaped thin film.

CO17: Demonstration of the formation of Newton's rings, expression for wavelength measurement, determination of the refractive index of rare liquids.

CO18: Idea about the construction and the principle of working of a Michelson's interferometer.

CO19: Ideas of intensity of the fringe system formed by the transmitted light in a Febry-Perot interferometer experiment.

CO20: Ideas of Kirchhoff's integral theorem, integral formula, Fraunhofer diffraction pattern due to a single slit, double slit and multiple slit.

CO21: Ideas on Fresnel diffraction pattern of a straight edge, a slit and a wire, Fresnel's half-period zones for plane wave.

CO22: Ideas and calculation of resolving power of a telescope and a diffraction grating.

CO23: Discussion about the principle of holography, recording and reconstruction method of holography and theory of holography.

Semester	II
Title of Course	Waves and Optics (CC-4)
Paper Code	C4P (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (H) of Semester-II will acquire the practical knowledge about the Melde's Experiment, Motion of Coupled Oscillators, Lissajous Figures, Schuster's Method of Focusing, Refractive Index of a Material of a Prism, Dispersive Power and Cauchy Constants of a Material, Wavelength of a Sodium Source using Michelson's Interferometer, Fresnel Biprism and Newton's Rings, Thickness of a Thin Paper using Wedge-shape Film, Wavelength of Sodium Source and Spectral Lines of Mercury Source using Plane Diffraction Grating, Dispersive Power and Resolving Power of Plane Diffraction Grating by hands on practical experiments.

The lab paper (C4P) of this course (CC-4) provides the student with-

CO1: Study of necessary theory, working formula and experimental measurement of the frequency of an electric tuning fork by Melde's experiment.

CO2: Study of necessary theory, working formula and experimental observation for investigation of the motion of coupled oscillators.

CO3: Study of necessary theory, working formula and experimental determination of Lissajous figures.

CO4: Study of necessary theory, working formula and experimental setup with Schuster's focusing method to determine the angle of prism.

CO5: Study of necessary theory, working formula and experimental determination of refractive index of the material of a prism using sodium source.

CO6: Study of necessary theory, working formula and experimental determination of the dispersive power and Cauchy constants of the material of a prism using mercury source.

CO7: Study of necessary theory, working formula and experimental determination of the wavelength of sodium source using Michelson's interferometer.

CO8: Study of necessary theory, working formula and experimental determination of the wavelength of sodium light using Fresnel's biprism.

CO9: Study of necessary theory, working formula and experimental determination of the wavelength of sodium light using Newton's rings.

CO10: Study of necessary theory, working formula and experimental determination of the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped film.

CO11: Study of necessary theory, working formula and experimental determination of the wavelength of (1) sodium source and (2) spectral lines of mercury source using plane diffraction grating.

CO12: Study of necessary theory, working formula and experimental determination of the dispersive power and resolving power of a plane diffraction grating.

Semester	III
Title of Course	Mathematical Physics – II (CC-5)
Paper Code	C5T (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (H) of Semester-III will acquire the knowledge about the Fourier Series of Periodic and Non-periodic Functions, its Application to Summing of Infinite Series, Differentiation and Integration of Fourier Series, Frobenius Method and its Applications to Differential Equations, Beta and Gamma Functions, Variational Calculus and Solutions to Partial Differential Equations using Method of Separation of Variables by studying this course.

The theory paper (C5T) of this course (CC-5) provides the student with-

CO1: Study of periodic functions, orthogonality of sine and cosine functions and the Dirichlet conditions.

CO2: Theory of expansion of periodic functions in a series of sine and cosine functions and the determination of Fourier coefficients, complex representation of Fourier series.

CO3: Familiarization with Fourier expansion of functions with arbitrary periods and the expansion of non-periodic functions over an interval.

CO4: Study of the Fourier expansions for even and odd functions and their application, summing of infinite series.

CO5: Study of the term-by-term differentiation and integration of Fourier series and Parseval identity.

CO6: Concept of singular points of second order linear differential equations and their importance, Frobenius method and its applications to differential equations.

CO7: Study of Legendre differential equations, properties of Legendre polynomials, Rodrigues formula, generating function and the orthogonality of Legendre polynomials.

CO8: Familiarization with the simple recurrence relations for the Legendre polynomials and the idea of expansion of function in a series of Legendre polynomials.

CO9: Mathematical solutions to Bessel, Hermite and Laguerre differential equations and the properties of their polynomials.

CO10: Study of Bessel functions of the first kind, generating function, simple recurrence relations, zeros of Bessel functions ($J_0(x)$ and $J_1(x)$) and their orthogonality.

CO11: Mathematical definition of Beta and Gamma functions and the relation between them, expression of integrals in terms of Gamma functions, error function (probability integral).

CO12: Basic ideas of functionals, extremization of action as a basic principle in mechanics and Lagrangian formulation.

CO13: Study of Euler's equations of motion for simple systems like harmonic oscillators, simple pendulum, spherical pendulum, coupled oscillators.

CO14: Concept of cyclic co-ordinates, relationship between the symmetries and the conservation laws.

CO15: Theory of Legendre transformations and the Hamiltonian formulation of mechanics, Canonical equations of motion and their applications to simple systems.

CO15: Study of solutions to partial differential equations using separation of variables, Laplace's equation in problems of rectangular, cylindrical and spherical symmetry.

CO16: Study of wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes and the solution to diffusion equation.

Estd.-1966

Semester	III
Title of Course	Mathematical Physics – II (CC-5)
Paper Code	C5P (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (H) of Semester-III will acquire the knowledge about the Basics of Numerical Computation using Scipy and Numpy Modules of Python, Basics of Linear Algebra using Linalg Submodule, Curve Fitting, Least Square Fit, Solutions of Linear Systems of Equation, Matrix Algebra, Generation of Functions and the Solution of Ordinary Differential Equations using Different Methods like Euler Method, Runge-Kutta, Fixed Difference Method by hands on computer programming.

The lab paper (C5P) of this course (CC-5) provides the student with-

CO1: Introduction to Python numpy module, array definition in numpy, array operations, array item selection, array slicing and shaping of arrays.

CO2: Doing basic linear algebra using the linalg submodule, graph plotting using matplotlib, introduction to the scipy module and its uses in optimization and solution of differential equations.

CO3: Learning the Curve fitting, least square fit, goodness of fit and standard deviation, use of Ohm's law to calculate the resistance and Hooke's law to calculate spring constant.

CO4: Python program for the solution of linear system of equations by Gauss elimination method and Gauss Seidel method.

CO5: Python program for the diagonalization of matrix, inverse of a matrix and eigenvalues and eigenvectors of matrix.

CO7: Python program to generate and plot Legendre polynomials and Bessel functions.

CO8: Python program for finding the solutions to ordinary differential equations (ODEs) using Euler method or Runge-Kutta method. The ODEs can be related to physics problems like radioactive decay, current in RC, LC circuits with DC source, Newton's law of cooling, Harmonic oscillator, damped oscillator etc.

CO9: Python program for finding solutions to partial differential equations (PDEs) related to wave equation, heat equation, Poisson equation and Laplace equation.

Semester	III
Title of Course	Thermal Physics (CC-6)
Paper Code	C6T (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (H) of Semester-III will acquire the knowledge about the Laws of Thermodynamics and their Applications, Various Thermodynamic Processes, Thermodynamic Potentials, Maxwell's Thermodynamic Relations, Kinetic Theory of Gases with Maxwell-Boltzmann Distribution of Velocities in an Ideal Gas, Transport Phenomenon in Ideal Gases and Behaviour of Real Gases by studying this course.

The theory paper (C6T) of this course (CC-6) provides the student with-

CO1: Thermodynamic description of a system, extensive and intensive thermodynamic variables, thermodynamic equilibrium, zeroth law of thermodynamics and the concept of temperature.

CO2: Concept of work and heat, state functions, first law of thermodynamics and its differential form, idea of internal energy and examples of various thermodynamic processes involving the first law.

CO3: Applications of first law of thermodynamics, general relation between C_P and C_V, calculations of work done during isothermal and adiabatic processes, compressibility and expansion coefficient.

CO4: Concept of reversible and irreversible processes with examples, conversion of work into heat and heat into work, heat engines, Carnot's cycle, Carnot's engine and its efficiency, idea of refrigerator and coefficient of performance.

CO5: Statement of second law of thermodynamics, Kelvin-Planck and Clausius statements and their equivalence, Carnot's theorem.

CO6: Study of applications of second law of thermodynamics, thermodynamic scale of temperature and its equivalence to perfect gas scale.

CO7: Concept of entropy, Clausius theorem, Clausius inequality, second law of thermodynamics in terms of entropy, entropy of a perfect gas and principle of increase of entropy.

CO8: Study of entropy change in reversible and irreversible processes, entropy-temperature diagrams, third law of thermodynamics and the unattainability of absolute zero.

CO9: Theoretical and mathematical understanding of the thermodynamic potentials e.g. internal energy, enthalpy, Gibbs free energy and Helmholtz free energy.

CO10: Study of surface films and variation of surface tension with temperature, magnetic work, cooling due to adiabatic demagnetization.

CO11: Study of first and second order phase transitions with examples, Clausius-Clapeyron equation and Ehrenfest equations.

CO12: Derivations of Maxwell's relations and applications of Maxwell's relations to (a) Clausius-Clapeyron equation, (b) values of Cp-Cv, (c) TdS equations, (d) Joule-Kelvin coefficient for ideal and Van der Waal Gases, (e) energy equations, (f) change of temperature during adiabatic process.

CO13: Derivation of Maxwell-Boltzmann law of velocity distribution in an ideal gas and its experimental verification, mean, RMS and most probable speeds, Doppler broadening of spectral lines and Stern's experiment.

CO14: Concept of degrees of freedom, statement of the law of equipartition of energy and its application to specific heats of gases.

CO15: Study of the molecular collisions, mean free path, collision probability and the estimates of mean free path.

CO16: Study of the transport phenomena in ideal gas, viscosity, thermal conductivity and diffusion, Brownian motion and its significance.

CO17: Study of the behaviour of real gases, deviations from the ideal gas equation, the Virial equation, description of Andrew's experiments.

CO18: Concept of the continuity of liquid and gaseous state, vapour and gas, definition of Boyle temperature.

CO19: Study of Van der Waals equation of state for real gases, values of critical constants, law of corresponding states, comparison with experimental curves, P-V diagrams.

CO20: Theory of Joule's experiment, free adiabatic expansion of a perfect gas.

Semester	III
Title of Course	Thermal Physics (CC-6)
Paper Code	C6P (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (H) of Semester-III will acquire the practical knowledge about the Mechanical Equivalent of Heat, Coefficient of Thermal Conductivity of Good Conductor and Bad Conductor, Temperature Coefficient of Resistance, Variations of Thermo EMF across Junctions of a Thermocouple and Calibration of a Thermocouple to Measure Temperature in a Specified Range using Difference Method by hands on practical experiments.

The lab paper (C6P) of this course (CC-6) provides the student with-

CO1: Study of necessary theory, working formula and experimental method to determine mechanical equivalent of heat J, by Callender and Barne's constant flow method.

CO2: Study of necessary theory, working formula and experimental method to determine the coefficient of thermal conductivity of Cu by Searle's apparatus.

CO3: Study of necessary theory, working formula and experimental method to determine the coefficient of thermal conductivity of Cu by Angstrom's method.

CO4: Study of necessary theory, working formula and experimental method to determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.

CO5: Study of necessary theory, working formula and experimental method to determine the temperature coefficient of resistance by platinum resistance thermometer.

CO6: Study of necessary theory, working formula and experimental method to study the variation of thermo EMF of a thermocouple with difference of temperature of its two junctions.

CO7: Study of necessary theory, working formula and experimental method to calibrate a thermocouple to measure temperature in a specified range using (i) null method and (ii) direct measurement using Op-Amp difference amplifier and determination of neutral temperature.

Semester	III
Title of Course	Digital Systems and Applications (CC-7)
Paper Code	C7T (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (H) of Semester-III will acquire the knowledge about the Integrated Circuits, Digital Circuits, Boolean Algebra, Data Processing Circuits, Circuits, Timers, Shift Registers, Counters (4 bits), Computer Organization by studying this course.

The theory paper (C7T) of this course (CC-7) provides the student with-

CO1: Understanding the basics of active and passive components, discrete components, wafer, chip, advantages and drawbacks of ICs.

CO2: Basic concept on scale of integration i.e. SSI, MSI, LSI and VLSI, classification of various types ICs, example of linear and digital ICs.

CO3: Differentiation between digital and analog circuits, binary numbers, decimal to binary and binary to decimal conversion, BCD, octal and hexadecimal numbers.

CO4: Building up ideas on AND, OR and NOT gates, realization of these gates using diodes and transistors, NAND and NOR gates as universal gates, XOR and XNOR gates, application as parity checkers.

CO5: Ideas on De Morgan's theorems, Boolean laws, simplification of logic circuit using Boolean algebra, fundamental products of Boolean algebra.

CO6: Basic idea of minterms and maxterms, conversion of a truth table into equivalent logic circuits by (1) sum of product method and (2) Karnaugh map.

CO7: Basic concept for the data processing circuits, ideas on multiplexers, de-multiplexers, decoders, encoders.

CO8: Basic concept on arithmetic circuits, binary addition, binary subtraction using 1's and 2's complement method.

CO9: Ideas of half and full adders, half and full subtractors, 4-bit binary adder, 4-bit binary subtractor.

CO10: Understanding the concept sequential circuits, SR flip-flops, D flip-flops, JK flip-flops, clocked flip-flops.

CO11: Building up ideas on preset and clear operations, concept on race-around condition (RAC), race-around conditions in JK flip-flop, M/S JK flip-flop.

CO12: Ideas on block diagram of IC 555, applications of IC 555, concept on astable multivibrator and monostable multivibrator.

CO13: Ideas of shift registers (up to 4 bits), serial-in-serial-out shift registers, serial-in-parallel-out shift registers, parallel-in-serial-out shift registers, parallel-in-parallel-out shift registers (only up to 4 bits).

CO14: Description of 4 bits counters, ring counter, asynchronous counter, decade counter, synchronous counter.

CO15: Building up ideas on computer organization, various types input/output devices.

CO16: Description of data storage (RAM, ROM), computer memory, memory organization and addressing, memory interfacing, memory map.

Semester	III
Title of Course	Digital Systems and Applications (CC-7)
Paper Code	C7P (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (H) of Semester-III will acquire the practical knowledge about the Periodic Waveform using CRO, Testing of Diode and Transistor using Multimeter, Designing a Switch using Transistor, Verification of AND, OR, NOT, XOR using NAND Gates, Designing Combination Logic System for Specified Truth Table, Conversion of Boolean Expression into Logic Circuit using ICs, Minimizing Logic Circuit, Half Adder, Full Adder and 4-bit binary Adder, Half Subtractor, Full Subtractor, Build Flip-Flop using NAND Gates, 4-bit Shift Registers, Astable and Monostable Multivrabator using 555 Timer by hands on practical experiments.

The lab paper (C7P) of this course (CC-7) provides the student with-

CO1: Study of necessary theory, working formula and experimental measurement of (a) voltage and (b) time period of a periodic waveform using CRO.

CO2: Study of necessary theory, working formula and experimental observation of testing a diode and transistor using a multimeter.

CO3: Study of necessary theory, working formula and experimental design a switch (NOT gate) using a transistor.

CO4: Study of necessary theory, working formula and experimental verification of AND, OR, NOT and NOR gates using NAND gates.

CO5: Study of necessary theory, working formula and experimental observation of a combinational logic system for a specified truth table.

CO6: Study of necessary theory, working formula and experimental observation to convert a Boolean expression into logic circuit and design it using logic gate ICs.

CO7: Study of necessary theory, working formula and experimental determination of minimization of a given logic circuit.

CO8: Study of necessary theory, working formula and experimental determination of half adder, full adder and 4-bit binary adder.

CO9: Study of necessary theory, working formula and experimental determination of half subtractor, Full subtractor, adder-subtractor using full adder ICs.

