FYUP 2024

PHYSICS

BSc Multidisciplinary

B.Sc (Multidisciplinary)
DSC 1- PHYSICS

Pre-requisite : Physics and Mathematics in class XII

Semester	Course Title	Course Code	Credit	Classes/week	Total Credit
I	Mechanics Lab 1	24-PHY-D-112 24-PHY-D-110	3 1	Lecture - 3 Lab - 2	4
II	Mathematical Physics Lab 2	24-PHY-D-171 24-PHY-D-170	3 1	Lecture - 3 Lab - 2	4
III	Basic Electronics Lab 3	24-PHY-D-232 24-PHY-D-230	3 1	Lecture - 3 Lab - 2	4
IV	Elem of Modern Phys. Thermal Physics Lab 4	24-PHY-D-272 24-PHY-D-273 24-PHY-D-270	3 3 2	Lecture - 3 Lecture - 3 Lab - 4	8
V	Wave Optics Electromagnetism I Lab 5	24-PHY-D-333 24-PHY-D-334 24-PHY-D-330	3 3 2	Lecture - 3 Lecture - 3 Lab - 4	8
VI	Electromagnetism II Expt Techniques Digital Electronics Lab 6	24-PHY-D-371 24-PHY-D-374 24-PHY-D-375 24-PHY-D-370	3 3 3 3	Lecture - 3 Lecture – 3 Lecture - 3 Lab - 6	12
VII	Electro-Magnetic Theory Quantum Mechanics Computational Physics Lab 7	24-PHY-D-431 24-PHY-D-434 24-PHY-D-435 24-PHY-D-430	3 3 3 3	Lecture - 3 Lecture – 3 Lecture - 3 Lab - 6	12
VIII	Classical Mechanics Nuclear Particle Physics Solid State Physics Lab 8	24-PHY-D-471 24-PHY-D-474 24-PHY-D-475 24-PHY-D-470	3 3 3 3	Lecture - 3 Lecture – 3 Lecture - 3 Lab - 6	12

B.Sc (Multidisciplinary)
DSC 2- PHYSICS

(With 1 courses in semesters I-V & 2 courses in semesters VI, VII, VIII)

Pre-requisite : Physics and Mathematics in class XII

Semester	Course Title	Course Code	Credit	Classes/week	Total Credit
I	Mechanics Lab 1	24-PHY-D-112 24-PHY-D-110	3 1	Lecture - 3 Lab - 2	4
II	Mathematical Physics Lab 2	24-PHY-D-171 24-PHY-D-170	3 1	Lecture - 3 Lab - 2	4
III	Basic Electronics Lab 3	24-PHY-D-232 24-PHY-D-230	3 1	Lecture - 3 Lab - 2	4
IV	Thermal Physics Lab 4	24-PHY-D-273 24-PHY-D-270	3 1	Lecture - 3 Lab - 2	4
V	Wave Optics Lab 5	24-PHY-D-333 24-PHY-D-340	3 1	Lecture - 3 Lab - 2	4
VI	Electromagnetism I Elem of Modern Phys. Lab 6	24-PHY-D-376 24-PHY-D-377 24-PHY-D-380	3 3 2	Lecture - 3 Lecture - 3 Lab - 4	8
VII	Electromagnetism II Quantum Mechanics Lab 7	24-PHY-D-436 24-PHY-D-434 24-PHY-D-440	3 3 2	Lecture – 3 Lecture - 3 Lab - 4	8
VIII	Digital Electronics Solid State Physics Lab 8	24-PHY-D-476 24-PHY-D-475 24-PHY-D-480	3 3 2	Lecture – 3 Lecture - 3 Lab - 4	8

B.Sc (Multidisciplinary)
DSC 3 - PHYSICS
&
DSC 2 - PHYSICS

(With 1 course in all semester)

Pre-requisite : Physics and Mathematics in class XII

Semester	Course Title	Course Code	Breakup Credit	Classes /week	Total Credit
I	Mechanics Lab1	24-PHY-D-112 24-PHY-D-110	Lecture -3 Lab -1	Lecture - 3 Lab - 2	4
II	Math Physics Lab2	24-PHY-D-171 24-PHY-D-170	Lecture -3 Lab -1	Lecture - 3 Lab - 2	4
III	Basic Electronics Lab3	24-PHY-D-232 24-PHY-D-230	Lecture -3 Lab -1	Lecture - 3 Lab - 2	4
IV	Thermal Physics Lab 4	24-PHY-D-273 24-PHY-D-270	Lecture -3 Lab -1	Lecture - 3 Lab - 2	4
V	Wave Optics Lab 5	24-PHY-D-333 24-PHY-D-340	Lecture -3 Lab -1	Lecture - 3 Lab - 2	4
VI	Electromagnetism I Lab 6	24-PHY-D-376 24-PHY-D-380	Lecture -3 Lab -1	Lecture - 3 Lab - 2	4
VII	Elem of Modern Phys. Lab 7	24-PHY-D-437 24-PHY-D-440	Lecture -3 Lab -1	Lecture - 3 Lab - 2	4
VIII	Digital Electronics Lab 8	24-PHY-D-476 24-PHY-D-480	Lecture -3 Lab -1	Lecture - 3 Lab - 2	4

<u>B.Sc (Multidisciplinary)</u>

<u>DSC 1- PHYSICS</u>

<u>With 1 courses in semesters I-III</u>
<u>& 2 courses in semesters IV-V</u>
<u>& 3 courses in VI-VIII</u>

Semester	Course Title	Course Code	Credit	Classes/week	Total Credit
I	Mechanics Lab 1	24-PHY-D-112 24-PHY-D-110	3 1	Lecture - 3 Lab - 2	4
II	Mathematical Physics Lab 2	24-PHY-D-171 24-PHY-D-170	3 1	Lecture - 3 Lab - 2	4
III	Basic Electronics Lab 3	24-PHY-D-232 24-PHY-D-230	3 1	Lecture - 3 Lab - 2	4
IV	Elem of Modern Phys. Thermal Physics Lab 4	24-PHY-D-272 24-PHY-D-273 24-PHY-D-270	3 3 2	Lecture - 3 Lecture - 3 Lab - 4	8
V	Wave Optics Electromagnetism I Lab 5	24-PHY-D-333 24-PHY-D-334 24-PHY-D-330	3 3 2	Lecture - 3 Lecture - 3 Lab - 4	8
VI	Electromagnetism II Expt Techniques Digital Electronics Lab 6	24-PHY-D-371 24-PHY-D-374 24-PHY-D-375 24-PHY-D-370	3 3 3 3	Lecture - 3 Lecture – 3 Lecture - 3 Lab - 6	12
VII	Electro-Magnetic Theory Quantum Mechanics Computational Physics Lab 7	24-PHY-D-431 24-PHY-D-434 24-PHY-D-435 24-PHY-D-430	3 3 3 3	Lecture - 3 Lecture – 3 Lecture - 3 Lab - 6	12
VIII	Classical Mechanics Nuclear Particle Physics Solid State Physics Lab 8	24-PHY-D-471 24-PHY-D-474 24-PHY-D-475 24-PHY-D-470	3 3 3 3	Lecture - 3 Lecture – 3 Lecture - 3 Lab - 6	12

Semester - I

Course Title - Mechanics

Course Type – Multidisciplinary (DSC)

Course Code – 24-PHY-D-112

Course Level – 100

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite – Physics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome – The objective of this course is to impart the fundamental knowledge on mechanics. The course first teaches the fundamentals of linear and rotational motions to understand any dynamical systems. The laws of motion, the laws of conservations and other fundamental ideas will be given. The students will also learn about different kind of oscillations.