CO10: Study of necessary theory, working formula and experimental determination of flip-flop (RS, clocked RS, D-type and JK) circuits using NAND gates.

CO11: Study of necessary theory, working formula and experimental determination of JK master-slave flip-flop using flip-flop ICs.

CO12: Study of necessary theory, working formula and experimental determination of a 4-bit counter using D-type/JK flip-flop ICs and study timing diagram.

CO13: Study of necessary theory, working formula and experimental determination of a 4-bit shift register (serial and parallel) using D-type/JK flip-flop ICs.

CO14: Study of necessary theory, working formula and experimental determination of an astable multivibrator of a given specifications using 555 timer.

CO15: Study of necessary theory, working formula and experimental determination of a monostable multivibrator of a given specifications using 555 timer.

Estd.-1966

Semester	III
Title of Course	Electrical Circuits and Network Skills (SEC-1)
Paper Code	SEC1T (Theory)
Credits	02
Hours	02 hours/week

The students of Physics (H) of Semester-III will acquire the knowledge about the Electrical Circuits and Network Skills, Different Electrical Circuits, Electrical Drawing and Symbols, Generators and Transformers, Electric Motors, Solid-State Devices, Electrical Protection as well as Electrical Wiring by studying this course.

The theory paper (SEC1T) of this course (SEC-1) provides the student with-

CO1: Physical concept and basic idea and formula of voltage, current, resistance, and power as well as understanding of Ohm's law with its mathematical formulation along with calculation and concept of series, parallel, and series-parallel combinations.

CO2: Physical concept and basic idea on AC electricity and DC electricity and familiarization with multimeter, voltmeter and ammeter along with its working procedure and circuit diagram.

CO3: Basic idea and circuit diagram and working procedure of main electric circuit elements and their combination along with DC sourced electrical circuits.

CO4: Familiarization with current and voltage drop across the DC circuit elements, single-phase and three phase alternating current sources.

CO5: Study of rules to analyze AC sourced electrical circuits along with calculation of real, imaginary and complex power components of AC source, power factor and saving energy and money.

CO6: Analysis, gathering knowledge and schematic of drawing symbols, blueprints, reading schematics, ladder diagrams, electrical schematics, power circuits, control circuits.

CO7: Basic knowledge and familiarization on reading of circuit schematics, tracking the connections of elements and identify current flow and voltage drop.

CO8: Theory, schematic diagram and working procedure of DC power sources, AC or DC generators, inductance, capacitance, and impedance, transformers.

CO9: Theory, schematic diagram, basic design and working procedure of single-phase, three-phase circuit.

CO10: Theory, schematic diagram, basic design and working procedure of DC motors along with interfacing DC or AC sources to control heaters and motors and calculation of speed and power of ac motor.

CO11: Familiarization on resistors, inductors and capacitors, diode, rectifiers, components in series or in shunt, response of inductors and capacitors with DC or AC sources.

CO12: Physical concept, working procedure and analysis of relays, fuses, disconnect switches, circuit breakers, overload devices.

CO13: Understanding on ground-fault protection, grounding and isolating, phase reversal, surge protection, interfacing DC or AC sources to control elements (relay protection device).

CO14: Understanding the basic concept of different types of conductors and cables, wiring - star and delta connection, voltage drop and losses across cables and conductors.

CO15: Theory, schematic diagram and working procedure of instruments to measure current, voltage, power in DC and AC circuits.

CO16: Understanding the basic concept of insulation, solid and stranded cable, conduit, cable trays, splices, wire nuts, crimps, terminal blocks, split bolts, and solder as well as circuit diagram for the preparation of extension board.

Estd.-1966

Semester	IV
Title of Course	Mathematical Physics – III (CC-8)
Paper Code	C8T (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (H) of Semester-IV will acquire the knowledge about the Complex Analysis of Complex Numbers and Functions of Complex Variables with their Analyticity and Cauchy-Riemann Conditions, Cauchy's Residue Theorem and Integral Formula, Integral Transforms, specifically Fourier Transform of Functions and Derivatives, Application of Fourier Transform to Differential Equations, Matrix Analysis, Eigenvalue and Eigenfunction problems by studying this course.

The theory paper (C8T) of this course (CC-8) provides the student with-

CO1: Brief study of complex numbers and their graphical representations, Euler's formula and De Moivre's theorem regarding complex numbers.

CO2: Familiarization with the functions of complex variables, their analyticity and Cauchy-Riemann conditions, examples of analytic functions.

CO3: Study of singular functions, poles and branch points, order of singularity and branch cuts, concept of simply and multiply connected regions.

CO4: Integration of functions of complex variables, Cauchy's inequality and Cauchy's integral formula.

CO5: Study of Laurent and Taylor's expansion of complex functions, examples of these series for some complex functions.

CO6: Mathematical definition of residue, calculation of residues for some complex functions, Cauchy's residue theorem and its application in solving definite integrals.

CO7: Theory of Fourier transforms and the statement of Fourier integral theorem, examples of Fourier transform.

CO8: Familiarization with the Fourier transform of trigonometric, Gaussian, finite wave train and other functions, representation of Dirac delta function as a Fourier integral.

CO9: Study of Fourier transform of derivatives, inverse Fourier transform and the statement and proof of convolution theorem.

CO10: Familiarization with the properties of Fourier transforms - translation, change of scale, complex conjugation etc.

CO11: Study of three dimensional Fourier transforms with examples, application of Fourier transforms to differential equations: one dimensional wave and diffusion or heat flow equations.

CO12: Brief study of addition and multiplication of matrices, null matrices, diagonal, scalar and unit matrices.

CO13: Familiarization with the upper-triangular and lower-triangular matrices, transpose of a matrix, symmetric and skew-symmetric matrices.

CO14: Mathematical definition of conjugate of a matrix, Hermitian and skew-Hermitian matrices, singular and non-singular matrices, orthogonal and unitary matrices, trace of a matrix and inner product of matrices and their examples.

CO15: Statement of Cayley-Hamilton theorem and its applications, diagonalization of matrices, solutions of coupled linear ordinary differential equations and study of functions of a matrix.

Estd.-1966

Semester	IV
Title of Course	Mathematical Physics – III (CC-8)
Paper Code	C8P (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (H) of Semester-IV will acquire the knowledge of Computational Analysis through Python Programming for finding Solutions of Ordinary Differential Equations, Evaluating the Value of Integrals, finding Fourier Coefficients of a given Periodic Function, Error Analysis, Least Square Fitting, Computing Roots of a Function by hands on computer programming.

The lab paper (C8P) of this course (CC-8) provides the student with-

CO1: Numerical methods for ordinary differential equations (ODE) and Python program to solve ODEs such as

$$\frac{dy}{dx} + e^{-x} = x^2$$

$$\frac{d^2y}{dt^2} + 2\frac{dy}{dt} = -y$$

$$\frac{d^2y}{dt^2} + e^{-t}\frac{dy}{dt} = -y$$

CO2: Python program to evaluate the following integral

$$\frac{1}{\sqrt{2\pi\sigma^2}} \int e^{-\frac{(x-2)^2}{2\sigma^2}} (x+3)dx, \text{ for } \sigma = 1, 0.1, 0.01.$$

CO3: Python program to evaluate Fourier coefficients of a given periodic function, say a square wave.

CO4: Python program to show the orthogonality of Legendre polynomials

$$\int_{-1}^{+1} P_n(\mu) P_m(\mu) d\mu = \delta_{n,m}$$

and a Python program to plot Legendre polynomials $P_n(x)$.

CO5: Python program to calculate error for each data point of observations recorded in some experiment.

CO6: Python program to compute root of a function, square root of a complex number.

CO7: Python program to evaluate trigonometric functions e.g. $\sin\theta$ for some specified values of θ.

CO8: Python program to find the fast Fourier transform (FFT) of a specific function, say $f(x) = e^{-x^2}$.

Semester	IV
Title of Course	Elements of Modern Physics (CC-9)
Paper Code	C9T (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (H) of Semester-IV will acquire the knowledge about the Planck's Quantum Theory, Position Measurement of Various Charged Particles, Eigen Values and Eigen Functions, Nuclear Size, Ideas about Various Non-Relativistic Particles and Operator, Radioactivity, Conservation Laws, Fission and Fusion, Laser and its Applications by studying this course.

The theory paper (C9T) of this course (CC-9) provides the student with-

CO1: Understanding the basics of Planck's quantum theory, Planck constant, light as a collection of photons, photo electric effect, Compton scattering.

CO2: Basic concept of blackbody radiation, de Broglie hypothesis, de Broglie wavelength, matter waves.

CO3: Demonstration of Davisson-Germer experiment, wave description of particle by wave packets, group velocity and phase velocity and relation between them.

CO4: Basic ideas on two-slit experiment with electrons, probability, wave amplitude and wave functions.

CO5: Demonstration of the gamma ray microscopic thought experiment, concept on wave-particle duality.

CO6: Concept on Heisenberg uncertainty principle, uncertainty relations involving canonical pair of variables, derivation from wave packets impossibility of a particle following a trajectory.

CO7: Knowing about the estimating minimum energy of a confined particle using uncertainty principle, energy-time uncertainty principle, application to virtual particles and range of an interaction.

CO8: Basic concept for two slit interference experiment with photons, atoms and particles, linear superposition principle as a consequence.

CO9: Understanding the phenomena matter waves and waves amplitude, Schrodinger equation for non-relativistic particles.

CO10: Basic idea on momentum and energy operator, stationary states, physical interpretation of a wave function, probabilities and normalization of current densities in one dimension.

CO11: Basic idea on one dimensional infinitely rigid box, calculation of energy eigenvalues and eigenfunctions.

CO12: Description of quantum mechanical scattering, tunnelling in one dimension-across a step potential and rectangular potential barrier, quantum dot.

CO13: Basic concept on atomic nucleus size and structure, relation with atomic weight, impossibility of an electron in the nucleus as consequence of the uncertainty principle.

CO14: Basic concept on liquid drop model, semi-empirical mass formula, binding energy, nuclear shell model, magic number, nuclear force, NZ graph.

CO15: Concept of radioactivity, stability of the nucleus, law of radioactive decay, mean life and half life.

CO16: Concept on alpha decay, beta decay, spectrum and Pauli's prediction of neutrino.

CO17: Description gamma ray emission, energy momentum, conservation of electron-proton pair creation by gamma photons.

CO18: Concept of fission and fusion, mass deficit, relativity and generation of energy, nature of fragments and emission of neutrino.

CO19: Idea about nuclear reactor, slow neutrons interacting with U-235, fusion, thermonuclear reactions, stellar energy.

CO20: Basic concept on lasers, Einstein's A and B coefficients, metastable state, spontaneous and stimulated emissions.

CO21: Familiarization with the ideas of optical pumping and population inversion, three-level and four level lasers, ruby laser and He-Ne laser.

Semester	IV
Title of Course	Elements of Modern Physics (CC-9)
Paper Code	C9P (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (H) of Semester-IV will acquire the practical knowledge about the Planck's Constant, Photo-Electric Effect, Work Function of Material of Filament, Planck's Constant using LEDs, Wavelength of H-alpha Emission Line of Hydrogen Atom, Ionization Potential of Mercury, Absorption Lines in the Rotational Spectrum of Iodine Vapour, e/m by Magnetic Focusing or Bar Magnet, Millikan Oil Drop Apparatus Method, Tunnel Diode Characteristics, Wavelength of a Laser Source using Single Slit and Double Slit, Wavelength and Angular Spread of He-Ne Laser using Grating by hands on practical experiments.

The lab paper (C9P) of this course (CC-9) provides the student with-

CO1: Study of necessary theory, working formula and experimental measurement of Planck's constant using black body radiation and photo detector.

CO2: Study of necessary theory, working formula and experimental observation of photo current versus intensity and wavelength of light and maximum energy of photo electrons versus frequency of light.

CO3: Study of necessary theory, working formula and experimental determination of work function of a material of filament of directly heated vacuum diode.

CO4: Study of necessary theory, working formula and experimental determination of the Planck's constant using LEDs of at least four different colours.

CO5: Study of necessary theory, working formula and experimental determination of the wavelength of H-alpha emission line of hydrogen atom.

CO6: Study of necessary theory, working formula and experimental determination of the ionization potential of mercury.

CO7: Study of necessary theory, working formula and experimental determination of the absorption lines in the rotational spectrum of iodine vapour.

CO8: Study of necessary theory, working formula and experimental determination of the value of e/m by (a) magnetic focusing or (b) bar magnet.

CO9: Study of necessary theory, working formula and experimental setup of the Millikan oil drop apparatus and determination of the charge of an electron.

CO10: Study of necessary theory, working formula and experimental demonstration of the tunnelling effect in tunnel diode using I-V characteristics.

CO11: Study of necessary theory, working formula and experimental determination of the wavelength of laser source using diffraction of a single slit.

CO12: Study of necessary theory, working formula and experimental determination of the wavelength of laser source using diffraction of a double slit.

CO13: Study of necessary theory, working formula and experimental determination of (a) wavelength and (b) angular spread of He-Ne laser using plane diffraction grating.

Semester	IV
Title of Course	Analog Systems and Applications (CC-10)
Paper Code	C10T (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (H) of Semester-IV will acquire the knowledge about the Semiconductor Diodes, Two-Terminal Devices and their Applications, Bipolar Junction Transistors, Field Effect Transistors, Amplifiers by studying this course.

The theory paper (C10T) of this course (CC-10) provides the student with-

CO1: Concept of n-type and p-type semiconductors, mobility, drift velocity, fabrication of p-n junctions, forward and reverse biased junctions, concept of an energy barrier formation in a p-n junction.

CO2: Calculation of current flow mechanism in forward and reverse biased p-n junction, derivation of barrier potential and barrier width.

CO3: Application of p-n junction for different type of rectifiers, filters and voltage regulators, e.g. half-wave rectifiers, centre-tapped and bridge full-wave rectifiers etc., idea about voltage ripples during filtering, calculation of ripple factor.

CO4: Basic principles on the working of solar cells, light emitting diodes and photo-diodes.

CO5: Familiarizing about n-p-n and p-n-p transistors and basic configurations namely common base (CB), common emitter (CE) and common collector (CC) and also about current and voltage gains and their relations.

CO6: Ideas about load line analysis, DC load line and Q-point, active, cutoff and saturation regimes in current characteristics.

CO7: Basic Principles of operation of field effect transistors (FETs) with examples, n-channel and p-channel FETs and their properties, discussion on different types of FETs.

CO8: Concept on transistor biasing and equivalent circuits, discussion about input and output impedance, current, voltage and power gains.

CO9: Basic idea on different types of amplifier classes e.g. class A, B and C amplifiers with examples.

CO10: Concept on hybrid or h-parameter equivalent circuit, analysis of a single-stage CE amplifier using hybrid model.

CO11: Ideas about coupled amplifiers with one illustration of two stage RC-coupled amplifier.

CO12: Basic introduction on feedback circuit in amplifiers and effect of positive and negative feedbacks on its performance.

CO13: Basics on sinusoidal oscillators, Barkhausen's criterion for self-sustained oscillations.

CO14: Illustrations and working mechanisms of a few useful oscillators e.g. Hartley oscillator, Colpitt's oscillator, phase shift oscillator.

CO15: Operational amplifiers and knowledge about different configurations namely inverting and non-inverting modes, ideas about different parameters that characterize an Op-Amp.

CO16: Various applications of operational amplifiers in linear circuits as well as non-linear circuits.

CO17: Ideas on conversion circuits, examples of D to A and A to D conversions.

Estd.-1966

Semester	IV
Title of Course	Analog Systems and Applications (CC-10)
Paper Code	C10P (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (H) of Semester-IV will acquire the practical knowledge about the Characteristics of p-n Junction Diode, LED, Zener Diode, Solar Cell, Bipolar Junction Transistors, Various Transistor Amplifiers and their Operations, Wien Bridge Oscillator, Colpitt's Oscillator, Phase Shift Oscillator, Converters, Op-Amps and their Operations in Various Configurations by hands on practical experiments.

The lab paper (C10P) of this course (CC-10) provides the student with-

CO1: Study of necessary theory, working formula and experimental measurement of I-V characteristics of a p-n junction diode and a light emitting diode.

CO2: Study of necessary theory, working formula and experimental measurement of I-V characteristics of a Zener diode and its use as a voltage regulator.

CO3: Study of necessary theory, working formula and experimental measurement of I-V characteristics and power curves of a solar cell and calculation of its maximum power point and efficiency.

CO4: Study of necessary theory, working formula and experimental observation for the characteristics of a bipolar junction transistor (BJT) in CE configuration.

CO5: Study of necessary theory, working formula and experimental observation of various biasing configurations of BJT for normal class A operation.

CO6: Study of necessary theory, working formula and experimental design of a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias circuit.

CO7: Study of necessary theory, working formula and experimental design to study the frequency response of voltage gain of a RC-coupled transistor amplifier.

CO8: Study of necessary theory, working formula and experimental design of a Wien bridge oscillator for given frequency using an Op-Amp.

CO9: Study of necessary theory, working formula and experimental design of a phase shift oscillator of given specifications using BJT.

CO10: Study of necessary theory, working formula and experimental design to study the Colpitt's oscillator.

CO11: Study of necessary theory, working formula and experimental design of a digital to analog converter (DAC) IC of given specifications.

CO12: Study of necessary theory, working formula and experimental design to study the analog to digital convertor (ADC) IC.

CO13: Study of necessary theory, working formula and experimental design of an inverting amplifier using Op-Amp (IC 741, 351) for DC voltage of a given gain.

CO14: Study of necessary theory, working formula and experimental design of an inverting amplifier using Op-Amp (IC 741, 351) for AC voltage and study of its frequency response.

CO15: Study of necessary theory, working formula and experimental design of a non-inverting amplifier using Op-Amp (IC 741, 351) for AC voltage and study of its frequency response.

CO16: Study of necessary theory, working formula and experimental design to study the working of zero-crossing detector and comparator using an Op-Amp.

CO17: Study of necessary theory, working formula and experimental design to add two DC voltages using Op-Amp both in inverting and non-inverting modes.

CO18: Study of necessary theory, working formula and experimental design of a precision differential amplifier of given input specification using Op-Amp.

CO19: Study of necessary theory, working formula and experimental investigation of an Op-Amp as an integrator.

CO20: Study of necessary theory, working formula and experimental investigation of an Op-Amp as a differentiator.

CO21: Study of necessary theory, working formula and experimental design of a circuit to simulate the solution of a 1st or 2nd order differential equation.

Semester	IV
Title of Course	Renewable Energy and Energy Harvesting (SEC-2)
Paper Code	SEC2T (Theory)
Credits	01
Hours	01 hour/week

The students of Physics (H) of Semester-IV will acquire the knowledge about the Fossil Fuels and Alternate Sources of Energy, Solar Energy, Wind Energy Harvesting, Ocean Energy, Geothermal Energy, Hydro Energy, Piezoelectric Energy Harvesting and Electromagnetic Energy Harvesting by studying this course.

The theory paper (SEC2T) of this course (SEC-2) provides the student with-

CO1: Basic concept of fossil fuels and nuclear energy, renewable energy, non-conventional energy sources, ocean thermal energy, solar energy.

CO2: Understanding the over view of developments in offshore wind energy, tidal energy, wave energy systems, biomass, biochemical conversion, biogas generation, geothermal energy, hydroelectricity.

CO3: Learning the concept of solar energy, importance of solar energy, non-convective solar pond, solar water heater, flat plate collector, solar green houses, solar cell, solar distillation, absorption air conditioning.

CO4: Learning the concept and characteristics of photovoltaic (PV) systems, PV models, equivalent circuits, sun tracking systems.

CO5: Understanding the fundamentals of wind energy, wind turbines and different electrical machines in wind turbines, power electronic interfaces and grid interconnection topologies.

CO6: Understanding the relationship of ocean energy potential against wind and solar energy, wave energy devices, tide characteristics and statistics, tide energy technologies, ocean thermal energy, osmotic power, ocean biomass.

CO7: Basic idea on geothermal resources, geothermal technologies, hydropower resources, hydropower technologies, environmental impact of hydro power sources.

CO8: Understanding the phenomena of piezoelectric energy harvesting, physics and characteristics of piezoelectric effect, piezoelectric parameters and modelling piezoelectric generators, piezoelectric energy harvesting, human power.

Semester	IV
Title of Course	Renewable Energy and Energy Harvesting (SEC-2)
Paper Code	SEC2P (Lab)
Credits	01
Hours	02 hours/week

The students of Physics (H) of Semester-IV will acquire the practical knowledge about the Training Modules on Solar Energy, Conversion of Vibration to Voltage using Piezoelectric Materials, Conversion of Thermal Energy into Voltage using Thermoelectric Modules by hands on practical experiments.

The lab paper (SEC2P) of this course (SEC-2) provides the student with-

CO1: Study of necessary theory, working formula and experimental demonstration of training modules on solar energy, wind energy etc.

CO2: Study of necessary theory, working formula and experimental determination of conversion of vibration to voltage using piezoelectric materials.

CO3: Study of necessary theory, working formula and experimental determination of conversion of thermal energy into voltage using thermoelectric modules.

Semester	V
Title of Course	Quantum Mechanics and Applications (CC-11)
Paper Code	C11T (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (H) of Semester-V will acquire the knowledge about the Schrodinger Equation, Wave Functions, Eigenvalues and Eigenfunctions, Stationary States, Applications of Quantum Mechanics to Free Particle, Bound Systems like Square-Well Potential, Simple Harmonic Oscillator, Hydrogen-like Atoms, Atoms in Electric and Magnetic Fields and Many Electron Atoms by studying this course.

The theory paper (C11T) of this course (CC-11) provides the student with-

CO1: Introduction to quantum mechanics, time dependent Schrodinger equation and dynamical evolution of quantum state.

CO2: Study of the properties of wave function, its statistical interpretation and probability current densities in three dimensions.

CO3: Study of the conditions for physical acceptability of wave functions, idea of normalization of wave function, linearity and superposition principles.

CO4: Concept of eigenvalues and eigenfunctions, position, momentum and energy operators.

CO5: Study of the commutators of different dynamical operators, commutator of position and momentum operators, expectation values of position and momentum.

CO6: Derivation of time independent Schrodinger equation from the time dependent Schrodinger equation, the general solution of it, concept of stationary states and energy eigenvalues.

CO7: Idea of expansion of an arbitrary wave function as a linear combination of energy eigenfunctions.

CO8: General solution of the time dependent Schrodinger equation in terms of linear combination of stationary states.

CO9: Study of the wavefunction of a free particle by solving the Schrodinger equation, spread of Gaussian wave-packet for a free particle in one dimension, concept of wave packets.

CO10: Concept of momentum space wavefunctions through Fourier transforms of (position space) wavefunctions, position-momentum uncertainty principle.

CO11: Study of continuity of wave functions, boundary conditions and emergence of discrete energy levels.

CO12: Application of boundary conditions to the one dimensional square well potential and the calculations of discrete energy levels.

CO13: Study of simple harmonic oscillator (SHO), its energy eigenvalues and eigenfunctions using Frobenius method, idea of ground state and zero point energy from the application of uncertainty principle.

CO14: Study of hydrogen-like atoms by solving time independent Schrodinger equation in spherical polar coordinates with the help of the method of separation of variables for second order partial differential equations.

CO15: Study of radial wavefunctions for hydrogen-like atoms, shapes of the probability densities for ground and excited states, introduction of angular momentum operator and quantum numbers.

CO16: Study of atoms in external electric and magnetic field, elctron spin and spin angular momentum through Stern-Gerlac experiment.

CO17: Concept of spin magnetic moment, Larmor precession, electron magnetic moment and magnetic energy and study of normal and anomalous Zeeman effect, Paschen-Back effect and Stark effect.

CO18: Study of many electron atoms through the understanding of symmetric and antisymmetric wavefunctions, Pauli's exclusion principle, spin-orbit coupling in atoms - L-S and J-J coupling, Hund's rule, spectra of hydrogen and alkali atoms.

Semester	V
Title of Course	Quantum Mechanics and Applications (CC-11)
Paper Code	C11P (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (H) of Semester-V will acquire the knowledge of Computational Analysis through Python Programming for the Solution of s-wave Radial Schrodinger Equation for Hydrogen and Hydrogen-like Atoms and Molecules, Electron Spin Resonance (ESR), Zeeman Effect and Hyperfine Structure, Tunnelling Effect in Tunnel Diode using the I-V Characteristics and Quantum Efficiency of Charge-Coupled Device (CCD) by hands on computer programming.

The lab paper (C11P) of this course (CC-11) provides the student with-

CO1: Computational analysis through Python programming for solving the s-wave Schrodinger equation for the ground and first excited state of hydrogen atom:

$$\frac{d^2y}{dr^2} = A(r)u(r),\ A(r) = \frac{2m}{h^2}[V(r) - E] \text{ where } V(r) = -\frac{e^2}{r}$$

where the symbols have their usual meaning.

CO2: Computational analysis through Python programming for solving the s-wave radial Schrodinger equation for an atom:

$$\frac{d^2y}{dr^2} = A(r)u(r),\ A(r) = \frac{2m}{h^2}[V(r) - E]$$

where m is the reduced mass of the system and the screened Coulomb potential is given by

$$V(r) = \frac{e^2}{r}e^{-r/a}.$$

CO3: Computational analysis through Python programming for solving the s-wave radial Schrodinger equation for a particle of mass m:

$$\frac{d^2y}{dr^2} = A(r)u(r),\ A(r) = \frac{2m}{h^2}[V(r) - E]$$

for the anharmonic oscillator potential

$$V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3.$$

CO4: Computational analysis through Python programming for solving the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2\mu}{h^2}[V(r) - E]$$

where μ is the reduced mass of the two-atom system for the Morse potential

$$V(r) = D(e^{-2\alpha r'} - e^{-\alpha r'}), r' = \frac{r-r_0}{r}.$$

CO5: Study of the theory of electron spin resonance (ESR) and experimentally determine the magnetic field as a function of the resonance frequency.

CO6: Experimental study of the Zeeman effect with external magnetic field and the study of hyperfine splitting.

CO7: Experimental study of the tunnelling effect in tunnel diode using I-V characteristics.

CO8: Experimental determination of the quantum efficiency of the charge-coupled device (CCD).

Semester	V
Title of Course	Solid State Physics (CC-12)
Paper Code	C12T (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (H) of Semester-V will acquire the knowledge about the Crystal Structure, Elementary Lattice Dynamics, Magnetic Properties of Matter, Dielectric Properties of Materials, Ferroelectric Properties of Materials, Elementary Band Theory, Superconductivity by studying this course.

The theory paper (C12T) of this course (CC-12) provides the student with-

CO1: Brief idea about crystalline and amorphous substances, introduction about lattice and basis, unit cell and different types of lattices.

CO2: Concept of Miller indices, reciprocal lattice, concept of Brillouin zones and its methods of calculation in various lattices.

CO3: Illustration of diffraction of X-rays by crystalline materials, Bragg's law and its explanation by atomic form factor and structure factor.

CO4: Knowledge of lattice vibrations, concept of phonons and its application to infinite one-dimensional chain with monatomic and diatomic basis.

CO5: Ideas about phonon branches and qualitative description of the phonon spectrum in solids.

CO6: Formal idea of lattice specific heat in depth of knowledge of Einstein and Debye theory of specific heat of solids.

CO7: A basic knowledge of different types of magnetism e.g. diamagnetism, paramagnetism, ferromagnetism etc. with examples.

CO8: Introduction to the classical and quantum treatment for the explanation of diamagnetism and paramagnetism.

CO9: Basic discussion on ferromagnetic domains, B-H hysteresis loop and energy loss, its explanation.

CO10: Basic understanding about the dielectrics and polarization, depolarization field, electric susceptibility, polarizability etc.

CO11: Basics on Clausius Mosotti relation, classical theory of electric polarizability and normal and anomalous dispersion.

CO12: Idea about complex dielectric constant and its applications on plasma oscillations, plasma frequency, plasmons, TO modes etc.

CO13: Brief introduction to the ferroelectric properties of materials with classification of different crystals.

CO14: Illustration of piezoelectric effect, pyroelectric effect, ferroelectric effect, familiarization of Curie-Weiss law with ferroelectric domains and their usefulness.

CO15: Understanding the band theory of solids using preliminary Kronig-Penny model and differentiating the structures of insulators, conductors and semiconductors.

CO16: Understanding the conductivity of semiconductor using Drude model, mobility, introduction to Hall effect and measurement of Hall conductivity.

CO17: Understanding the basic idea about superconductors and their classifications, ideas about different parameters.

CO18: Introduction to the microscopic details about different phenomena of superconductors qualitatively by BCS Theory.

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Semester	V
Title of Course	Solid State Physics (CC-12)
Paper Code	C12P (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (H) of Semester-V will acquire the practical knowledge about the Quincke's Tube Method, Magnetic Susceptibility of Solids, Coupling Coefficients of Piezoelectric Materials, Dielectric Constant of Dielectric Materials, Complex Dielectric Constant and Plasma Frequency, Refractive Index of a Dielectric Layer, P-E and B-H Hysteresis Loops, Measuring Hall Coefficient, Resistivity of a Semiconductor by hands on practical experiments.

The lab paper (C12P) of this course (CC-12) provides the student with-

CO1: Study of necessary theory, working formula and experimental measurement of the susceptibility of a paramagnetic solution (via Quincke's tube method).

CO2: Study of necessary theory, working formula and experimental measurement of the magnetic susceptibility of various solids.

CO3: Study of necessary theory, working formula and experimental determination of the coupling coefficient of a piezoelectric crystal.

CO4: Study of necessary theory, working formula and experimental measurement of the dielectric constant of a dielectric material with frequency.

CO5: Study of necessary theory, working formula and experimental determination of the complex dielectric constant and plasma frequency of metals using surface plasmon resonance (SPR).

CO6: Study of necessary theory, working formula and experimental determination of the refractive index of a dielectric layer using surface plasmon resonance (SPR).

CO7: Study of necessary theory, working formula and experimental verification for the P-E hysteresis loop of a ferroelectric crystal.

CO8: Study of necessary theory, working formula and experimental verification for the B-H hysteresis curve of iron using a solenoid and determination of energy loss from the hysteresis.

CO9: Study of necessary theory, working formula and experimental measurement of the resistivity of a semiconductor sample with temperature by four-probe method and determination of its band gap.

CO10: Study of necessary theory, working formula and experimental determination of the Hall coefficient of a given semiconductor sample.

Semester	V
Title of Course	Classical Dynamics (DSE-1)
Paper Code	DSE1T (Theory)
Credits	06
Hours	06 hours/week

The students of Physics (H) of Semester-V will acquire the knowledge about the Classical Mechanics of Point Particle, Small Amplitude Oscillations, Special Theory of Relativity, Fluid Dynamics by studying this course.

The theory paper (DSE1T) of this course (DSE-1) provides the student with-

CO1: Learning the review of Newtonian mechanics of single particle i.e. linear equation of motion, rotational motion and conservation of energy.

CO2: Knowing about the application to the motion of a charge particle in external electric and magnetic field.

CO3: Concepts about the motion of point particles in electric and magnetic field and knowing about linear quantities, rotational quantities and energy of the system.

CO4: Concepts on gyroradius and gyrofrequency of point particles and equation of motion in crossed electric and magnetic fields.

CO5: Concepts on generalized coordinates and generalized velocity of point particles and derivation of their mathematical formation.

CO6: Discussion about Lagrangian mechanics, Galileo's relativity principle, Lagrangian of a free particle and for a system of particles.

CO7: Discussion about the Hamiltonian mechanics, derivation of the Hamiltonian equation, uniqueness etc.

CO8: Knowing the application of Hamiltonian for a harmonic oscillator, solution of Hamiltonian's equation for simple harmonic oscillations.

CO9: Learning about central force field of a particle, conservation of angular momentum and conservation of energy.

CO10: Theoretical derivation of Laplace-Runge-Lenz vector of a point particle.

CO11: Idea about the small amplitude oscillations of point particle, condition for minima of potential energy, viewpoints of stable equilibrium.