Reference Books:

1. An introduction to mechanics : Kleppner & Kolenkow.
2. Feynman Lectures-Volume I,
3. Newtonian Mechanics : A.P.French,
4. Mechanics : Berkeley Physics Course
5. Vibrations and Waves : A. P. French.
6. The Physics of Waves and Oscillations : N.K. Bajaj

Course Syllabus -

Unit I: Fundamentals of Dynamics

Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Newton's Laws of motion, dynamics of a system of particles, centre of mass, conservation of momentum, impulse, Work-energy theorem, potential energy, conservative and non-conservative forces, force as gradient of potential energy. Stable and unstable equilibrium, Work done by non-conservative forces. Law of conservation of Energy and momentum.

Unit II: Rotational Dynamics

Angular momentum of a system of particles, torque and conservation of angular momentum, rotation about a fixed axis, moment of inertia tensor: its calculation for regular bodies, kinetic energy of rotation; Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

Unit III: System of particles

Collisions : Elastic and inelastic collisions between particles, Elastic scattering : centre of mass and laboratory frame. Kinematics of elastic scattering in the laboratory system, Bouncing balls and other problems, Inelastic scattering : cross-section, The Rutherford formula, Problems. Variable mass problems : Rockets and other problems with things fall apart, Avalanche and other problems with stuff gathering.

Unit IV: Harmonic Oscillations

Simple Harmonic Motion, Simple pendulum, Compound pendulum, Linearity and Superposition Principle, Superpositions of two and N collinear oscillations, Superposition of two perpendicular oscillations, Graphical and Analytical method, Lissajous Figures, Free Damped oscillation. Forced oscillations: Transient and steady states; Resonance, Power Dissipation and Quality Factor

Semester - I

Course Title - Lab 1 - Mechanics & Oscillation I

Course Type – Multidisciplinary Lab

Course Code – 24-PHY-D-110

Course Level – 100

Total Credits – 1

Classes /week – 2

Max. Marks – 25

Prerequisite – Mechanics

Course Advisor's Name :

Course Advisor's Email :

<u>List of Experiments :</u>

1. Measurements of length using vernier caliper, screw gauge and travelling microscope.
2. To determine **g** using simple pendulum.
3. To study the Motion of Spring and calculate Spring constant by static and dynamic method.
4. To determine the value of g using Bar Pendulum. (4)
5. To determine the value of g using Kater's Pendulum. (4)

Semester - II

Course Title - Mathematical Physics

Course Type – Multidisciplinary (DSC)

Course Code – 24-PHY-D-171

Course Level – 100

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite – Mathematics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome - Physics is generally referred as mathematical description of nature. To understand the underlying physical laws in nature one has to be equipped with proper mathematical training. In this mathematical physics course students will be exposed to different mathematical topics which they need to understand other areas of physics which they will read in their first year. It will also help them to understand the next level courses of mathematical physics as well.

Reference Books:

1. Vector Analysis : Schaum Series
2. Advanced Engineering Mathematics : Kreyzig
3. Linear Algebra : Schaum Series
4. Complex Variable : Spiegel
5. Linear Vector Spaces : M. C. Jain

Course Syllabus -

Unit I: Matrices and Linear Vector Space :

Different types of matrices; Matrix algebra, Applications of matrices in solving simple linear equations, Systems of Linear Equations, Eigenvalues and Eigenvectors, Geometric interpretation of vectors, Definition of a linear vector space, Examples of linear vector spaces Subspaces, Linear combination of vectors, Linear dependence and independence, Basis and dimension of a finite-dimensional vector space, Row space, column space, and null space, Coordinate representation of vectors with respect to a basis

Unit II: Vector Calculus :

Vector algebra; normal derivative; Gradient; Divergence; Curl; Laplacian, Vector identities, Ordinary Integrals of Vectors, Notion of infinitesimal line, surface, volume elements; Line, surface, volume integrals of vector fields. Flux of a vector field, Gauss theorem, Green's theorem and Stokes Theorems, Orthogonal curvilinear coordinates: Calculation of divergence, gradient, curl and Laplacian in spherical polar and cylindrical coordinates. Multiple Integrals, Jacobian. Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials.

Unit III: Ordinary Differential Equations :

Classifying equations by order, degree, and linearity; understanding general vs. particular solutions, Solving equations via separation of variables and the integrating factor method for linear equations. Applications, Homogeneous Equations: Solving second-order linear equations with constant coefficients using the characteristic equation., Non-Homogeneous Equations: Finding particular solutions using the method of undetermined coefficients.

Unit IV: Fourier Series and Dirac Delta Function:

Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function Properties and representation of Dirac delta function in 1D, 2D, 3D; integral representation; Fourier series: Periodic functions; Dirichlet Conditions; Fourier coefficients; complex form, Expansion of arbitrary period function, non-periodic function, even and odd functions; Half range expansions; Summing of infinite series; Parseval Identity.

Semester - II

Course Title - Lab 2 – Mechanics & Oscillation II

Course Type – Multidisciplinary Lab

Course Code - 24-PHY-D-170

Course Level – 100

Total Credits – 01

Classes /week – 02

Max. Marks – 25

Prerequisite – Mechanics

Course Advisor’s Name :

Course Advisor’s Email :

List of Experiments :

1. To determine the Moment of Inertia of a Flywheel.
2. To determine surface tension of a fluid by capillary rise method.
3. To determine the coefficient of viscosity of a liquid by Stoke’s law.
4. To determine Coefficient of Viscosity of water by Capillary Flow Method .
5. To determine the Young's Modulus of a rod.
6. To determine the surface tension of a liquid by Jaeger’s method.

Semester - III

Course Title – Basic Electronics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-232

Course Level – 200

Total Credits – 3

Classes /week – 3

Max. Marks – 75

Prerequisite – Physics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome – The objective of this course is to impart basic background in analog circuits. The course would use simple models; description of the semiconductors, different diodes and applications, transistors and applications and operational amplifiers will be covered. The broad behavioral description of the blocks in the op-amp will be used to explain the circuit operation.

Reference Books:

1. Basic Electronics : D C Tayal,.
2. Principles of Electronics : V. K. Mehta.
3. Electronic Devices and Circuit : Robert Boylestad, Louis Nashelsky,
4. Basic Electronics and Linear Circuits : N. N. Bhargava, D. C. KulShreshtha.

Course Syllabus -

Unit I: Circuits Analysis

Kirchhoffs Laws, Mesh and Node Analysis of Circuits. RC circuits, Networks, Equivalent Star (T) and delta Networks. Star to Delta and Delta to Star Conversion. Network Theorems, Superposition theorem, Thevenin Theorem, Norton theorem.

Unit II: Semiconductor Diodes

P and N Type Semiconductors. Energy Level Diagram. Conductivity and Mobility, Drift velocity, PN junction Diodes and its characteristics. Barrier Formation, Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode, Barrier Width and Current for Step Junction. PN junction Rectifier Diode, Half-wave Rectifier, Full-wave Rectifiers its Ripple Factor and Efficiency. Idea of Filters. Zener diode and voltage regulation,Photo diode, varactor diode, LED, solar cell.