CO12: Learning the basis on expansion of the potential energy around a minimum, small amplitude oscillations.

CO13: Knowing about the normal modes of oscillations, example of N identical masses connected in a linear fashion to (N - 1) identical spring.

CO14: Idea on the postulates of special theory of relativity (STR), Lorentz transformation, time dilation, length contraction.

CO15: Concepts on Minkowski space, the invariant interval, light cone, world lines and twin paradox.

CO16: Ideas about four-vectors, space like vectors, time like vectors, light like vectors, four velocity and acceleration.

CO17: The basic description on metric and alternating tensor, four-momentum, energy-momentum and their relation.

CO18: Ideas about Doppler effect from a four-vector perspective.

CO19: Concept of four-force, four-momentum, conservation of four-momentum.

CO20: Basic idea on relativistic kinematics, application to two-body decay of an unstable particle.

CO21: Basic knowledge about fluid dynamics, density ρ and pressure P in a fluid, an element of fluid and its velocity.

CO22: Idea about Poiseuille's equation for flow of liquid through a pipe, continuity equation, mass conservation stream-lined motion, laminar flow.

CO23: Concepts on Navier-Stokes equation, description of turbulence, Reynolds number.

Semester	V
Title of Course	Nuclear and Particle Physics (DSE-2)
Paper Code	DSE2T (Theory)
Credits	06
Hours	06 hours/week

The students of Physics (H) of Semester-V will acquire the knowledge about the General Properties of Nuclei, Nuclear Models, Radioactivity Decay, Nuclear Reactions, Interaction of Nuclear Radiation with Matter, Detector for Nuclear Radiations, Particle Accelerators, Particle Physics by studying this course.

The theory paper (DSE2T) of this course (DSE-2) provides the student with-

CO1: Learning the ground state properties of a nucleus, the constituents and their properties, mass number and atomic number.

CO2: Idea about relation between the mass number and the radius, average density, range of force, saturation property, stability curve etc.

CO3: Concepts of packing fraction and binding energy, binding energy per nucleon vs mass number graph, explanation of fusion and fission from the nature of the binding energy graph.

CO4: Concepts on angular momentum, parity, magnetic moment, nuclear states etc.

CO5: Knowing about the nuclear models and their roles in explaining the ground state properties of the nucleus.

CO6: Discussion about the liquid drop model, its justification as far as the nuclear properties are concerned, the semi-empirical mass formula.

CO7: Discussion about the shell model, evidence of shell structure, magic numbers, predictions of ground state spin and parity.

CO8: Theoretical deduction of the shell structure, consistency of the shell structure with the Pauli's exclusion principles.

CO9: Learning about the process of radioactivity, the radioactive decay law, the emission of alpha, beta and gamma rays.

CO10: Theoretical derivation of various theoretical formulations of these nuclear disintegrations.

CO11: Idea about the properties of the constituents of these rays and their mechanisms of the emission, outlines of Gamow's theory of alpha decay.

CO12: Concept about Pauli's theory of beta decay with the neutrino hypothesis, the electron capture.

CO13: Introduction to the fine structure of alpha particle spectrum, the Geiger-Nuttall law, the radioactive series.

CO14: Learning the basic aspects of nuclear reactions, the Q-value of such reaction and its derivation from conservation laws.

CO15: Basics on the reaction cross-sections, the types of nuclear reactions, direct and compound nuclear reactions, Rutherford scattering by Coulomb potential.

CO16: Learn some basic aspects of interaction of nuclear radiation with matter-interaction of gamma ray by photoelectric effect.

CO17: Introduction to Compton scattering and pair production.

CO18: Ideas about energy loss due to ionization, Cerenkov radiation.

CO19: Learning the basics about the detectors of nuclear radiations.

CO20: The basic description about the Geiger-Mueller counter, the scintillation counter, the photo-multiplier tube, the solid state and semiconductor detectors for charged particles, photon detectors, neutron detectors.

CO21: Learning about the working principles of an accelerator.

CO22: Basic constructions of particle accelerators such as the Van de Graff generator, cyclotron, betatron and synchrotron etc.

CO23: Basic knowledge about the accelerator facilities available in India.

CO24: Gaining knowledge on the basic aspects of particle physics, the fundamental interactions, elementary and composite particles.

CO25: Fundamentals on the classifications of particles: leptons, hadrons (baryons and mesons), quarks, gauge bosons.

CO26: Knowledge about the quantum numbers of particles e.g. energy, linear momentum, angular momentum, isospin, electric charge, colour charge, strangeness, lepton numbers, baryon numbers etc.

CO27: Concept of symmetry and the conservation laws associated with them.

Semester	VI
Title of Course	Electromagnetic Theory (CC-13)
Paper Code	C13T (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (H) of Semester-VI will acquire the knowledge about the Maxwell Equations, EM Wave Propagation in Unbounded Media, EM Wave in Bounded Media, Polarization of Electromagnetic Waves, Wave guides, Optical Fibres by studying this course.

The theory paper (C13T) of this course (CC-13) provides the student with-

CO1: Physical concept and mathematical derivation of Maxwell's equations and displacement current.

CO2: Familiarize with scalar and vector potentials, Lorentz and Coulomb gauge transformations.

CO3: Physical concept and mathematical derivation of electromagnetic wave at interface between different media, wave equations and plane waves in dielectric media.

CO4: General idea about the Pointing theorem for energy flow of EM wave and mathematical derivation of the Pointing vector.

CO5: Theoretical concept and mathematical derivation of electromagnetic (EM) energy density.

CO6: Fundamental ideas of electromagnetic field energy density, momentum density, angular momentum density and transverse nature of plane EM wave.

CO7: Theory and mathematical derivation of propagation of plane EM waves through vacuum and isotropic dielectric medium along with calculation of refractive index, dielectric constant, wave impedance.

CO8: Study of general equation of EM wave propagation through conducting media and mathematical derivation of relaxation time, skin depth.

CO9: Study of general equation of EM wave propagation through ionized gases along with calculation of electrical conductivity, plasma frequency, refractive index, skin depth and familiarity of its application to propagation of EM wave through ionosphere.

CO10: Basic idea and concept on boundary conditions of propagation of EM at a plane interface between two media, reflection and refraction and mathematical derivation for the proof of laws of reflection and refraction, Fresnel's equations.

CO11: Basic idea of polarization of EM waves and derivation of Fresnel's equation for perpendicular and parallel polarization cases as well as Brewster's law.

CO12: Concept on total internal reflection, evanescent waves and metallic reflection for normal incidence and mathematical derivation.

CO13: Description of linear, circular and elliptical polarization and mathematical derivation of wave equations with Fresnel's formula for propagation of EM waves in anisotropic media.

CO14: Understanding the basic concept of dielectric tensor, uniaxial, biaxial crystals along with light propagation in uniaxial crystal.

CO15: Theoretical concept on double refraction, polarization by double refraction, Nicol prism, ordinary and extraordinary refractive indices.

CO16: Physical concept and derivation of production and detection of plane, circularly and elliptically polarized light, phase retardation through quarter and half wave plates.

CO17: Familiarization with Babinet compensator and its uses along with the analysis of polarized light.

CO18: Concept of optical rotation along with the study of Biot's laws for rotatory polarization, Fresnel's theory of optical rotation, calculation of angle of rotation and experimental verification of Fresnel's theory.

CO19: Physical demonstration of specific rotation through Laurent's half-shade polarimeter.

CO20: Familiarization with planar optical and dielectric wave guide, condition of continuity at interface, phase shift on total reflection along with calculation of eigen value equations.

CO21: Derivation of phase and group velocity of guided waves, field energy and power transmission through wave guide.

CO22: Concept and definition of numerical aperture, step and graded index and single and multiple mode optical fibres.

Semester	VI
Title of Course	Electromagnetic Theory (CC-13)
Paper Code	C13P (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (H) of Semester-VI will acquire the practical knowledge about the Malus Law, Specific Rotation of Sugar, Analysis of Elliptically Polarized Light by using a Babinet's Compensator, Dependence of Radiation on Angle for a Simple Dipole Antenna, Wavelength and Velocity of Ultrasonic Waves in Liquid, Reflection, Refraction of Microwaves, Polarization and Double Slit Interference in Microwaves, Determination of Refractive Index of Liquid and Glass, Polarization of Light, Determination of Stefan's constant and Determination of the Boltzmann constant by hands on practical experiments.

The lab paper (C13P) of this course (CC-13) provides the student with-

CO1: Study of necessary theory, working formula and experimental verification of Malus law for plane polarized light.

CO2: Study of necessary theory, working formula and experimental determination of the specific rotation of sugar solution using polarimeter.

CO3: Study of necessary theory, working formula and experimental verification of elliptically polarized light by using a Babinet's compensator.

CO4: Study of necessary theory, working formula and experimental verification of dependence of radiation on angle for a simple dipole antenna.

CO5: Study of necessary theory, working formula and experimental verification for the determination of the wavelength and velocity of ultrasonic waves in a liquid (kerosene oil, xylene etc.) by studying the diffraction through ultrasonic grating.

CO6: Study of necessary theory, working formula and experimental verification of the reflection, refraction of microwaves.

CO7: Study of necessary theory, working formula and experimental verification of polarization and double slit interference in microwaves.

CO8: Study of necessary theory, working formula and experimental verification for the determination of the refractive index of liquid by total internal reflection using Wollaston's air-film.

CO9: Study of necessary theory, working formula and experimental verification for the determination of the refractive index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.

CO10: Study of necessary theory, working formula and experimental verification of polarization of light by reflection and determination of the polarizing angle for air-glass interface.

CO11: Study of necessary theory, working formula and experimental verification of the Stefan's law of radiation to determine Stefan's constant.

CO12: Study of necessary theory, working formula and experimental verification for the determination of Boltzmann constant using I-V characteristics of p-n junction diode.

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Semester	VI
Title of Course	Statistical Mechanics (CC-14)
Paper Code	C14T (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (H) of Semester-VI will acquire the knowledge about the Phase Space, Ensemble, Entropy, Classical (Maxwell-Boltzmann) Statistics, Classical and Quantum Theories of Radiations, Quantum Statistics namely Bose-Einstein Statistics and Fermi-Dirac Statistics and their Applications to Radiation of Photon Gas, Electron Gas in Metals, Specific Heat of Solids by studying this course.

The theory paper (C14T) of this course (CC-14) provides the student with-

CO1: Theoretical concepts of macrostate and microstate, phase space, ensemble and its different kinds, idea of entropy, thermodynamic probability and their mathematical relation.

CO2: Basic postulates of classical or Maxwell-Boltzmann (M-B) statistics, derivation of M-B distribution function and its application to a system of ideal gas.

CO3: Theoretical concept and mathematical derivation of partition function for microcanonical and canonical ensembles, classical expression of entropy, Gibb's paradox and Sackur-Tetrode equation.

CO4: Study of the law of equipartition of energy with mathematical proof, its applications to specific heat and its limitations, concept of negative temperature, grand canonical ensemble and chemical potential.

CO5: Classical understanding of thermal radiation and blackbody radiation, its pure temperature dependence and the study of Kirchhoff's law.

CO6: Idea of the radiation pressure, the Stefan-Boltzmann law and its thermodynamic proof.

CO7: Study of Wien's distribution law, Wien's displacement law and Rayleigh-Jeans' law for the blackbody radiation, ultraviolet catastrophe and Saha's ionization formula.

CO8: Study of the spectral distribution of the blackbody radiation, Planck's revolutionary postulates and the concept of quantum of radiation energy.

CO9: Study of Planck's law of blackbody radiation, its mathematical derivation and the verification of the law through the experimental findings.

CO10: Derivation of Stefan-Boltzmann law, Wien's distribution law, Wien's displacement law and Rayleigh-Jeans law from Planck's law of radiation.

CO11: Postulates of Bose-Einstein (B-E) statistics and the derivation of the B-E distribution function.

CO12: Study of the thermodynamic functions of a strongly degenerate Bose gas, Bose-Einstein condensation and the qualitative properties of liquid He.

CO13: Idea of the radiation as a photon gas and its thermodynamic functions, Bose's derivation of Planck's law based on this idea.

CO14: Postulates of Fermi-Dirac (F-D) statistics and the derivation of the F-D distribution function.

CO15: Study of thermodynamic functions of a completely and strongly degenerate Fermi gas, idea of Fermi energy.

CO16: Study of electron gas in metal, specific heat of metals, relativistic Fermi gas, white dwarf stars, Chandrasekhar mass limit.

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Semester	VI
Title of Course	Statistical Mechanics (CC-14)
Paper Code	C14P (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (H) of Semester-VI will gain the knowledge on Computational Analysis through Python Programming for different Statistical Problems like Maxwell Velocity Distribution for a Collection of Particles, Partition Functions for Systems with Finite Number of Single Particle Levels, Comparison of Planck's Law of Blackbody Radiation with Rayleigh-Jeans Law, Plotting of Specific Heat (C_V) for Solids, Comparison and Analysis of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac Distribution Functions by hands on computer programming.

The lab paper (C14P) of this course (CC-14) provides the student with-

CO1: Computational analysis of the local number density in the equilibrium state, transient behaviour of the system, velocity distribution of particles and comparison with the Maxwell velocity distribution etc. for a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential.

CO2: Computational analysis of the partition function (Z), average energy (<E>), energy fluctuation ΔE, specific heat at constant volume (C_V) etc. for examples of systems with a finite number of single particle levels (e.g. 2 levels, 3 levels etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics.

CO3: Computational analysis of Planck's law for blackbody radiation by plotting and comparing it with Rayleigh-Jeans law at high temperature and low temperature.

CO4: Computational analysis of Specific heat (C_V) of solids by plotting it using Dulong-Petit law, Einstein distribution function and Debye distribution function for high temperature and low temperature and comparing them for the two cases.

CO5: Computational analysis of Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein distribution functions by plotting them with energy at different temperatures.

Semester	VI
Title of Course	Nano Materials and Applications (DSE-3)
Paper Code	DSE3T (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (H) of Semester-VI will acquire the knowledge about the Nanoscale Systems, Synthesis of Different Nanostructure Materials, Characterization Techniques of Nanostructure Materials, Optical Properties of Nanostructure Materials and Electron Transport in Nanostructure Materials along with Different Applications of Nanostructure Materials by studying this course.

The theory paper (DSE3T) of this course (DSE-3) provides the student with-

CO1: General concept and basic idea on length scales in physics, 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods).

CO2: Physical concept and basic idea on band structure and mathematical calculation of density of states of nanoscale materials, size effects in nano systems, quantum confinement.

CO3: Physical concept and mathematical derivation of applications of Schrodinger equation for infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.

CO4: Familiarization with top down and bottom up approach of nanoparticle synthesis as well as detail experimental procedure along with working principle of photolithography and ball milling, gas phase condensation.

CO5: Working principle and detail experimental procedure and design of synthesis of nanoscale materials by gas phase condensation, vacuum deposition, physical vapor deposition (PVD), thermal evaporation, e-beam evaporation, pulsed laser deposition, chemical vapor deposition (CVD), sol-gel, electro deposition, spray pyrolysis, hydrothermal synthesis, colloidal methods, MBE etc.

CO6: Basic concept, theory, working principle of X-ray diffraction, optical microscopy, scanning electron microscopy (SEM), transmission electron microscopy (TEM), atomic force microscopy (AFM), scanning tunnelling microscopy (STM) as well as characterization of nanoscale materials by these characterization methods.

CO7: Theory of Coulomb interaction in nanostructures, concept of dielectric constant for nanostructures and charging of nanostructure.

CO8: Concept on quasi-particles and excitons and excitons in direct and indirect band gap semiconductor nanocrystals along with quantitative analysis of quasi-particles and excitons, charging effects.

CO9: Detail theoretical study of radiative processes, absorption, emission and luminescence along with optical properties of hetero-structures and nanostructures materials.

CO10: Basic idea and concept and theoretical analysis of carrier transport in nanostructures along with Coulomb blockade effect, thermionic emission, tunnelling and hopping conductivity.

CO11: Basic idea of defects and impurities along with study of deep level and surface defects.