Unit III: Transistors and Amplifiers

N-P-N and P-N-P Transistors, Characteristics of CB, CE and CC configurations. Active, Cut-off, and Saturation Regions. Load line and Q- point. Current gains and relation between them, Amplifiers and their classification, Class A, B, and C Amplifiers. Ideal amplifier, Voltage gain, current gain, Power gain, Input resistance, output resistance, load line. Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. RC-coupled amplifier and its frequency response.

Unit IV: AC circuits

AC Circuits: Alternating currents, mean and r.m.s. values, Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. phase diagrams, Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit. Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR. Oscillators : Barkhausen criterion for self-sustained oscillations, Hartley oscillator, Colpitts oscillator, RC phase shift oscillator, multivibrators, crystal oscillator.

Semester - III

Course Title - Lab 3 - Basic Electronics I

Course Type – Multidisciplinary lab

Course Code - 24-PHY-D-230

Course Level – 200

Total Credits – 01

Classes /week – 02

Max. Marks - 25

Prerequisite – Electronics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Analyze and interpret electrical and electronic circuits' behavior.
2. Apply theoretical knowledge to practical experiments.
3. Demonstrate understanding of semiconductor devices' characteristics.
4. Design and test simple electronic circuits.
5. Measure and calculate electrical parameters accurately.

<u>List of Experiments :</u>

1. To study V-I characteristics of PN junction diode
2. To study the V-I characteristics of a Zener diode
3. To study use of Zener diode as voltage regulator.
4. To study growth and decay of charge on a condenser in RC circuit.
5. To verify the network theorems - Superposition theorem and Maximum power transfer

Semester - IV

Course Title – Elements of Modern Physics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-272

Course Level – 200

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite – Physics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Explain the principles of wave-particle duality and uncertainty.
2. Apply quantum mechanics to atomic and nuclear phenomena.
3. Describe the structure and properties of atomic nuclei.
4. Analyze radioactive decay and nuclear reactions.
5. Understand the principles of nuclear energy production.

Reference Books:

1. A. Beiser : Concepts of Modern Physics
2. H. S. Mani and G. K. Mehta : Modern Physics
3. I.Kaplan : Nuclear Physics
4. Cohen : Concepts of Nuclear Physics

Course Syllabus

Unit I: Introduction to Modern Physics

Blackbody Radiation, Planck radiation formula, Planck's quantum hypothesis, Planck's constant and light as a collection of photons; Photo-electric effect, Compton scattering, X-ray diffraction.

Unit II: Wave Particle Duality

Wave-particle duality, De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Energy-time uncertainty principle, Application.

Rutherford scattering, Atomic model. Atomic spectra, energy levels, Bohr theory, quantum numbers, Frank Hertz experiment, Qualitative idea of spin and Pauli exclusion principle.

Unit III: Atomic Structure

Rutherford scattering, Atomic model. Atomic spectra, energy levels, Bohr theory, quantum numbers, Frank Hertz experiment, Qualitative idea of spin and Pauli exclusion principle.

Unit IV:Nuclear Structure

Size and structure of atomic nucleus and its relation with atomic weight, Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy,

Semester - IV

Course Title – Thermal Physics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-273

Course Level – 100

Total Credits – 3

Classes /week – 3

Max. Marks – 75

Prerequisite – Physics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Apply kinetic theory and thermodynamic principles to explain physical phenomena.
2. Analyze and interpret data related to gas behavior and thermodynamic processes.
3. Demonstrate understanding of fundamental laws and equations governing thermodynamics.
4. Apply mathematical models to solve problems in thermodynamics.
5. Develop problem-solving skills using analytical and numerical methods.

Reference Books:

1. A Text book of heat: M. N Saha and B.N Srivastava
2. Heat and Thermodynamics: Zemansky, Richard Dittman .
3. Thermal Physics : Garg, Bansal and Ghosh .
4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics: Sears, Salinger

Course Syllabus

Unit I: Kinetic theory of gases

Basic postulates of kinetic theory, Pressure of an ideal gas, Maxwell-Boltzmann Law of Distribution of velocities and energy of an Ideal Gas. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy and its applications, Specific heats of Gases Mean Free Path, Collision Probability, Distribution of Mean Free Paths,

Unit II: Ideal and Real gases

Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance. Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants.

Unit III: Thermodynamics

Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics, Concept of Temperature, Work and Heat, State Functions, Internal Energy, First Law of Thermodynamics, General Relation between Cp and Cv, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient. Reversible and Irreversible process, Conversion of Work and Heat. Heat Engines. Carnot's Cycle, Carnot engine and efficiency, Refrigerator and coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements, Carnot's Theorem. Thermodynamic Scale of Temperature

Unit IV: Entropy, Thermodynamic Potentials and Maxwell's relations

Entropy, Clausius Theorem, Clausius Inequality, Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes. Entropy of the Universe. Temperature–Entropy diagrams for Carnot's Cycle, Third Law of Thermodynamics. Unattainability of Absolute Zero, Thermodynamic Potentials : Enthalpy, Helmholtz Free Energy, Gibbs Free Energy: Properties and applications, Maxwell's Thermodynamic Relations - Derivations and applications of Maxwell's Relations such as Clausius-Clapeyron Equation, Cp-Cv, TdS Equations,

Semester - IV

Course Title - Lab 4 - Basic Electronics II

Course Type – Multidisciplinary Lab

Course Code - 24-PHY-D-270

Course Level – 200

Total Credits – 02

Classes /week – 04

Max. Marks: 50

Prerequisite – Electronics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Analyze and interpret electrical and electronic circuits' behavior.
2. Apply theoretical knowledge to practical experiments.
3. Demonstrate understanding of semiconductor devices' characteristics.
4. Design and test simple electronic circuits.
5. Measure and calculate electrical parameters accurately.

<u>List of Experiments :</u>

1. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
2. To study Half wave rectifier and find their ripple factor with various filters.
3. To study Full wave rectifier and find their ripple factor with various filters.
4. To verify the network theorems - Norton and Thevenin theorem
5. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.

Semester - V

Course Title – Wave Optics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-333

Course Level – 300

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite – Physics in class XII & Mechanics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Understand wave motion, interference, diffraction, and polarization principles.
2. Apply mathematical models to describe wave phenomena.
3. Analyze optical systems and instruments.
4. Explain electromagnetic nature of light.
5. Demonstrate problem-solving skills in wave optics.

Reference Books:

1. Optics : A. K.Ghatak
2. Fundamentals of Optics : Jenkins and White
3. Principles of Optics : Max Born andf Emil Wolf
4. Optics : Eugene Hecht

Course Syllabus

Unit I: Wave Motion

Wave Equation. Solutions of wave equation. Wave front. Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave, Energy Transport, Intensity of Wave, Water Waves: Ripple and Gravity Waves. Superposition of Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free ends, Phase and Group Melde's experiment. Longitudinal Standing Waves and normal modes, Open and Closed Pipes.

Unit II: Interference :

Electromagnetic nature of light. Definition and properties of wave front, Huygens Principle. Temporal and Spatial Coherence.Division of amplitude and wavefront. Young's double slit experiment. Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings, Michelson Interferometer, Fabry-Perot interferometer. Applications.