CO12: Study on the applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells).

CO13: Description of single electron transfer devices, carbon nano tube (CNT) based transistors, quantum dots (QD) hetero-structure lasers, optical switching and optical data storage.

CO14: Understanding the basic concept of magnetic quantum well, magnetic dots for magnetic data storage, various micro electromechanical systems (MEMS) and nano electromechanical systems (NEMS).

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Semester	VI
Title of Course	Nano Materials and Applications (DSE-3)
Paper Code	DSE3P (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (H) of Semester-VI will acquire the practical knowledge about the Synthesis of Different Metal, Oxide, Composite Nanostructure Materials, Thin Film of Nanostructure Material, Different Synthesis Techniques, p-n Diode and Capacitor preparation, XRD and Optical Characterization Techniques of Nanostructure Materials, Optical Properties of Nanostructure Materials and Structure Analysis of Nanostructure Materials by hands on practical experiments.

The lab paper (DSE3P) of this course (DSE-3) provides the student with-

CO1: Synthesis of metal nanoparticles (Au, Ag, etc.) by chemical route along with its necessary theory, reaction mechanism and detail experimental procedure.

CO2: Synthesis of semiconductor nanoparticles (ZnO, ZnS, PbO, etc.) by chemical route along with its necessary theory, reaction mechanism and detail experimental procedure.

CO3: Study of theory, working formula and experimental procedure along with mathematical analysis for the estimation of particle size of nanostructure materials by XRD study.

CO4: Synthesis of metal nanoparticles (Au, Ag, etc.) by chemical route along with its necessary theory, reaction mechanism and detail experimental procedure to study the effect of size on colour of nanomaterials.

CO5: Synthesis of composite of CNTs with other materials along with its necessary theory, reaction mechanism and detail experimental procedure for composite preparation.

CO6: Study of necessary theory, working formula and experimental procedure of growth of quantum dots by thermal evaporation method.

CO7: Preparation of a disc of ceramic of a compound using ball milling, pressing and sintering and study of its XRD pattern along with its necessary theory and experimental procedure.

CO8: Fabrication of a thin film of nanoparticles by spin coating (or chemical route) and study of its transmittance spectra in UV-visible region along with its necessary theory and experimental procedure.

CO9: Fabrication of a p-n diode by diffusing Al over the surface of n-type Si and study of its I-V characteristic along with its necessary theory, working formula and experimental procedure.

CO10: Preparation of a thin film capacitor and measurement capacitance as a function of temperature or frequency along with its necessary theory, working formula and experimental procedure.

CO11: Necessary theory, working formula and experimental procedure of surface Plasmon study of metal nanoparticles by UV-visible spectrophotometer.

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Semester	VI
Title of Course	Experimental Techniques (DSE-4)
Paper Code	DSE4T (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (H) of Semester-VI will acquire the knowledge about the Measurements, Signals and Systems, Shielding and Grounding, Transducers and Industrial Instrumentation, Digital Multimeter, Impedance Bridges and Q-meter, Vacuum Systems by studying this course.

The theory paper (DSE4T) of this course (DSE-4) provides the student with-

CO1: General concept and basic idea on accuracy and precision, significant figures, error and uncertainty analysis, gross error, systematic error, random error.

CO2: Physical concept and statistical analysis of data by arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square, curve fitting and Guassian distribution.

CO3: Physical concept and basic idea on periodic and aperiodic signals, impulse response, transfer function and frequency response of first and second order systems, fluctuations.

CO4: Familiarization with noise in measurement system, S/N ratio, noise figure, noise in frequency domain, sources of noise, inherent fluctuations, thermal noise, shot noise, 1/f noise.

CO5: Physical concept, working principle, circuit diagram and analysis of methods of safety grounding, energy coupling, grounding, shielding, electrostatic shielding, electromagnetic interference.

CO6: Basic concept on static and dynamic characteristics of measurement systems, generalized performance of systems, zero order first order, second order and higher order systems, electrical, thermal, mechanical systems, calibration.

CO7: Theory, working principle and circuit diagram of transducers and sensors, characteristics of transducers, transducers as electrical element and their signal conditioning, temperature transducers.

CO8: Theory and working principle of RTD, thermistor, thermocouples, semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning.

CO9: Theory and working principle of linear position transducer, strain gauge, piezoelectric and inductance change transducer, linear variable differential transformer (LVDT), capacitance change transducers.

CO10: Basic and principle of gas filled detector, ionization chamber, scintillation detector.

CO11: Concept of analog and digital instruments, block diagram of digital multimeter, principle of measurement of I, V, C, and accuracy along with resolution of measurement.

CO12: Description of block diagram, circuit diagram and working principles of RLC bridge, digital LCR bridge and Q-meter and its working operation.

CO13: Concept and realization on characteristics of vacuum, different gas laws, mean free path, application of vacuum.

CO14: Description and working principle of vacuum system, vacuum chamber, mechanical pumps, diffusion pump and turbo modular pump.

CO15: Definition and calculation of pumping speed and basic concept, realization, circuit diagram and working principle of Pirani, Penning and ionization gauges.

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Semester	VI
Title of Course	Experimental Techniques (DSE-4)
Paper Code	DSE4P (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (H) of Semester-VI will acquire the practical knowledge about the Determination of Output Characteristics of LVDT and Measure Displacement, Measurement of Strain using Strain Gauge, Measurement of Level using Capacitive Transducer, Study of the Characteristics of a Thermostat, Calibration of AD590, LM35 or LM75, Distance Measurement using Ultrasonic Transducer, Measurement of Change in Temperature of Ambient using RTD, Measurement of Chamber Pressure using a Pressure Gauge, Comparison of Pickup of Noise in Cables, Design and Study of the Sample and Hold Circuit, Design of the Clippers and Clampers Circuits, Frequency Response of Microphone, Measurement Q of a Coil and Influence of Frequency using a Q-meter by hands on practical experiments.

The lab paper (DSE4P) of this course (DSE-4) provides the student with-

CO1: Theory, working principle, circuit diagram and experimental procedure to determine output characteristics of a LVDT and measure displacement using LVDT.

CO2: Theory, working principle, circuit diagram and experimental procedure for measurement of strain using strain gauge.

CO3: Theory, working principle, circuit diagram and experimental procedure for measurement of level using capacitive transducer.

CO4: Theory, working principle, circuit diagram and experimental procedure for the study the characteristics of a thermostat and determine its parameters.

CO5: Theory, working principle, circuit diagram and experimental procedure for the study of distance measurement using ultrasonic transducer.

CO6: Theory, working principle, circuit diagram and experimental procedure for the calibration of semiconductor type temperature sensor (AD590, LM35 or LM75).

CO7: Theory, working principle, circuit diagram and experimental procedure for the measurement of the change in temperature of ambient using resistance temperature device (RTD).

CO8: Theory, working principle, circuit diagram and experimental procedure for the creation vacuum in a small chamber using a mechanical (rotary) pump and measurement of chamber pressure using a pressure gauge.

CO9: Theory, working principle, circuit diagram and experimental procedure for the comparison of pickup of noise in cables of different types (co-axial, single shielded, double shielded, without shielding) of a given length, understanding of importance of grounding using function generator of mV level and an oscilloscope.

CO10: Theory, working principle, circuit diagram and experimental procedure for the design and study the sample and hold circuit.

CO11: Theory, working principle, circuit diagram and experimental procedure for the design and realization of the clippers and clampers circuits using junction diode.

CO12: Theory, working principle, circuit diagram and experimental procedure for the plotting of the frequency response curve of a microphone.

CO13: Theory, working principle, circuit diagram and experimental procedure for the measurement Q of a coil and influence of frequency, using a Q-meter.

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Course Outcome

Physics (GE)

Semester	I
Title of Course	Elements of Modern Physics (GE-1)
Paper Code	GE1T (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (Gen) of Semester-V will acquire the knowledge about the Planck's Quantum Theory, Problems with Rutherford Model, Position Measurement, Two Slit Interference Experiment, One Dimensional Infinitely Rigid Box, Size and Structure of Atomic Nucleus, Radioactivity, Fission and Fusion by studying this course.

The theory paper (GE1T) of this course (GE-1) provides the student with-

CO1: Understanding the basics of Planck's quantum theory, Planck constant, light as a collection of photons, photo electric effect, Compton scattering.

CO2: Basic concept of blackbody radiation, de Broglie hypothesis, de Broglie wavelength, matter waves.

CO3: Demonstration of Davisson-Germer experiment, wave description of particle by wave packets, group and phase velocity and relation between them.

CO4: Basic ideas on two-slit experiment with electrons, probability, wave amplitude and wave functions.

CO5: Demonstration about the gamma ray microscopic thought experiment, concept on wave-particle duality, Rutherford model, hydrogen like atom and their spectra, Bohr's quantization rule, atomic stability.

CO6: Concept on Heisenberg uncertainty principle, uncertainty relations involving canonical pair of variables, derivation from wave packets.

CO7: Knowing about the estimating minimum energy of a confirmed particle using uncertainty principle, energy-time uncertainty principle, application to virtual particles and range of an interaction.

CO8: Basic concept for two slit interference experiment with photons, atoms and particles, linear superposition principle as a consequence.

CO9: Understanding the phenomena of matter waves and waves amplitude, Schrodinger equation for non-relativistic particles.

CO10: Basic idea on momentum and energy operator, stationary states, physical interpretation of a wave function, probabilities and normalization of current densities in one dimension.

CO11: Basic idea on one dimensional infinitely rigid box, calculation of energy eigenvalues and eigenfunctions.

CO12: Description of quantum mechanical scattering, tunnelling in one dimension-across a step potential and rectangular potential barrier, quantum dot.

CO13: Basic concept on atomic nucleus size and structure, relation with atomic weight, impossibility of an electron in the nucleus as consequence of the uncertainty principle.

CO14: Basic concept on liquid drop model, semi-empirical mass formula, binding energy, nuclear shell model, magic number, nuclear force, NZ graph.

CO15: Concept of radioactivity, stability of the nucleus, law of radioactive decay, mean life and half-life.

CO16: Concept on alpha decay, beta decay, spectrum and Pauli's prediction of neutrino.

CO17: Description gamma ray emission, energy momentum, conservation of electron-proton pair creation by gamma photons.

CO18: Concept of fission and fusion, mass deficit, relativity and generation of energy, nature of fragments and emission of neutrino.

CO19: Idea about nuclear reactor, slow neutrons interacting with U-235, fusion, thermonuclear reactions, stellar energy.

Semester	I
Title of Course	Elements of Modern Physics (GE-1)
Paper Code	GE1P (Lab)
Credits	02
Hours	04 hours/week

The students of other science subjects (H) of Semester-I will acquire the practical knowledge about the Planck's Constant, Photo-Electric Effect, Work Function of Material of Filament, Planck's Constant using LEDs, Wavelength of H-alpha Emission Line of Hydrogen Atom, Ionization Potential of Mercury, Absorption Lines in the Rotational Spectrum of Iodine Vapour, e/m by Magnetic Focusing or Bar Magnet, Millikan Oil Drop Apparatus Method, Tunnel Diode Characteristics, Wavelength of a Laser Source using Single Slit and Double Slit, Wavelength and Angular Spread of He-Ne Laser using Grating by hands on practical experiments.

The lab paper (GE1P) of this course (GE-1) provides the student with-

CO1: Study of necessary theory, working formula and experimental measurement of Boltzmann constant using V-I characteristic of p-n diode.

CO2: Study of necessary theory, working formula and experimental observation of photo current versus intensity and wavelength of light and maximum energy of photo electrons versus frequency of light.

CO3: Study of necessary theory, working formula and experimental determination work function of a material of filament of directly heated vacuum diode.

CO4: Study of necessary theory, working formula and experimental determination the Planck's constant using LEDs of at least four different colours.

CO5: Study of necessary theory, working formula and experimental determination the wavelength of H-alpha emission line of hydrogen atom.

CO6: Study of necessary theory, working formula and experimental determination of the ionization potential of mercury.

CO7: Study of necessary theory, working formula and experimental determination of the absorption lines in the rotational spectrum of iodine vapour.

CO8: Study of necessary theory, working formula and experimental determination the value of e/m by (a) magnetic focusing or (b) bar magnet.

CO9: Study of necessary theory, working formula and experimental setup the Millikan oil drop apparatus and determine the charge of an electron.

CO10: Study of necessary theory, working formula and experimental determination the wavelength of laser source using diffraction of single slit and double slit.

Semester	II
Title of Course	Thermal Physics and Statistical Mechanics (GE-2)
Paper Code	GE2T (Theory)
Credits	04
Hours	04 hours/week

The students of other science subjects (H) of Semester-II will acquire the knowledge about the Laws of Thermodynamics and their Applications, Various Thermodynamic Processes, Thermodynamic Potentials, Kinetic Theory of Gases, Blackbody Radiations, Different Distribution Laws for Blackbody Radiations, Classical and Quantum Statistical Mechanics and their Applications by studying this course.

The theory paper (GE2T) of this course (GE-2) provides the student with-

CO1: General thermodynamic description of a system, zeroth law of thermodynamics and the concept of temperature.

CO2: Statement and understanding of first law of thermodynamics, idea of internal energy and the conversion of heat into work, examples of various thermodynamic processes.

CO3: Study of the applications of first law of thermodynamics, general relation between C_P and C_V, calculations of work done during isothermal and adiabatic processes, compressibility and expansion coefficient.

CO4: Concept of reversible and irreversible processes, statement of second law of thermodynamics and the idea of entropy.

CO5: Study of Carnot's cycle and Carnot's theorem, entropy changes in reversible and irreversible processes, Entropy-temperature diagrams, third law of thermodynamics and the unattainability of absolute zero.

CO6: Theoretical and mathematical understanding of the thermodynamic potentials e.g. enthalpy, Gibbs free energy, Helmholtz free energy and internal energy functions.

CO7: Study of Maxwell's relations and applications in Joule-Thompson effect, Clausius- Clapeyron equation, expression for $(C_P - C_V)$, C_P/C_V and TdS equations.

CO8: Derivation of Maxwell's law of distribution of velocities and its experimental verification, mean free path (zeroth order).

CO9: Study of transport phenomena, viscosity, conduction and diffusion (for vertical case), law of equipartition of energy and its applications to specific heat of gases, mono-atomic and diatomic gases.

CO10: Theoretical concept of blackbody radiation, its spectral distribution, concept of energy density of radiations.

CO11: Fundamental postulates and mathematical derivation of Planck's law of blackbody radiation.

CO12: Deduction of Wien's distribution law, Rayleigh-Jeans law, Stefan Boltzmann law and Wien's displacement law from Planck's law of blackbody radiations.

CO13: Theoretical concept of phase space, macrostate and microstate, entropy and thermodynamic probability.

CO14: Study of Maxwell-Boltzmann distribution law and its applications to the distribution of velocity of the atoms/molecules of an ideal gas.

CO15: Fundamental postulates of quantum statistics - Fermi-Dirac distribution law and its application to a system of electron gas, Bose-Einstein distribution law and its application to a photon gas, comparison of three statistics.

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Semester	II
Title of Course	Thermal Physics and Statistical Mechanics (GE-2)
Paper Code	GE2P (Lab)
Credits	02
Hours	04 hours/week

The students of other science subjects (H) of Semester-II will acquire the practical knowledge about the Mechanical Equivalent of Heat, Measurement of Planck's Constant using Blackbody Radiation, Determination of Stefan's Constant, Coefficient of Thermal Conductivity, Temperature Coefficient of Resistance, Variations of Thermo EMF across Junctions of a Thermocouple and Calibration Resistance Temperature Device (RTD) by hands on practical experiments.

The lab paper (GE2P) of this course (GE-2) provides the student with-

CO1: Study of necessary theory, working formula and experimental method to determine mechanical equivalent of heat J, by Callender and Barne's constant flow method.

CO2**:** Study of necessary theory, working formula and experimental method to measure Planck's constant using black body radiation.

CO3: Study of necessary theory, working formula and experimental method to determine Stefan's constant.

CO4: Study of necessary theory, working formula and experimental method to determine the coefficient of thermal conductivity of Cu by Searle's apparatus.