Unit III: Diffraction :

Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

Unit IV: Polarization :

Polarisation of light by reflection – Brewster's – law; Double refraction – ordinary and extraordinary ray; Optic axis; Huygen's construction for uniaxial crystals; Nicol prism, polaroids; Production and analysis of (i) plane polarized, (ii) circularly polarized and (iii) elliptically polarized light; Double refraction, Wave plates, Optical activity, Babinet's compensator.

Semester - V

Course Title – Electricity Magnetism I

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-334

Course Level – 100

Total Credits – 3

Classes /week – 3

Max. Marks – 75

Prerequisite – Mathematical Physics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Apply mathematical techniques to solve problems in electromagnetism.
2. Analyze and interpret physical phenomena using vector calculus.
3. Demonstrate understanding of fundamental laws and principles in electromagnetism.
4. Apply theoretical knowledge to solve practical problems.
5. Develop problem-solving skills using analytical and numerical methods

Reference Books:

1. Introduction to Electrodynamics : D.J. Griffiths
2. Electricity and Magnetism : A.S. Mahajan and A.A. Rangwala
3. Electricity and Magnetism : Berkeley Physics Course ed. E.M. Purcell
4. Physics (Vol. 2) : Halliday and Resnick
5. Feynman Lectures in Physics (Vol II)

Course Syllabus

Unit I: Vector Analysis

Vector Algebra, Triple products, Differential calculus, gradient, divergence and curl, Product rules, Vector identities, Line, surface and volume integrals, Fundamental theorems, curvilinear coordinates, Helmoholz theorm.

Unit II: Electrostatics

Coulomb's law, Electric field, Continuous charge distribution, Divergence of Electric field, Electric flux. Gauss' Law with applications, Curl of Electric field, Electrostatic potential,. Conservative nature of Electrostatic Field, Laplace's and Poisson equations, Work and energy, Conductors, Surface charge and force on a conductor. Capacitors,

Unit III: Magnetostatics

Magnetic effect of steady current, Equation of continuity and steady current, Lorentz force and concept of magnetic induction, force on linear current element, Biot-Savart law and its simple applications: straight wire and circular loop, Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Divergence and curl of magnetic field, Vector potential. Boundary conditions.

Unit IV: Electromagnetic Induction

Electromagnetic induction: Integral and differential forms. Induced electric field and emf. Mutual and self-inductance. Transformers. Magnetic field energy. Electromotive Force, Motional e.m.f.-simple problems, Electromagnetic induction, Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Calculation of self and mutual inductance in simple cases, Energy stored in a Magnetic Field. Charge Conservation and Displacement current. Introduction to Maxwell's Equations.

Semester - V

Course Title - Lab 5 - Modern Physics

Course Type – Multidisciplinary Lab

Course Code - 24-PHY-D-330

Course Level – 300

Total Credits – 2

Classes /week – 4

Max. Marks - 50

Prerequisite – Optics

Course Advisor’s Name :

Course Advisor’s Email :

Expected Learning Outcome –

Overall Learning Outcome

Upon successful completion of these experiments, students will be able to apply fundamental principles of modern physics, semiconductor physics, electromagnetism, and quantum mechanics through hands-on experimentation. Students will also develop competence in experimental techniques, data analysis, error estimation, scientific observation, and interpretation of results, thereby strengthening their understanding of the physical concepts underlying contemporary science and technology.

List of Experiments :

1. Determination of Planck's constant by photocell and verify the radiation law.
2. Determination of wavelength of Sodium light using Michelson's Interferometer
3. Determination of the band gap of a semiconductor using four probe method.
4. Determination of magnetic susceptiblity of MnCl2 by Quinck’s method
5. Determination of Planck's constant by cut off method.
6. Determination of e/m by Thomson's method.
7. To determine the Hall coefficient of a semiconductor sample.

Semester - VI

Course Title – Electricity & Magnetism II

Course Type – Multidisciplinary (Core)

Course Code - 24-PHY-D-371

Course Level – 300

Total Credits – 3

Classes /week – 3

Max. Marks: 75

Prerequisite – Electricity & Magnetism I

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Analyze electrostatic and magnetic fields in matter.
2. Apply multipole expansion techniques.
3. Understand dielectric and magnetic properties of materials.
4. Solve AC circuit problems using complex analysis.
5. Design and analyze electrical systems.

Reference Books:

1. Introduction to Electrodynamics : D.J. Griffiths
2. Electricity and Magnetism : A.S. Mahajan and A.A. Rangwala
3. Electricity and Magnetism : Berkeley Physics Course ed. E.M. Purcell
4. Physics (Vol. 2) : Halliday and Resnick

Course Syllabus

Unit I: Multipole expansion

Multipole Expansion of a charge distribution at large distance, Monopole and Dipole Terms, Electric Field of a Dipole, Force and Torque on a electric dipole, Multipole Expansion of the Vector Potential, Current Loop as a Magnetic Dipole and its Dipole Moment, Force and Torque on a magnetic dipole, Magnetic dipole moment for rotating charge bodies, Gyro-magnetic ratio.

Unit II: Electrostatic fields in matter

Dielectrics, Induced Dipoles, Polarization, Bound Charges, Physical Interpretation, Field Inside a Dielectric , Gauss's Law in the Presence of Dielectrics, Boundary Conditions, Susceptibility, Permittivity, Dielectric Constant, Capacitor (parallel plate, spherical, cylindrical) filled with dielectric Forces on Dielectrics

Unit III: Magnetic fields in matter

Magnetization vector (M). Dia, para and ferromagnetism. The field of a magnetized object. Bound currents, Physical Interpretation, Magnetic field inside matter, Magnetic Intensity H, Ampere's law in magnetized medium. Boundary conditions. Magnetic susceptibility and permeability. Ferromagnetism. Hysteresis and the B-H curve.

Unit IV: Boundary Value Problems

Poisson's equation, Laplace's equation, boundary conditions, uniqueness theorem. Method of images, Different image problems; Boundary value problems with linear dielectric materials and linear magnetic materials.

Semester - VI

Course Title – Experimental Techniques

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-374

Course Level – 300

Total Credits – 3

Classes /week – 3

Max. Marks – 75

Prerequisite – Physics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Apply measurement principles and data analysis techniques.
2. Understand signal processing and system response.
3. Design and characterize thin film materials.
4. Develop vacuum systems for various applications.
5. Integrate knowledge of measurement, signals, and materials for industrial applications.

<u>Reference Books:</u>

1. Electrical Measurements & Electronic Measurements : A.K. Sawhney
2. Modern electronic Instrumentation and measurement techniques : Helfrick Cooper
3. Electronic test instruments: analog and digital measurements: R. A. Witte
4. Instrumentation, devices and systems : Rangan, Sarma and Mani
5. Electronic Instrumentation : H. S. Kalsi .

Course Syllabus

Unit I: Measurements and Data processing

Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting. Guassian distribution. Recording and analysis of data, data uncertainty, Error: - accuracy and precision, computer-aided data acquisition

Unit II: Signals, Systems and Shielding

Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first and second order systems. Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise, Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference.

Unit III: Thin Film Growth and Characterization Techniques

Physical vapour deposition, thermal evaporation, e-beam evaporation, sputtering, pulsed laser deposition, molecular beam epitaxy, MOCVD, thin film technology for industrial applications. UV-Vis absorption spectroscopy, FTIR spectroscopy, Photoluminscence.

Unit IV: Vacuum Systems

Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system- Chamber, Mechanical pumps, Diffusion pump & Turbo Modular pump, Pumping speed, Pressure gauges (Pirani, Penning, ionization)

Semester - VI

Course Title – Digital Electronics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-375

Course Level – 300

Total Credits – 3

Classes /week – 3

Max. Marks – 75

Prerequisite – Physics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Understand number systems, codes, and Boolean algebra.
2. Design and analyze digital logic circuits.
3. Apply arithmetic and data processing concepts to digital circuits.
4. Design and analyze sequential logic circuits.
5. Convert between analog and digital signals.

Reference Books:

1. Digital Electronics : Gothman
2. Digital Principals & Applications : Malvino & Leach
4. Digital Computer Electronics : A.P.Malvino
5. Analog and Digital Electronics : Peter.H.Beards.
6. Integrated Electronics : Millman & Halkias

Course Syllabus

Unit I: Number system and codes

Introduction to decimal, binary, octal, hexadecimal number system, Inter conversion of binary, decimal, BCD, Octal and hexadecimal, BCD codes, Excess-3, grey codes. Simple binary arithmetic, binary addition, binary subtraction, 1`s and 2`s compliment of a binary number.

Unit II: Boolean algebra

Boolean laws, OR, AND and NOT operations (realization using Diodes and Transistor), NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. De Morgan's theorems, simplification of logic circuit using Boolean algebra, sum-of-products (SOP) and product-of-sums (POS), idea of minterms and maxterms, conversion of a truth table into equivalent logic circuit by SOP and POS method, Karnaugh Map.

Unit III: Arithmetic and Data Processing Circuits

Half adder, Full adder, Half and Full subtractors, Adder-subtractor, Digital comparators, Multiplexers, Demultiplexers, Decoders, Encoders, Parity checker and Generator

Unit IV: Sequential Logic Circuits

Clock and timer : clock parameters, propagation delay, IC 555 block diagram, working principle, astable multivibrator, monostable multivibrator.
Flip-flops : RS flip-flops, D flip-flop and JK flip-flop, the use of clock, racing, edge triggering, pulse triggering, master-slave flip-flop, preset and clear operations.
Shift Register : serial-in-serial-out, serial-in-parallel-out, parallel-in-serial-out and parallel-in - parallel-out shifting operations, applications of shift register
Counter : asynchronous counter, synchronous counter, decade counter, applications
D/A and A/D Conversions : Weighted resistor D/A converter, R-2R ladder D/A converter, accuracy and resolution, A/D Conversion

Semester - VI

Course Title - Lab 6 - Optics

Course Type – Lab

Course Code - 24-PHY-D-370

Course Level – 300

Total Credits – 3

Classes /week – 6

Max. Marks - 75

Prerequisite – Optics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Measure optical properties of materials and systems.
2. Apply principles of optics to experimental techniques.
3. Analyze data from optical experiments.
4. Demonstrate understanding of diffraction, refraction, and polarization.
5. Develop problem-solving skills in optics.

<u>List of Experiments :</u>

1. Focal length of two lenses by Nodal Slide method and verification of Newton's formula.
2. To determine wavelength of Na source using plane diffraction grating
3. Determination of refractive Index and dispersive power of a prism using pectrometer.
4. Determination of wavelength of LASER using plane transmission diffraction grating.
5. Determination of wavelength of sodium light by Newton's Rings method.
6. Determination of specific rotation of sugar solution by Laurent's Half-Shade Polarimeter
7. Verification of Hartman's dispersion formula
8. To determine wavelength of spectral lines of Hg source using plane diffraction grating.
9. To determine dispersive power and resolving power of a plane diffraction grating
10. To determine the wavelength of Sodium light by using Fresnel's Biprism.

Semester - VII

Course Title – Electro-Magnetic Theory

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-431

Course Level – 400

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite – Electricity &Magnetism II

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Understand electromagnetic wave propagation principles.
2. Analyze EM wave behavior in unbounded and bounded media.
3. Apply boundary conditions to solve reflection and refraction problems.
4. Explain polarization phenomena and anisotropic media.
5. Design and analyze optical waveguides.

Reference Books:

1. Introduction to Electrodynamics : D.J. Griffiths
2. Foundations of Electromagnetic Theory : Reitz, Millford and Christy
3. Classical Electrodynamics : J.D.Jackson
4. Introduction to Electromagnetic Field and Waves : Corson and Lorrain

Course Syllabus

Unit I: Review of Maxwell’s Equation

Review of Maxwell’s equations. Scalar and vector potentials. Gauge transformations. Coulomb and Lorentz Gauge, Conservation of energy and momentum, Poynting theorem, Maxwell’s Stress tensor. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density.

Unit II: EM Wave Propagation in Unbounded Media

Wave Equations, Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.

Unit III: EM Wave in Bounded Media

Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence)

Unit IV: Wave Guides

Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission

Semester - VII

Course Title – Quantum Mechanics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-C-433

Course Level – 400

Total Credits – 3

Classes /week – 3

Max. Marks: 75

Prerequisite – Elements of Modern Physics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Understand quantum mechanics principles and applications.
2. Solve time-dependent and time-independent Schrödinger equations.
3. Analyze bound states in various potentials.
4. Explain quantum theory of hydrogen-like atoms.
5. Understand atomic structure, electron spin, and magnetic properties.

<u>Reference</u>

1. Concepts in Modern Physics: Beiser
2. Quantum Mechanics: Zettili
3. Quantum Mechanics: Griffiths
4. A text book on Quantum Mechanics : M.C.Jain

Course Syllabus

Unit I: Schrodinger equations

Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions, Hamiltonian, stationary states and energy eigenvalues; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Ehrenfest theorem. Time independent Schrodinger equation.

Unit II: One dimensional potentials

Continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential (infinite and finite), Potential barrier problems - step potential and rectangular potential. Quantum mechanics of simple harmonic oscillator-energy levels and eigen states.

Unit III: Angular momentum and Hydrogen atom

Time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wave functions; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells,

Unit IV: Atomic Structure

SternGerlach Experiment, Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Normal and Anomalous Zeeman Effect. Gyromagnetic Ratio and Bohr Magneton. Pauli's Exclusion Principle. Symmetric & Antisymmetric Wave Functions. Periodic table.

Semester - VII

Course Title – Computational Physics

Course Type – Multidisciplinary

Course Code - 24-PHY-D-435

Course Level – 400

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite –

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

Student should be able to write concise computer codes to solve matrix, algebraic, discrete iterative or differential equations to desired accuracy. S/he should be able to compute answers, plot the graphs and interpret them. This course sufficiently equips them to go to a computing environment to solve real world problems.

References :

1. Computer Programming in Fortran : V Rajaram
2. Computational Physics Fortran version : S E Koonin
3. Computational Physics : K N Anagnostopoulos
4. Computational Physics : R. Fitzpatrick
5. An Introduction to Computational Physics : Tao Pang

Course Syllabus

Computer oriented procedures, flow charts, FORTRAN programming preliminaries, constant and variables, data types, arithmetic expressions, input/output statements, control statements : IF statement, DO loops, dimension statement, FORMAT statements, functions and subroutines, processing files, writing programs in FORTRAN.