CO5: Study of necessary theory, working formula and experimental method to determine the coefficient of thermal conductivity of Cu by Angstrom's method.

CO6: Study of necessary theory, working formula and experimental method to determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.

CO7: Study of necessary theory, working formula and experimental method to determine the temperature coefficient of resistance by platinum resistance thermometer.

CO8: Study of necessary theory, working formula and experimental method to study the variation of thermo EMF across two junctions of a thermocouple with temperature.

CO9: Study of necessary theory, working formula and experimental method to record and analyze the cooling temperature of a hot object as a function of time using a thermocouple and suitable data acquisition system.

CO10: Study of necessary theory, working formula and experimental method to calibrate resistance temperature device (RTD) using null method/off-balance bridge.

Semester	III
Title of Course	Solid State Physics (GE-3)
Paper Code	GE3T (Theory)
Credits	04
Hours	04 hours/week

The students of other science subjects (H) of Semester-III will acquire the knowledge about the Crystal Structure, Elementary Lattice Dynamics, Magnetic Properties of Matter, Dielectric Properties of Materials, Elementary Band Theory, Superconductivity by studying this course.

The theory paper (GE3T) of this course (GE-3) provides the student with-

CO1: Brief idea about crystalline and amorphous substances, introduction about lattice and basis, unit cell and different types of lattices.

CO2: Concept of Miller indices, reciprocal lattice, concept of Brillouin zones and its methods of calculation in various lattices.

CO3: Illustration of diffraction of X-rays by crystalline materials, Bragg's law and its explanation by atomic form factor and structure factor.

CO4: Knowledge of lattice vibrations, concept of phonons and its application to infinite one-dimensional chain with monatomic and diatomic basis.

CO5: Ideas about phonon branches and qualitative description of the phonon spectrum in solids.

CO6: Formal idea of lattice specific heat in depth of knowledge of Einstein and Debye theory of specific heat of solids.

CO7: A basic knowledge of different types of magnetism e.g. diamagnetism, paramagnetism, ferromagnetism etc. with examples.

CO8: Introduction to the classical and quantum treatment for the explanation of diamagnetism and paramagnetism.

CO9: Basic discussion on ferromagnetic domains, B-H hysteresis loop and energy loss, its explanation.

CO10: Basic understanding about the dielectrics and polarization, depolarization field, electric susceptibility, polarizability etc.

CO11: Basics on Clausius Mosotti relation, classical theory of electric polarizability and normal and anomalous dispersion.

CO12: Idea about complex dielectric constant and its applications on plasma oscillations, plasma frequency, plasmons, TO modes etc.

CO13: Understanding the band theory of solids using preliminary Kronig-Penny model and differentiating the structures of insulators, conductors and semiconductors.

CO14: Understanding the conductivity of semiconductor using Drude model, mobility, introduction to Hall effect and measurement of Hall conductivity.

CO15: Understanding the basic idea about superconductors and their classifications, ideas about different parameters.

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Semester	III
Title of Course	Solid State Physics (GE-3)
Paper Code	GE3P (Lab)
Credits	02
Hours	04 hours/week

The students of other science subjects (H) of Semester-III will acquire the practical knowledge about the Quincke's Tube Method, Magnetic Susceptibility of Solids, Coupling Coefficients of Piezoelectric Materials, Dielectric Constant of Dielectric Materials, Complex Dielectric Constant and Plasma Frequency, Refractive Index of a Dielectric Layer, P-E and B-H Hysteresis Loops, Measuring Hall Coefficient, Resistivity of a Semiconductor by hands on practical experiments.

The lab paper (GE3P) of this course (GE-3) provides the student with-

CO1: Study of necessary theory, working formula and experimental measurement of the susceptibility of a paramagnetic solution (via Quincke's tube method).

CO2: Study of necessary theory, working formula and experimental measurement of the magnetic susceptibility of various solids.

CO3: Study of necessary theory, working formula and experimental determination of the coupling coefficient of a piezoelectric crystal.

CO4: Study of necessary theory, working formula and experimental measurement of the dielectric constant of a dielectric material with frequency.

CO5: Study of necessary theory, working formula and experimental determination of the complex dielectric constant and plasma frequency of metals using surface plasmon resonance (SPR).

CO6: Study of necessary theory, working formula and experimental determination of the refractive index of a dielectric layer using surface plasmon resonance (SPR).

CO7: Study of necessary theory, working formula and experimental verification for the P-E hysteresis loop of a ferroelectric crystal.

CO8: Study of necessary theory, working formula and experimental verification for the B-H hysteresis curve of Fe using a solenoid and determination of energy loss from the hysteresis.

CO9: Study of necessary theory, working formula and experimental measurement of the resistivity of a semiconductor sample with temperature by four-probe method and determination of its band gap.

CO10: Study of necessary theory, working formula and experimental determination of the Hall coefficient of a given semiconductor sample.

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Semester	IV
Title of Course	Digital, Analog Circuits and Instrumentation (GE-4)
Paper Code	GE4T (Theory)
Credits	04
Hours	04 hours/week

The students of other science subjects (H) of Semester-IV will acquire the knowledge about the Digital Circuits, Semiconductor Device and Amplifier, Operational Amplifier, Instrumentations by studying this course.

The theory paper (GE4T) of this course (GE-4) provides the student with-

CO1: Differentiation between digital and analog circuits, binary numbers, decimal to binary and binary to decimal conversion.

CO2: Building up ideas on AND, OR and NOT gates, realization of these gates using diodes and transistors, NAND and NOR gates as universal gates, XOR gate, XNOR gate.

CO3: Ideas on de Morgan's theorems, Boolean laws, simplification of logic circuit using Boolean algebra, fundamental products of Boolean algebra.

CO4: Basic idea of minterms and maxterms, conversion of a truth table into equivalent logic circuits by (1) sum of product method and (2) Karnaugh map.

CO5: Basic concept on arithmetic circuits, binary addition, binary subtraction using 1's and 2's complement method.

CO6: Ideas of half and full adders, half and full subtractors, 4-bit binary adder, 4-bit binary subtractor.

CO7: Basic idea about semiconductor diodes, barrier formation in p-n junction diode, current flow mechanism in forward and reverse biased in diodes, static and dynamic resistance, principle and structure of (a) LEDs (b) photodiode and (c) solar cell.

CO8: Description on bipolar junction transistors, p-n-p and n-p-n transistors, CE, CB and CC configuration of transistor, input and output characteristics of transistors.

CO9: Analytical treatment of load line of transistor, current gain α and β, relation between α and β, DC load line and Q point, voltage divider bias circuit of CE configuration.

CO10: Basic idea about H-parameter, equivalent circuit, single stage CE amplifier using hybrid model, input and output impedance, class A, B and C amplifier, voltage and power gains.

CO11: Familiarization of an idea and practical Op-Amp (IC-741), open loop and closed loop gain, CMRR, concept on virtual ground, inverting and non-inverting amplifier, adder, subtractor, differentiator, integrator and zero crossing detector.

CO12: Building up ideas on sinusoidal oscillator, Barkhausen's criterion for self-sustained oscillator, frequency determination of RC oscillator.

CO13: Description of CRO, block diagram of CRO, study of wavefront, measurements of voltage, current, frequency and phase difference.

CO14: Basic concept of power supply, half wave bridge rectifier, centre tapped rectifier, full wave bridge rectifier, ripple factor, rectifier efficiency.

CO15: Basic idea about Zener diode, voltage regulation, capacitor filter.

CO16: Ideas about IC 555, block diagram of IC 555, applications of IC 555, concept on astable multivibrator and monostable multivibrator.

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Semester	IV
Title of Course	Digital, Analog Circuits and Instrumentation (GE-4)
Paper Code	GE4P (Lab)
Credits	02
Hours	04 hours/week

The students of other science subjects (H) of Semester-IV will acquire the practical knowledge about the Periodic Waveform using CRO, Verification of AND, OR, NOT, XOR using NAND Gates, Design of Combination Logic System for Specified Truth Table, Conversion of Boolean Expression into Logic Circuit using ICs, Minimize Logic Circuit, Half Adder, Full Adder and 4-bit Binary Adder, Astable and Monostable Multivibrator using 555 Timer, I-V Characteristics of p-n Diode, Zener Diode, LED, Transistor CE Configuration, Design of CE amplifier using Voltage Divider Bias, Inverting and Non-Inverting Amplifier using IC-741, Integrator and Differentiator using Op-Amp, Wien Bridge Oscillator by hands on practical experiments.

The lab paper (GE4P) of this course (GE-4) provides the student with-

CO1: Study of necessary theory, working formula and experimental measurement of (a) voltage and (b) time period of a periodic waveform using CRO.

CO2: Study of necessary theory, working formula and experimental verification of AND, OR, NOT and NOR gates using NAND gates.

CO3: Study of necessary theory, working formula and experimental observation of a combinational logic system for a specified truth table.

CO4: Study of necessary theory, working formula and experimental observation to convert a Boolean expression into logic circuit and design it using logic gate ICs.

CO5: Study of necessary theory, working formula and experimental determination of minimization a given logic circuit.

CO6: Study of necessary theory, working formula and experimental determination of half adder, full adder and 4-bit binary adder.

CO7: Study of necessary theory, working formula and experimental determination of an astable multivibrator of a given specifications using 555 timer.

CO8: Study of necessary theory, working formula and experimental determination of a monostable multivibrator of a given specifications using 555 timer.

CO9: Study of necessary theory, working formula and experimental determination of the I-V characteristic of p-n diode, Zener and light emitting diode.

CO10: Study of necessary theory, working formula and experimental observation of the characteristics of transistor in CE configuration.

CO11: Study of necessary theory, working formula and experimental determination of gain of a CE amplifier using voltage divider bias.

CO12: Study of necessary theory, working formula and experimental observation of inverting and non-inverting amplifier of a given gain using Op-Amp 741.

CO13: Study of necessary theory, working formula and experimental investigation of differentiator using Op-Amp.

CO14: Study of necessary theory, working formula and experimental investigation of Wien bridge oscillator using Op-Amp.

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Course Outcome

Physics (DSC)

Semester	I
Title of Course	Mechanics (DSC-1A)
Paper Code	DSC1AT (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (Gen) of Semester-I will acquire the knowledge about the Vectors, Ordinary Differential Equations, Laws of Motion, Momentum and Energy, Rotational Motion, Gravitation, Oscillations, Elasticity, Special Theory of Relativity by studying this course.

The theory paper (DSC1AT) of this course (DSC-1A) provides the student with-

CO1: Basic theory of vector algebra, scalar product, vector product, scalar triple product and their interpretation in terms of area and volume respectively.

CO2: Theory of directional derivatives and normal derivative, divergence and curl of a vector field.

CO3: Solution of problems on first order differential equations with integrating factor, homogeneous equations with constant coefficients.

CO4: Understanding the basics of Newton's laws of motion and their application to various dynamical situations, idea of inertial frames.

CO5: Basic concept of dynamics of a system of particles and centre of mass, procedure to evaluate centre of mass in different bodies, concept of impulse.

CO6: Familiarization with elastic potential energy, conceptual background of force as gradient of potential energy, methods to calculate the work done by and against a force field, work done by non-conservative forces.

CO7: Learning the concept of conservation of energy, linear momentum, angular momentum and their applications to basic problems, motion of rockets.

CO8: Understanding the analogy between translational and rotational dynamics, angular velocity and angular acceleration, torque and application of both motions in simultaneous analysis of rolling with slipping.

CO9: Understanding the basics of laws of gravitation, inertial and gravitational mass, potential and field due to spherical shell and solid sphere.

CO10: Application of Kepler's law to describe the motion of planets and satellites in circular orbit through the study of law of gravitation, concept of geosynchronous orbits and global positioning system (GPS).

CO11: Explanation of the phenomena of simple harmonic motion and the properties of systems executing such motions, e.g. kinetic energy, potential energy, the solution of the differential equation of SHM.

CO12: Building up ideas on damped oscillation, forced oscillations, transient and steady states.

CO13: Understanding the principles of elasticity through Hooke's law, stress-strain diagram.

CO14: Basic study of a few elastic constants e.g. Young modulus, modulus of rigidity, Poisson's ratio, twisting torque on a cylinder or wire, idea about torsional pendulum and its working principle.

CO15: Demonstration of special theory of relativity (STR) through Michelson-Morley experiment and postulates of STR.

CO16: Ideas of length contraction, time dilation, effects of STR on the mass and energy of a moving object, relativistic addition of velocities.

Semester	I
Title of Course	Mechanics (DSC-1A)
Paper Code	DSC1AP (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (Gen) of Semester-I will acquire the practical knowledge about the Slide Callipers, Screw Gauge and Travelling Microscope, Sextant, Moment of Inertia of a Flywheel, Digital Timing Technique, Optical Lever Method, Bar Pendulum, Kater's Pendulum, Elastic Constants by Searle's Method, Maxwell's Needle Method, Motion of a Spring by hands on practical experiments.

The lab paper (DSC1AP) of this course (DSC-1A) provides the student with-

CO1: Study of necessary theory, working formula and experimental measurement of length (or diameter) using slide callipers, screw gauge and travelling microscope.

CO2: Study of necessary theory, working formula and experimental determination of the height of a building using a sextant.

CO3: Study of necessary theory, working formula and experimental determination the moment of inertia of a flywheel.

CO4: Study of necessary theory, working formula and experimental determination of the Young's modulus of a wire by optical lever method.

CO5: Study of necessary theory, working formula and experimental determination of the modulus of rigidity of a wire by Maxwell's needle.

CO6: Study of necessary theory, working formula and experimental determination of the elastic constants of a wire by Searle's method.

CO7: Study of necessary theory, working formula and experimental determination the value of acceleration due to gravity (g) using bar pendulum.

CO8: Study of necessary theory, working formula and experimental determination the value of acceleration due to gravity (g) using Kater's pendulum.

CO9: Study of necessary theory, working formula and experimental determination of acceleration due to gravity (g) and velocity for a freely falling body using digital timing technique.

CO10: Study of necessary theory, working formula and experimental observation for the motion of a spring and calculation of its spring constant and acceleration due to gravity (g).

Semester	II
Title of Course	Electricity and Magnetism (DSC-1B)
Paper Code	DSC1BT (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (Gen) of Semester-II will acquire the knowledge about the Vector Analysis, Electrostatics, Magnetism, Electromagnetic Induction, Maxwell's Equations and Electromagnetic Wave Propagation by studying this course.

The theory paper (DSC1BT) of this course (DSC-1B) provides the student with-

CO1: Theory of scalar product, vector product, scalar triple product and their interpretation in terms of area and volume respectively.

CO2: Theory of directional derivatives and normal derivative, gradient of a scalar field and its geometrical interpretation, divergence and curl of a vector field, Del and Laplacian operators.

CO3: Concept and theory of ordinary integrals of vectors, line, surface and volume integrals of vector field along with solution of different mathematical problems on these topics.

CO4: Statements of Gauss' divergence theorem, Green's and Stokes theorems and their applications in terms of different mathematical problems.

CO5: Demonstration of Gauss' law and Coulomb's law for the electric field and application to systems of point charges as well as line, surface and volume distributions of charges.

CO6: Explanation and differentiation of the vector (electric fields from Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics.

CO7: Application of Gauss' law of electrostatics to solve a variety of problems.

CO8: Basic knowledge of electric current, resistance and capacitance in terms of electric field and electric potential, idea about electrostatic energy and calculation.

CO9: Concept of electric fields in matter, polarization and polarization charges, dielectric materials.

CO10: Demonstration of working and understanding of capacitors of various shapes filled with dielectrics.

CO11: Concept of displacement vector D, applications of Gauss' law in dielectric materials.

CO12: Demonstration of Biot Savart law for current carrying elements and application to systems of straight wire and current loops.

CO13: Concept of Ampere's circuital law and its application to (1) infinite straight wire, (2) infinite planar surface current and (3) solenoids.

CO14: Concept of magnetic dipoles, magnetic vector potential and magnetic forces.

CO15: Understanding the magnetic properties of materials and magnetic susceptibility, magnetic permeability, magnetic hysteresis.