Introduction to plotting softwares, LINUX operating system, Linux commands, file system, directories and filenames, directory hierarchy, command line structure, installing packages
Numerical methods using computers : root finding : bisection method, Regula Falsi, Newton-Raphson method, roots of polynomials, roots of non-linear equations, numerical integration : rectangular method, trapezoidal method, solving ordinary differential equations : Euler method, Runge Kutta method RK2, RK4, interplanetary journeys, system of linear equations, Gauss elimination Gauss Jordan method.

Fast Fourier Transform : FT of discretely sampled data, FFT of real functions, sine and cosine transforms, FFT in two or more dimensions, convolution and deconvolution using FFT, correlation and autocorrelation using FFT

Dynamics using computers, non linear systems : Logistic map, iterative evolution, pitchfork bifurcation, Liapunov coefficient, evolution of chaos, chaotic pendulum, Lorentz system, Rossler system etc.
Random numbers, random walk, percolation, Monte carlo, molecular dynamics, Partial differential equations in Physics

Semester - VII

Course Title - Lab 7 - Electricity & Magnetism

Course Type – Multidisciplinary Lab

Course Code - 24-PHY-D-430

Course Level – 400

Total Credits – 3

Classes /week – 6

Max. Marks - 75

Prerequisite – Electricity & Magnetism

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Measure electrical quantities using various instruments and techniques.
2. Analyze electrical circuits and determine circuit parameters.
3. Understand electromagnetic principles and applications.
4. Apply measurement techniques to electrical systems.
5. Develop problem-solving skills in electricity & magnetism.

List of Experiments:

1. Determination of E.C.E. of copper using a Copper Voltameter and checking the accuracy of ammeter.
2. Determination of Self Inductance of a coil using Anderson's Bridge.
3. Determination Self Inductance of a coil by Owen's Bridge.
4. Study of LCR circuit and determination of impedence.
5. Determination of magnetic field by Helmholtz coil.
6. To draw the B-H curve for the iron and to determine the energy loss due to hysterisis.
7. To determine the temperature coefficient of resistance by Platinum Resistance Thermometer (PRT).
8. Conversion of a moving coil galvanometer into an ammeter and voltmeter.
9. To determine the dielectric constants for solids.
10. Study of the Wien bridge oscillator and determine the frequency of the oscillator.

Semester - VIII

Course Title – Classical Mechanics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-471

Course Level – 400

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite – Mechanics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

Student should be able to solve constrained system using Lagrangian and Hamiltonian systems. S/he should understand minimization problems in real life and solve them through action integrals. One should be able to transform a given Hamiltonian to another one having all cyclic coordinates to simplify the problem. One should understand general rotatory motion of rigid bodies in terms of principal axes rotations.

Reference Books:

1. Classical Mechanics: H. Goldstein.
2. Mechanics: L. D. Landau and E. M. Lifshitz
3. Classical Mechanics: N.C.Rana and P.S.Joag.
4. Theoretical Mechanics: Murray Spiegel.
5. Classical Mechanics Systems of Particles and Hamiltonian Dynamics:Walter Greiner

Course Syllabus

Unit I: Special Theory of Relativity

Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Four vectors and tensors, Space-time diagram; Space like, time-like and light like intervals; Light cone. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum.

Unit II: Gravitation and Central Force Motion

Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere, Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws of planetary motion, Nature of orbits in an attractive inverse square field, Condition for stable circular orbit, Satellite in circular orbit and applications. Geosynchronous orbits.

Unit III: Lagrangian Formalism

Newtonian mechanics and its limitations. Constrained motion. Constraints and their classification. Mechanics of a System of Particles, Lagrangian Formulation, Principle of virtual work. D' Alembert's principle. Generalised coordinates. Derivation of Lagrange's equations from D' Alembert's Principle. Generalised momenta and energy. Cyclic or ignorable coordinates. Symmetries of space and time with conservation laws.

Unit IV: Hamiltonian formalism

Calculus of Variations and Euler-Lagrange's Equation, Brachistochrone Problem, Hamilton's Principle, Extension of Hamilton's Principle to Non-Holonomic Systems, Legendre Transformation and the Hamilton Equations of Motion, Physical Significance of Hamiltonian, Derivation of Hamilton's Equations of Motion from a Variational Principle, Principle of Least Action

Semester - VII

Course Title – Nuclear &Particle Physics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-474

Course Level – 400

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite – Elements of Modern Physics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

To study simple models of Nuclear forces which are most complicated forces in nature. To understand particle accelerators to study particle interactions through bombardment to know nature of forces between various types of particles. To classify various fundamental particles based on few intrinsic characteristics, to know about various symmetries and related conservation laws.

Reference Books:

1. Nuclei and Particles : Segre
2. Nuclear Physics : Cohen
3. Nuclear Physics : Enge
4. Physics of Nuclei and Particles : Marmur and Sheldon
5. Introduction to Nuclear and Particle Physics : Das and Ferbel

Course Syllabus

Unit I: Radioactivity and Nuclear reactions

Radioactive decay, Alpha decay, Gamow's theory, Beta decay, Pauli's neutrino hypothesis, Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235, Fusion and thermonuclear reactions driving stellar energy

Unit II: Nuclear Model and Nuclear Forces

Angular momentum, Parity and symmetry, Magnetic dipole moment and electric quadrupole moment, Energy levels and mirror nuclei. Nuclear Shell Model and magic numbers. Characteristics of nuclear forces -Range and strength, Simple theory of two nucleon system -deuterons, Spin states of two nucleon system, Effect of Pauli's exclusion principle, Magnetic dipole moment and electric quadrupole moment of deuteron -The tensor forces.

Unit III: Accelerators and Detectors

Need of accelerators. Cyclotron. Betatron and Linac. Detectors for charged particles. Working principle of Cloud chamber, Bubble chamber, Ionisation chamber. Proportional counter. G.M. Counter. Scintillation Counter.

Unit IV: Elementary particles

Fundamental interactions in nature. Classification of elementary particles. Photons, leptons, mesons and baryons. Quantum numbers: isospin, strangeness, and charm. Quarks and confinement. Conservation laws.

Semester - VIII

Course Title – Solid State Physics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-475

Course Level – 400

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite – Quantum Mechanics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Understand crystal structures and bonding in solids.
2. Analyze lattice dynamics and thermal properties.
3. Apply band theory to electronic structures in solids.
4. Explain transport properties in metals and semiconductors.
5. Model real-world phenomena using solid-state physics principles.

<u>Reference Books:</u>

1. Solid State Physics : Hook and Hall : Hook and Hall
2. Introduction to Solid State Physics : Kittel
3. Solid State Physics : Ibach and Luth
4. Introduction to the Theory of Solids : H. M. Rosenberg
5. Solid State Physics : Blakemore
6. Solid State Physics : Ashcroft and Mermin
7. Solid State Physics : M.A. Wahab

Course Syllabus

Unit I: Bonding in crystals

Covalent, ionic (including Madelung constant), metallic, hydrogen bond, van der Waal's bond. Orbital symmetry and crystal structure. Crystalline solids, unit cell, primitive cell, Bravis lattices, closed packed structures. Atomic radius, lattice constant, packing fraction, density, Miller indices. Scattering from periodic structures, Bragg's law, X-ray diffraction, atomic form factor, structure factor, Laue's equation, reciprocal lattice, Brillouin zones.

Unit II: Lattice Dynamics

Lattice dynamics of atoms in crystals, vibrations of monoatomic and diatomic linear chains, acoustic and optical phonon modes, density of states, thermal properties of crystal lattices, thermal energy of the harmonic oscillator, specific heat capacity of the lattice, Debye theory of specific heats.