CO16: Concept of electromagnetic induction by Faraday's law and Lenz law, self inductance and mutual inductance.

CO17: Physical concept and mathematical derivation of Maxwell's equations and displacement current.

CO18: Physical concept and mathematical derivation of electromagnetic wave at interface between different media, wave equations and plane waves in dielectric media.

CO19: General idea about the Pointing theorem for energy flow of EM wave and mathematical derivation of the Pointing vector.

CO20: Theory and mathematical derivation of propagation of plane EM waves through vacuum and isotropic dielectric medium, transverse nature of EM waves.

Semester	II
Title of Course	Electricity and Magnetism (DSC-1B)
Paper Code	DSC1BP (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (Gen) of Semester-II will acquire the practical knowledge about the Multimeter for the Measurement of Resistances, AC and DC Voltages, DC Current, Capacitances and Checking of Electrical Fuses, Ballistic Galvanometer, Characteristics of a Series RC Circuit, Potentiometer, Carey Foster's Bridge, Solenoid, Series and Parallel LCR Circuits, Applications of Thevenin, Norton, Superposition, Maximum Power Transfer Theorems by hands on practical experiments.

The lab paper (DSC1BP) of this course (DSC-1B) provides the student with-

CO1: Study of necessary theory, working formula and experimental observation to use a multimeter for the measurement of (a) resistances, (b) AC and DC voltages, (c) DC current, (d) capacitances and (e) checking of electrical fuses.

CO2: Study of necessary theory, working formula and experimental observation to measure charge and current sensitivity of a ballistic galvanometer, also to measure high resistance by leakage method.

CO3: Study of necessary theory, working formula and experimental measurement to compare capacitances using De-Sauty's bridge.

CO4: Study of necessary theory, working formula and experimental measurement of field strength B and its variation in a solenoid.

CO5: Study of necessary theory, working formula and experimental measurement to study the characteristics of a series RC Circuit.

CO6: Study of necessary theory, working formula and experimental measurement to study the response curve of a series LCR circuit and determination of its (a) resonant frequency, (b) impedance at resonance, (c) quality factor Q and (d) band width.

CO7: Study of necessary theory, working formula and experimental measurement to study the response curve of a parallel LCR circuit and determination of its (a) anti-resonant frequency and (b) quality factor Q.

CO8: Study of necessary theory, working formula and experimental determination of an unknown low resistance using Carey Foster's bridge.

CO9: Study of necessary theory, working formula and experimental verification of the Thevenin and Norton theorems.

CO10: Study of necessary theory, working formula and experimental verification of the superposition and maximum power transfer theorems.

Semester	III
Title of Course	Thermal Physics and Statistical Mechanics (DSC-1C)
Paper Code	DSC1CT (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (Gen) of Semester-III will acquire the knowledge about the Laws of Thermodynamics and their Applications, Various Thermodynamic Processes, Thermodynamic Potentials, Kinetic Theory of Gases, Blackbody Radiations, Different Distribution Laws for Blackbody Radiations, Classical and Quantum Statistical Mechanics and their Applications by studying this course.

The theory paper (DSC1CT) of this course (DSC-1C) provides the student with-

CO1: General thermodynamic description of a system, zeroth law of thermodynamics and the concept of temperature.

CO2: Statement and understanding of first law of thermodynamics, idea of internal energy and the conversion of heat into work, examples of various thermodynamic processes.

CO3: Study of the applications of first law of thermodynamics, general relation between C_P and C_V, calculations of work done during isothermal and adiabatic processes, compressibility and expansion coefficient.

CO4: Concept of reversible and irreversible processes, statement of second law of thermodynamics and the idea of entropy.

CO5: Study of Carnot's cycle and Carnot's theorem, entropy changes in reversible and irreversible processes, Entropy-temperature diagrams, third law of thermodynamics and the unattainability of absolute zero.

CO6: Theoretical and mathematical understanding of the thermodynamic potentials e.g. enthalpy, Gibbs free energy, Helmholtz free energy and internal energy functions.

CO7: Study of Maxwell's relations and applications in Joule-Thompson effect, Clausius- Clapeyron equation, expression for $(C_P - C_V)$, C_P/C_V and TdS equations.

CO8: Derivation of Maxwell's law of distribution of velocities and its experimental verification, mean free path (zeroth order).

CO9: Study of transport phenomena, viscosity, conduction and diffusion (for vertical case), law of equipartition of energy and its applications to specific heat of gases, mono-atomic and diatomic gases.

CO10: Theoretical concept of blackbody radiation, its spectral distribution, concept of energy density of radiations.

CO11: Fundamental postulates and mathematical derivation of Planck's law of blackbody radiation.

CO12: Deduction of Wien's distribution law, Rayleigh-Jeans law, Stefan Boltzmann law and Wien's displacement law from Planck's law of blackbody radiations.

CO13: Theoretical concept of phase space, macrostate and microstate, entropy and thermodynamic probability.

CO14: Study of Maxwell-Boltzmann distribution law and its applications to the distribution of velocity of the atoms/molecules of an ideal gas.

CO15: Fundamental postulates of quantum statistics - Fermi-Dirac distribution law and its application to a system of electron gas, Bose-Einstein distribution law and its application to a photon gas, comparison of three statistics.

Estd.-1966

Semester	III
Title of Course	Thermal Physics and Statistical Mechanics (DSC-1C)
Paper Code	DSC1CP (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (Gen) of Semester-III will acquire the practical knowledge about the Mechanical Equivalent of Heat, Measurement of Planck's Constant using Blackbody Radiation, Determination of Stefan's Constant, Coefficient of Thermal Conductivity, Temperature Coefficient of Resistance, Variations of Thermo EMF across Junctions of a Thermocouple and Calibration Resistance Temperature Device (RTD) by hands on practical experiments.

The lab paper (DSC1CP) of this course (DSC-1C) provides the student with-

CO1: Study of necessary theory, working formula and experimental method to determine mechanical equivalent of heat J, by Callender and Barne's constant flow method.

CO2**:** Study of necessary theory, working formula and experimental method to measure Planck's constant using black body radiation.

CO3: Study of necessary theory, working formula and experimental method to determine Stefan's constant.

CO4: Study of necessary theory, working formula and experimental method to determine the coefficient of thermal conductivity of Cu by Searle's apparatus.

CO5: Study of necessary theory, working formula and experimental method to determine the coefficient of thermal conductivity of Cu by Angstrom's method.

CO6: Study of necessary theory, working formula and experimental method to determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.

CO7: Study of necessary theory, working formula and experimental method to determine the temperature coefficient of resistance by platinum resistance thermometer.

CO8: Study of necessary theory, working formula and experimental method to study the variation of thermo EMF across two junctions of a thermocouple with temperature.

CO9: Study of necessary theory, working formula and experimental method to record and analyze the cooling temperature of a hot object as a function of time using a thermocouple and suitable data acquisition system.

CO10: Study of necessary theory, working formula and experimental method to calibrate resistance temperature device (RTD) using null method/off-balance bridge.

Semester	III
Title of Course	Physics Workshop Skill (SEC-1)
Paper Code	SEC1T (Theory)
Credits	02
Hours	02 hours/week

The students of Physics (Gen) of Semester-III will acquire the knowledge about the Introduction, Mechanical Skill, Electrical and Electronic Skill, Prime Movers by studying this course.

The theory paper (SEC1T) of this course (SEC-1) provides the student with-

CO1: Familiarization with measuring units, getting accustomed with meter scale, slide callipers, screw gauge and their usage, idea to measure length, height, thickness, volume etc. in different scenario.

CO2: Concept of workshop practice, basics on manufacturing methods e.g. casting, foundry, machining, forming and welding, ideas of welding joints and welding defects.

CO3: Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines, cutting tools, lubricating oils.

CO4: Familiarization about smoothening of cutting edge of sheet using file, drilling of holes of different diameter, usage of bench vice and tools for fitting.

CO5: Developing concepts on electrical instruments, usage of a multimeter, oscilloscope, power supplies.

CO6: Idea on technical skills e.g. soldering of electrical circuits having discrete components (R, L, C, diode) and ICs on PCB, building timer circuits, electronic switches.

CO7: Idea on mover mechanism, gear system, wheel, fixing of gears with motor axel, idea on lever mechanism, lifting of heavy weight using lever.

CO8: Familiarization with pulley system, demonstration of pulley experiment, working principle of power generation systems.

Semester	IV
Title of Course	Waves and Optics (DSC-1D)
Paper Code	DSC1DT (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (Gen) of Semester-IV will acquire the knowledge about the Superposition of Collinear Harmonic Oscillations and Perpendicular Harmonic Oscillations, Wave Motions - General, Fluids, Sound, Wave Optics, Interference, Interferometer, Diffraction and Polarization by studying this course.

The theory paper (DSC1DT) of this course (DSC-1D) provides the student with-

CO1: Understanding the theory of superposition principle of collinear harmonic oscillations and solutions of harmonic oscillations with equal and different frequencies and phase.

CO2: Demonstration of Lissajous figure, both graphically and analytically and calculation of the resulting pattern with equal and unequal frequencies.

CO3: Physical concept of plane wave, spherical wave, longitudinal and transverse wave and expression for the fundamental frequency of the longitudinal waves.

CO4: Expression of the differential equation of a plane progressive wave, longitudinal wave and transverse wave and calculation of the wave velocity and pressure and intensity.

CO5: Learning the concept of water waves, ripple and gravity waves.

CO6: Brief discussion about the formation of stationary waves for the transverse vibration of a stretched string under tension and fixed at the end.

CO7: Expression for the phenomena of acoustics building, reverberation and time of reverberation, absorption coefficient, Sabine's formula, absorption time acoustic aspects of halls and auditoria.

CO8: Understanding the phenomena of Newton's formula for velocity of sound and Laplace's correction.

CO9: Ideas about surface tension, synclastic and anticlastic surface, excess pressure, spherical and cylindrical drop bubbles, Jaeger's method.

CO10: Understanding the phenomena of group velocity and phase velocity, relationship between them.

CO11: Understanding the phenomena viscosity, Poiseuille's formula, variation of viscosity of a liquid with temperature lubrication, concept on low pressure, production and measurements of low pressure.

CO12: Basic concept on rotary pump, diffusion pump, molecular pump, Knudsen absolute gauge, Penning and Pirani gauges, detection of leakage.

CO13: Ideas of electromagnetic nature of light, wave front of light, definition and properties of wave front, demonstration of Huygens principle, concept of temporal spatial coherence.

CO14: Demonstration of the Young's experiment for interference of light, calculation fringe width.

CO15: Explanation about the formation of interference fringes by Fresnel's biprism and Lloyd's mirror experiment, difference between Lloyd's mirror fringes and Fresnel's biprism experiment fringes.

CO16: Explanation for the Stokes' treatment for phase changes on reflection, interference pattern in parallel and wedge-shaped thin film.

CO17: Demonstration of the formation of Newton's rings, expression for wavelength measurement, determination the refractive index of rare liquids.

CO18: Idea about the construction and the principle of working of a Michelson's interferometer, determination of wavelength, refractive index and visibility of fringes.

CO19: Ideas of intensity of the fringe system formed by the transmitted light in a Febry-Perot interferometer experiment.

CO20: Ideas of Kirchhoff's integral theorem, integral formula, Fraunhofer diffraction pattern due to a single slit, double slit and multiple slit.

CO21: Ideas on Fresnel diffraction pattern of a straight edge, a slit and a wire, Fresnel's half-period zones for plane wave, theory of zone plates.

CO22: Ideas of resolving power of a diffraction grating, calculation resolving power of a telescope and a diffraction grating.

CO23: Discussion about the principle of plane polarized light, production and analysis of plane polarized light, circular and elliptical polarization.

Semester	IV
Title of Course	Waves and Optics (DSC-1D)
Paper Code	DSC1DP (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (Gen) of Semester-IV will acquire the practical knowledge about the Melde's Experiment, Motion of Coupled Oscillators, Lissajous Figures, Schuster's Method of Focusing, Refractive Index of a Material of a Prism, Dispersive Power and Cauchy Constants of a Material, Wavelength a Sodium Source using Michelson's Interferometer, Fresnel Biprism and Newton's Rings, Thickness of a Thin Paper using Wedge-shape Film, Wavelength of Sodium Source and Spectral Lines of Mercury Source using Plane Diffraction Grating, Dispersive Power and Resolving Power of Plane Diffraction Grating by hands on practical experiments.

The lab paper (DSC1DP) of this course (DSC-1D) provides the student with-

CO1: Study of necessary theory, working formula and experimental measurement of the frequency of an electric tuning fork by Melde's experiment.

CO2: Study of necessary theory, working formula and experimental observation for investigation of the motion of coupled oscillators.

CO3: Study of necessary theory, working formula and experimental determination of Lissajous figures.

CO4: Study of necessary theory, working formula and experimental setup with Schuster's focusing method to determine the angle of prism.

CO5: Study of necessary theory, working formula and experimental determination of refractive index of the material of a prism using sodium source.

CO6: Study of necessary theory, working formula and experimental determination of the dispersive power and Cauchy constants of the material of a prism using mercury source.

CO7: Study of necessary theory, working formula and experimental determination of the wavelength of sodium source using Michelson's interferometer.

CO8: Study of necessary theory, working formula and experimental determination of the wavelength of sodium light using Fresnel's biprism.

CO9: Study of necessary theory, working formula and experimental determination of the wavelength of sodium light using Newton's rings.

CO10: Study of necessary theory, working formula and experimental determination of the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped film.

CO11: Study of necessary theory, working formula and experimental determination of the wavelength of (1) sodium source and (2) spectral lines of mercury source using plane diffraction grating.

CO12: Study of necessary theory, working formula and experimental determination of the dispersive power and resolving power of a plane diffraction grating.

CO13: Study of necessary theory, working formula and experimental determination of the coefficient of viscosity of water by capillary tube method (Poiseuille's method).

CO14: Study of necessary theory, working formula and experimental determination of the resolving power of a given prism.

Estd.-1966

Semester	IV
Title of Course	Electrical Circuits and Network Skills (SEC-2)
Paper Code	SEC2T (Theory)
Credits	02
Hours	02 hours/week

The students of Physics (Gen) of Semester-IV will acquire the knowledge about the Electrical Circuits and Network Skills, Different Electrical Circuits, Electrical Drawing and Symbols, Generators and Transformers, Electric Motors, Solid-State Devices, Electrical Protection as well as Electrical Wiring by studying this course.

The theory paper (SEC2T) of this course (SEC-2) provides the student with-

CO1: Physical concept and basic idea and formula of voltage, current, resistance, and power as well as understanding of Ohm's law with its mathematical formulation along with calculation and concept of series, parallel, and series-parallel combinations.

CO2: Physical concept and basic idea on AC electricity and DC electricity and familiarization with multimeter, voltmeter and ammeter along with its working procedure and circuit diagram.

CO3: Basic idea and circuit diagram and working procedure of main electric circuit elements and their combination along with DC sourced electrical circuits.

CO4: Familiarization with current and voltage drop across the DC circuit elements, single-phase and three phase alternating current sources.

CO5: Study of rules to analyze AC sourced electrical circuits along with calculation of real, imaginary and complex power components of AC source, power factor and saving energy and money.

CO6: Analysis, gathering knowledge and schematic of drawing symbols, blueprints, reading schematics, ladder diagrams, electrical schematics, power circuits, control circuits.

CO7: Basic knowledge and familiarization on reading of circuit schematics, tracking the connections of elements and identify current flow and voltage drop.

CO8: Theory, schematic diagram and working procedure of DC power sources, AC or DC generators, inductance, capacitance, and impedance, transformers.

CO9: Theory, schematic diagram, basic design and working procedure of single-phase, three-phase circuit.

CO10: Theory, schematic diagram, basic design and working procedure of DC motors along with interfacing DC or AC sources to control heaters and motors and calculation of speed and power of ac motor.

CO11: Familiarization on resistors, inductors and capacitors, diode, rectifiers, components in series or in shunt, response of inductors and capacitors with DC or AC sources.

CO12: Physical concept, working procedure and analysis of relays, fuses, disconnect switches, circuit breakers, overload devices.

CO13: Understanding on ground-fault protection, grounding and isolating, phase reversal, surge protection, interfacing DC or AC sources to control elements (relay protection device).

CO14: Understanding the basic concept of different types of conductors and cables, wiring - star and delta connection, voltage drop and losses across cables and conductors.

CO15: Theory, schematic diagram and working procedure of instruments to measure current, voltage, power in DC and AC circuits.

CO16: Understanding the basic concept of insulation, solid and stranded cable, conduit, cable trays, splices, wire nuts, crimps, terminal blocks, split bolts, and solder as well as circuit diagram for the preparation of extension board.

Estd.-1966

Semester	V
Title of Course	Elements of Modern Physics (DSE-1A)
Paper Code	DSE1AT (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (Gen) of Semester-V will acquire the knowledge about the Planck's Quantum Theory, Problems with Rutherford Model, Position Measurement, Two Slit Interference Experiment, One Dimensional Infinitely Rigid Box, Size and Structure of Atomic Nucleus, Radioactivity, Fission and Fusion by studying this course.

The theory paper (DSE1AT) of this course (DSE-1A) provides the student with-

CO1: Understanding the basics of Planck's quantum theory, Planck constant, light as a collection of photons, photo electric effect, Compton scattering.

CO2: Basic concept of blackbody radiation, de Broglie hypothesis, de Broglie wavelength, matter waves.

CO3: Demonstration of Davisson-Germer experiment, wave description of particle by wave packets, group and phase velocity and relation between them.

CO4: Basic ideas on two-slit experiment with electrons, probability, wave amplitude and wave functions.

CO5: Demonstration about the gamma ray microscopic thought experiment, concept on wave-particle duality, Rutherford model, hydrogen like atom and their spectra, Bohr's quantization rule, atomic stability.

CO6: Concept on Heisenberg uncertainty principle, uncertainty relations involving canonical pair of variables, derivation from wave packets.

CO7: Knowing about the estimating minimum energy of a confirmed particle using uncertainty principle, energy-time uncertainty principle, application to virtual particles and range of an interaction.

CO8: Basic concept for two slit interference experiment with photons, atoms and particles, linear superposition principle as a consequence.

CO9: Understanding the phenomena of matter waves and waves amplitude, Schrodinger equation for non-relativistic particles.

CO10: Basic idea on momentum and energy operator, stationary states, physical interpretation of a wave function, probabilities and normalization of current densities in one dimension.

CO11: Basic idea on one dimensional infinitely rigid box, calculation of energy eigenvalues and eigenfunctions.

CO12: Description of quantum mechanical scattering, tunnelling in one dimension-across a step potential and rectangular potential barrier, quantum dot.

CO13: Basic concept on atomic nucleus size and structure, relation with atomic weight, impossibility of an electron in the nucleus as consequence of the uncertainty principle.

CO14: Basic concept on liquid drop model, semi-empirical mass formula, binding energy, nuclear shell model, magic number, nuclear force, NZ graph.

CO15: Concept of radioactivity, stability of the nucleus, law of radioactive decay, mean life and half-life.

CO16: Concept on alpha decay, beta decay, spectrum and Pauli's prediction of neutrino.

CO17: Description gamma ray emission, energy momentum, conservation of electron-proton pair creation by gamma photons.

CO18: Concept of fission and fusion, mass deficit, relativity and generation of energy, nature of fragments and emission of neutrino.

CO19: Idea about nuclear reactor, slow neutrons interacting with U-235, fusion, thermonuclear reactions, stellar energy.

Semester	V
Title of Course	Elements of Modern Physics (DSE-1A)
Paper Code	DSE1AP (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (Gen) of Semester-V will acquire the practical knowledge about the Planck's Constant, Photo-Electric Effect, Work Function of Material of Filament, Planck's Constant using LEDs, Wavelength of H-alpha Emission Line of Hydrogen Atom, Ionization Potential of Mercury, Absorption Lines in the Rotational Spectrum of Iodine Vapour, e/m by Magnetic Focusing or Bar Magnet, Millikan Oil Drop Apparatus Method, Tunnel Diode Characteristics, Wavelength of a Laser Source using Single Slit and Double Slit, Wavelength and Angular Spread of He-Ne Laser using Grating by hands on practical experiments.

The lab paper (DSE1AP) of this course (DSE-1A) provides the student with-

CO1: Study of necessary theory, working formula and experimental measurement of Boltzmann constant using V-I characteristic of p-n diode.

CO2: Study of necessary theory, working formula and experimental observation of photo current versus intensity and wavelength of light and maximum energy of photo electrons versus frequency of light.

CO3: Study of necessary theory, working formula and experimental determination work function of a material of filament of directly heated vacuum diode.

CO4: Study of necessary theory, working formula and experimental determination the Planck's constant using LEDs of at least four different colours.

CO5: Study of necessary theory, working formula and experimental determination the wavelength of H-alpha emission line of hydrogen atom.

CO6: Study of necessary theory, working formula and experimental determination of the ionization potential of mercury.

CO7: Study of necessary theory, working formula and experimental determination of the absorption lines in the rotational spectrum of iodine vapour.

CO8: Study of necessary theory, working formula and experimental determination the value of e/m by (a) magnetic focusing or (b) bar magnet.

CO9: Study of necessary theory, working formula and experimental setup the Millikan oil drop apparatus and determine the charge of an electron.

CO10: Study of necessary theory, working formula and experimental determination the wavelength of laser source using diffraction of single slit and double slit.

Semester	V
Title of Course	Renewable Energy and Energy Harvesting (SEC-3)
Paper Code	SEC3T (Theory)
Credits	01
Hours	01 hour/week

The students of Physics (Gen) of Semester-V will acquire the knowledge about the Fossil Fuels and Alternate Sources of Energy, Solar Energy, Wind Energy Harvesting, Ocean Energy, Geothermal Energy, Hydro Energy, Piezoelectric Energy Harvesting and Electromagnetic Energy Harvesting by studying this course.

The theory paper (SEC3T) of this course (SEC-3) provides the student with-

CO1: Basic concept of fossil fuels and nuclear energy, renewable energy, non-conventional energy sources, ocean thermal energy, solar energy.

CO2: Understanding the over view of developments in offshore wind energy, tidal energy, wave energy systems, biomass, biochemical conversion, biogas generation, geothermal energy, hydroelectricity.

CO3: Learning the concept of solar energy, importance of solar energy, non-convective solar pond, solar water heater, flat plate collector, solar green houses, solar cell, solar distillation, absorption air conditioning.

CO4: Learning the concept and characteristics of photovoltaic (PV) systems, PV models, equivalent circuits, sun tracking systems.

CO5: Understanding the fundamentals of wind energy, wind turbines and different electrical machines in wind turbines, power electronic interfaces and grid interconnection topologies.

CO6: Understanding the relationship of ocean energy potential against wind and solar energy, wave energy devices, tide characteristics and statistics, tide energy technologies, ocean thermal energy, osmotic power, ocean biomass.

CO7: Basic idea on geothermal resources, geothermal technologies, hydropower resources, hydropower technologies, environmental impact of hydro power sources.

CO8: Understanding the phenomena of piezoelectric energy harvesting, physics and characteristics of piezoelectric effect, piezoelectric parameters and modelling piezoelectric generators, piezoelectric energy harvesting, human power.

Semester	V
Title of Course	Renewable Energy and Energy Harvesting (SEC-3)
Paper Code	SEC3P (Lab)
Credits	01
Hours	02 hours/week

The students of Physics (Gen) of Semester-V will acquire the practical knowledge about the Training Modules on Solar Energy, Conversion of Vibration to Voltage using Piezoelectric Materials, Conversion of Thermal Energy into Voltage using Thermoelectric Modules by hands on practical experiments.

The lab paper (SEC3P) of this course (SEC-3) provides the student with-

CO1: Study of necessary theory, working formula and experimental demonstration of training modules on solar energy, wind energy etc.

CO2: Study of necessary theory, working formula and experimental determination of conversion of vibration to voltage using piezoelectric materials.

CO3: Study of necessary theory, working formula and experimental determination of conversion of thermal energy into voltage using thermoelectric modules.

Semester	VI
Title of Course	Digital, Analog Circuits and Instrumentation (DSE-1B)
Paper Code	DSE1BT (Theory)
Credits	04
Hours	04 hours/week

The students of Physics (Gen) of Semester-VI will acquire the knowledge about the Digital Circuits, Semiconductor Device and Amplifier, Operational Amplifier, Instrumentations by studying this course.

The theory paper (DSE1BT) of this course (DSE-1B) provides the student with-

CO1: Differentiation between digital and analog circuits, binary numbers, decimal to binary and binary to decimal conversion.

CO2: Building up ideas on AND, OR and NOT gates, realization of these gates using diodes and transistors, NAND and NOR gates as universal gates, XOR gate, XNOR gate.

CO3: Ideas on de Morgan's theorems, Boolean laws, simplification of logic circuit using Boolean algebra, fundamental products of Boolean algebra.

CO4: Basic idea of minterms and maxterms, conversion of a truth table into equivalent logic circuits by (1) sum of product method and (2) Karnaugh map.

CO5: Basic concept on arithmetic circuits, binary addition, binary subtraction using 1's and 2's complement method.

CO6: Ideas of half and full adders, half and full subtractors, 4-bit binary adder, 4-bit binary subtractor.

CO7: Basic idea about semiconductor diodes, barrier formation in p-n junction diode, current flow mechanism in forward and reverse biased in diodes, static and dynamic resistance, principle and structure of (a) LEDs (b) photodiode and (c) solar cell.

CO8: Description on bipolar junction transistors, p-n-p and n-p-n transistors, CE, CB and CC configuration of transistor, input and output characteristics of transistors.

CO9: Analytical treatment of load line of transistor, current gain α and β, relation between α and β, DC load line and Q point, voltage divider bias circuit of CE configuration.

CO10: Basic idea about H-parameter, equivalent circuit, single stage CE amplifier using hybrid model, input and output impedance, class A, B and C amplifier, voltage and power gains.

CO11: Familiarization of an idea and practical Op-Amp (IC-741), open loop and closed loop gain, CMRR, concept on virtual ground, inverting and non-inverting amplifier, adder, subtractor, differentiator, integrator and zero crossing detector.

CO12: Building up ideas on sinusoidal oscillator, Barkhausen's criterion for self-sustained oscillator, frequency determination of RC oscillator.

CO13: Description of CRO, block diagram of CRO, study of wavefront, measurements of voltage, current, frequency and phase difference.

CO14: Basic concept of power supply, half wave bridge rectifier, centre tapped rectifier, full wave bridge rectifier, ripple factor, rectifier efficiency.

CO15: Basic idea about Zener diode, voltage regulation, capacitor filter.

CO16: Ideas about IC 555, block diagram of IC 555, applications of IC 555, concept on astable multivibrator and monostable multivibrator.

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Semester	VI
Title of Course	Digital, Analog Circuits and Instrumentation (DSE-1B)
Paper Code	DSE1BP (Lab)
Credits	02
Hours	04 hours/week

The students of Physics (Gen) of Semester-VI will acquire the practical knowledge about the Periodic Waveform using CRO, Verification of AND, OR, NOT, XOR using NAND Gates, Design of Combination Logic System for Specified Truth Table, Conversion of Boolean Expression into Logic Circuit using ICs, Minimize Logic Circuit, Half Adder, Full Adder and 4-bit Binary Adder, Astable and Monostable Multivibrator using 555 Timer, I-V Characteristics of p-n Diode, Zener Diode, LED, Transistor CE Configuration, Design of CE amplifier using Voltage Divider Bias, Inverting and Non-Inverting Amplifier using IC-741, Integrator and Differentiator using Op-Amp, Wien Bridge Oscillator by hands on practical experiments.

The lab paper (DSE1BP) of this course (DSE-1B) provides the student with-

CO1: Study of necessary theory, working formula and experimental measurement of (a) voltage and (b) time period of a periodic waveform using CRO.

CO2: Study of necessary theory, working formula and experimental verification of AND, OR, NOT and NOR gates using NAND gates.

CO3: Study of necessary theory, working formula and experimental observation of a combinational logic system for a specified truth table.

CO4: Study of necessary theory, working formula and experimental observation to convert a Boolean expression into logic circuit and design it using logic gate ICs.

CO5: Study of necessary theory, working formula and experimental determination of minimization a given logic circuit.

CO6: Study of necessary theory, working formula and experimental determination of half adder, full adder and 4-bit binary adder.

CO7: Study of necessary theory, working formula and experimental determination of an astable multivibrator of a given specifications using 555 timer.

CO8: Study of necessary theory, working formula and experimental determination of a monostable multivibrator of a given specifications using 555 timer.

CO9: Study of necessary theory, working formula and experimental determination of the I-V characteristic of p-n diode, Zener and light emitting diode.

CO10: Study of necessary theory, working formula and experimental observation of the characteristics of transistor in CE configuration.

CO11: Study of necessary theory, working formula and experimental determination of gain of a CE amplifier using voltage divider bias.

CO12: Study of necessary theory, working formula and experimental observation of inverting and non-inverting amplifier of a given gain using Op-Amp 741.

CO13: Study of necessary theory, working formula and experimental investigation of differentiator using Op-Amp.

CO14: Study of necessary theory, working formula and experimental investigation of Wien bridge oscillator using Op-Amp.

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Semester	VI
Title of Course	Weather Forecasting (SEC-4)
Paper Code	SEC4T (Theory)
Credits	01
Hours	01 hour/week

The students of Physics (Gen) of Semester-VI will acquire the knowledge about the Atmosphere, Weather in terms of Wind, Humidity, Cloud, Rainfall etc., Weather System, Climate and Climate Change and the Basics of Weather Forecasting by studying this course.

The theory paper (SEC4T) of this course (SEC-4) provides the student with-

CO1: Idea of atmosphere, physical structure and composition, compositional layering of the atmosphere.

CO2: Study of the variation of pressure and temperature of the atmosphere with height, air temperature and the requirements to measure air temperature.

CO3: Theory and working principle of temperature sensors, different types of temperature sensors, atmospheric pressure and its measurement, cyclones and anticyclones and their characteristics.

CO4: Understanding the forces acting to produce wind, wind speed, units and its direction, measurement of wind speed and its direction.

CO5: Study of humidity, clouds, rainfall, radiation laws.

CO6: Study of global wind systems, air masses and fronts, classifications, jet streams, local thunderstorms, tropical cyclones and classification.

CO7: Study of climate and its classification, causes of climate change, global warming and its outcomes, air pollution, aerosols, ozone depletion, acid rain, environmental issues related to climate.

CO8: Fundamentals of weather forecasting, analysis and its historical background, need of measuring weather, types of weather forecasting.

CO9: Study of weather forecasting methods, criteria of choosing weather station, basics of choosing site and exposure.

CO10: Study of the use of satellite observations for weather forecasting, basic understanding of weather maps, uncertainty and predictability of weather forecasting and probability forecasts.

Semester	VI
Title of Course	Weather Forecasting (SEC-4)
Paper Code	SEC4P (Lab)
Credits	01
Hours	02 hours/week

The students of Physics (Gen) of Semester-VI will acquire the practical knowledge about the Working Principle of Weather Station, Processing and Analysis of Weather Data, Plotting and Analysis of Pressure Charts, Surface Charts and Upper Wind Charts and Different Types of Weather Forecasting or Warning by hands on practical experiments.

The lab paper (SEC4P) of this course (SEC-4) provides the student with-

CO1: Study of necessary theory and working principle of synoptic charts, weather reports and weather station.

CO2**:** Study of necessary theory, working principle and practical method for the processing and analysis of following weather data: (a) the sunniest time of the year, (b) the variation of rainfall amount and intensity by wind direction, (c) the sunniest/driest day of the week, (d) the maximum and minimum temperature throughout the year, (e) the relative humidity of the day and (f) the rainfall amount month wise.

CO3: Study of necessary theory, working principle and the methods for plotting and analysis of pressure charts, surface charts and upper wind charts.

CO4: Study of necessary theory, working principle and techniques of different types of weather forecasts or warnings both aviation and non-aviation type.