Unit III: Band Theory

Free electrons in solids, density of states, Fermi surface, Fermi gas at T=0 K, Fermi statistics, specific heat capacity of electrons in metals, thermionic emission of electrons from metals. Electronic band structure in solids, Electrons in periodic potentials, Bloch's Theorem, Kronig-Penney model, Nearly free electron model, Insulator, semiconductor and metals. Tight-binding model: density of states, examples of band structures. Fermi surfaces of metals and semiconductors.

Unit IV: Transport properties

Motion of electrons in bands and the effective mass, currents in bands and holes, scattering of electrons in bands, Boltzmann equation and relaxation time, electrical conductivity of metals, thermoelectric effects, the Wiedemann-Franz Law. Intrinsic and Extrinsic Semiconductors, Carrier

Semester - VIII

Course Title - Lab 8 – Digital Electronics

Course Type – Multidisciplinary Lab

Course Code - 24-PHY-D-470

Course Level – 400

Total Credits – 3

Classes /week – 6

Max. Marks - 75

Prerequisite – Digital Electronics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Design and analyze electronic circuits using operational amplifiers (Op-amps) and 555 timers.
2. Understand analog and digital circuit design principles.
3. Apply electronic circuit analysis and design techniques.
4. Develop problem-solving skills in electronic circuit design.
5. Demonstrate hands-on experience with electronic circuit implementation.

<u>List of Experiments :</u>

1. To design an inverting amplifier of given gain using Op-amp (741,351) and study the frequency response
2. To design non-inverting amplifier of given gain using Op-amp (741,351) and study its frequency response
3. To design and study an Op-amp adder
4. To design and study the use of an op-amp as an Integrator / Differentiator.
5. To determine the frequency and duty cycle of an astable 555 timer.
6. To design an astable multivibrator of frequency 1 kHz using a 555 timer.
7. To design a monostable 555 multivibrator and measure the pulsewidth of its output.
8. To verify and design AND, OR, NOT and XOR gates using NAND gates.
9. To design a Half Adder and Full Adder circuit using IC.
10. To construct Flip-Flop circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs

B.Sc (Multidisciplinary)
DSC 2- PHYSICS

(With 1 courses in semesters I-V & 2 courses in semesters VI, VII, VIII)

Semester	Course Title	Course Code	Credit	Classes/week	Total Credit
I	Mechanics Lab 1	24-PHY-D-112 24-PHY-D-110	3 1	Lecture - 3 Lab - 2	4
II	Mathematical Physics Lab 2	24-PHY-D-171 24-PHY-D-170	3 1	Lecture - 3 Lab - 2	4
III	Basic Electronics Lab 3	24-PHY-D-232 24-PHY-D-230	3 1	Lecture - 3 Lab - 2	4
IV	Thermal Physics Lab 4	24-PHY-D-273 24-PHY-D-270	3 1	Lecture - 3 Lab - 2	4
V	Wave Optics Lab 5	24-PHY-D-333 24-PHY-D-340	3 1	Lecture - 3 Lab - 2	4
VI	Electromagnetism I Elem of Modern Phys. Lab 6	24-PHY-D-376 24-PHY-D-377 24-PHY-D-380	3 3 2	Lecture - 3 Lecture - 3 Lab - 4	8
VII	Electromagnetism II Quantum Mechanics Lab 7	24-PHY-D-436 24-PHY-D-434 24-PHY-D-440	3 3 2	Lecture – 3 Lecture - 3 Lab - 4	8
VIII	Digital Electronics Solid State Physics Lab 8	24-PHY-D-476 24-PHY-D-475 24-PHY-D-480	3 3 2	Lecture – 3 Lecture - 3 Lab - 4	8

Semester - I

Course Title - Mechanics

Course Type – Multidisciplinary (DSC)

Course Code – 24-PHY-D-112

Course Level – 100

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite – Physics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome – The objective of this course is to impart the fundamental knowledge on mechanics. The course first teaches the fundamentals of linear and rotational motions to understand any dynamical systems. The laws of motion, the laws of conservations and other fundamental ideas will be given. The students will also learn about different kind of oscillations.

Reference Books:

1. An introduction to mechanics : Kleppner & Kolenkow.
2. Feynman Lectures-Volume I,
3. Newtonian Mechanics : A.P.French,
4. Mechanics : Berkeley Physics Course
5. Vibrations and Waves : A. P. French.
6. The Physics of Waves and Oscillations : N.K. Bajaj

Course Syllabus -

Unit I: Fundamentals of Dynamics

Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Newton's Laws of motion, dynamics of a system of particles, centre of mass, conservation of momentum, impulse, Work-energy theorem, potential energy, conservative and non-conservative forces, force as gradient of potential energy. Stable and unstable equilibrium, Work done by non-conservative forces. Law of conservation of Energy and momentum.

Unit II: Rotational Dynamics

Angular momentum of a system of particles, torque and conservation of angular momentum, rotation about a fixed axis, moment of inertia tensor: its calculation for regular bodies, kinetic energy of rotation; Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

Unit III: System of particles

Collisions : Elastic and inelastic collisions between particles, Elastic scattering : centre of mass and laboratory frame. Kinematics of elastic scattering in the laboratory system, Bouncing balls and other problems, Inelastic scattering : cross-section, The Rutherford formula, Problems. Variable mass problems : Rockets and other problems with things fall apart, Avalanche and other problems with stuff gathering.

Unit IV: Harmonic Oscillations

Simple Harmonic Motion, Simple pendulum, Compound pendulum, Linearity and Superposition Principle, Superpositions of two and N collinear oscillations, Superposition of two perpendicular oscillations, Graphical and Analytical method, Lissajous Figures, Free Damped oscillation. Forced oscillations: Transient and steady states; Resonance, Power Dissipation and Quality Factor

Semester - I

Course Title - Lab 1 - Mechanics & Oscillation I

Course Type – Multidisciplinary Lab

Course Code – 24-PHY-D-110

Course Level – 100

Total Credits – 1

Classes /week – 2

Max. Marks – 25

Prerequisite – Mechanics

Course Advisor's Name :

Course Advisor's Email :

<u>List of Experiments :</u>

1. Measurements of length using vernier caliper, screw gauge and travelling microscope.
2. To determine **g** using simple pendulum.
3. To study the Motion of Spring and calculate Spring constant by static and dynamic method.
4. To determine the value of g using Bar Pendulum. (4)
5. To determine the value of g using Kater's Pendulum. (4)

Semester - II

Course Title - Mathematical Physics

Course Type – Multidisciplinary (DSC)

Course Code – 24-PHY-D-171

Course Level – 100

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite – Mathematics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome - Physics is generally referred as mathematical description of nature. To understand the underlying physical laws in nature one has to be equipped with proper mathematical training. In this mathematical physics course students will be exposed to different mathematical topics which they need to understand other areas of physics which they will read in their first year. It will also help them to understand the next level courses of mathematical physics as well.

Reference Books:

1. Vector Analysis : Schaum Series
2. Advanced Engineering Mathematics : Kreyzig
3. Linear Algebra : Schaum Series
4. Complex Variable : Spiegel
5. Linear Vector Spaces : M. C. Jain

Course Syllabus -

Unit I: Matrices and Linear Vector Space :

Different types of matrices; Matrix algebra, Applications of matrices in solving simple linear equations, Systems of Linear Equations, Eigenvalues and Eigenvectors, Geometric interpretation of vectors, Definition of a linear vector space, Examples of linear vector spaces Subspaces, Linear combination of vectors, Linear dependence and independence, Basis and dimension of a finite-dimensional vector space, Row space, column space, and null space, Coordinate representation of vectors with respect to a basis

Unit II: Vector Calculus :

Vector algebra; normal derivative; Gradient; Divergence; Curl; Laplacian, Vector identities, Ordinary Integrals of Vectors, Notion of infinitesimal line, surface, volume elements; Line, surface, volume integrals of vector fields. Flux of a vector field, Gauss theorem, Green's theorem and Stokes Theorems, Orthogonal curvilinear coordinates: Calculation of divergence, gradient, curl and Laplacian in spherical polar and cylindrical coordinates. Multiple Integrals, Jacobian. Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials.

Unit III: Ordinary Differential Equations :

Classifying equations by order, degree, and linearity; understanding general vs. particular solutions, Solving equations via separation of variables and the integrating factor method for linear equations. Applications, Homogeneous Equations: Solving second-order linear equations with constant coefficients using the characteristic equation., Non-Homogeneous Equations: Finding particular solutions using the method of undetermined coefficients.

Unit IV: Fourier Series and Dirac Delta Function:

Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function Properties and representation of Dirac delta function in 1D, 2D, 3D; integral representation; Fourier series: Periodic functions; Dirichlet Conditions; Fourier coefficients; complex form, Expansion of arbitrary period function, non-periodic function, even and odd functions; Half range expansions; Summing of infinite series; Parseval Identity.

Semester - II

Course Title - Lab 2 – Mechanics & Oscillation II

Course Type – Multidisciplinary Lab

Course Code - 24-PHY-D-170

Course Level – 100

Total Credits – 01

Classes /week – 02

Max. Marks – 25

Prerequisite – Mechanics

Course Advisor's Name :

Course Advisor's Email :

List of Experiments :

1. To determine the Moment of Inertia of a Flywheel.
2. To determine surface tension of a fluid by capillary rise method.
3. To determine the coefficient of viscosity of a liquid by Stoke's law.
4. To determine Coefficient of Viscosity of water by Capillary Flow Method .
5. To determine the Young's Modulus of a rod.
6. To determine the surface tension of a liquid by Jaeger's method.

Semester - III

Course Title – Basic Electronics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-232

Course Level – 200

Total Credits – 3

Classes /week – 3

Max. Marks – 75

Prerequisite – Physics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome – The objective of this course is to impart basic background in analog circuits. The course would use simple models; description of the semiconductors, different diodes and applications, transistors and applications and operational amplifiers will be covered. The broad behavioral description of the blocks in the op-amp will be used to explain the circuit operation.

Reference Books:

1. Basic Electronics : D C Tayal,.
2. Principles of Electronics : V. K. Mehta.
3. Electronic Devices and Circuit : Robert Boylestad, Louis Nashelsky,
4. Basic Electronics and Linear Circuits : N. N. Bhargava, D. C. KulShreshtha.

Course Syllabus -

Unit I: Circuits Analysis

Kirchhoffs Laws, Mesh and Node Analysis of Circuits. RC circuits, Networks, Equivalent Star (T) and delta Networks. Star to Delta and Delta to Star Conversion. Network Theorems, Superposition theorem, Thevenin Theorem, Norton theorem.

Unit II: Semiconductor Diodes

P and N Type Semiconductors. Energy Level Diagram. Conductivity and Mobility, Drift velocity, PN junction Diodes and its characteristics. Barrier Formation, Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode, Barrier Width and Current for Step Junction. PN junction Rectifier Diode, Half-wave Rectifier, Full-wave Rectifiers its Ripple Factor and Efficiency. Idea of Filters. Zener diode and voltage regulation,Photo diode, varactor diode, LED, solar cell.

Unit III: Transistors and Amplifiers

N-P-N and P-N-P Transistors, Characteristics of CB, CE and CC configurations. Active, Cut-off, and Saturation Regions. Load line and Q- point. Current gains and relation between them, Amplifiers and their classification, Class A, B, and C Amplifiers. Ideal amplifier, Voltage gain, current gain, Power gain, Input resistance, output resistance, load line. Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. RC-coupled amplifier and its frequency response.

Unit IV: AC circuits

AC Circuits: Alternating currents, mean and r.m.s. values, Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. phase diagrams, Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit. Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR. Oscillators : Barkhausen criterion for self-sustained oscillations, Hartley oscillator, Colpitts oscillator, RC phase shift oscillator, multivibrators, crystal oscillator.

Semester - III

Course Title - Lab 3 - Basic Electronics I

Course Type – Multidisciplinary lab

Course Code - 24-PHY-D-230

Course Level – 200

Total Credits – 01

Classes /week – 02

Max. Marks - 25

Prerequisite – Electronics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Analyze and interpret electrical and electronic circuits' behavior.
2. Apply theoretical knowledge to practical experiments.
3. Demonstrate understanding of semiconductor devices' characteristics.
4. Design and test simple electronic circuits.
5. Measure and calculate electrical parameters accurately.

<u>List of Experiments :</u>

1. To study V-I characteristics of PN junction diode
2. To study the V-I characteristics of a Zener diode
3. To study use of Zener diode as voltage regulator.
4. To study growth and decay of charge on a condenser in RC circuit.
5. To verify the network theorems - Superposition theorem and Maximum power transfer

Semester - IV

Course Title – Thermal Physics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-273

Course Level – 200

Total Credits – 3

Classes /week – 3

Max. Marks – 75

Prerequisite – Physics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Apply kinetic theory and thermodynamic principles to explain physical phenomena.
2. Analyze and interpret data related to gas behavior and thermodynamic processes.
3. Demonstrate understanding of fundamental laws and equations governing thermodynamics.
4. Apply mathematical models to solve problems in thermodynamics.
5. Develop problem-solving skills using analytical and numerical methods.

Reference Books:

1. A Text book of heat: M. N Saha and B.N Srivastava
2. Heat and Thermodynamics: Zemansky, Richard Dittman .
3. Thermal Physics : Garg, Bansal and Ghosh .
4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics: Sears, Salinger

Course Syllabus

Unit I: Kinetic theory of gases

Basic postulates of kinetic theory, Pressure of an ideal gas, Maxwell-Boltzmann Law of Distribution of velocities and energy of an Ideal Gas. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy and its applications, Specific heats of Gases Mean Free Path, Collision Probability, Distribution of Mean Free Paths,

Unit II: Ideal and Real gases

Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance. Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants.

Unit III: Thermodynamics

Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics, Concept of Temperature, Work and Heat, State Functions, Internal Energy, First Law of Thermodynamics, General Relation between Cp and Cv, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient. Reversible and Irreversible process, Conversion of Work and Heat. Heat Engines. Carnot's Cycle, Carnot engine and efficiency, Refrigerator and coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements, Carnot's Theorem. Thermodynamic Scale of Temperature

Unit IV: Entropy, Thermodynamic Potentials and Maxwell's relations

Entropy, Clausius Theorem, Clausius Inequality, Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes. Entropy of the Universe. Temperature–Entropy diagrams for Carnot's Cycle, Third Law of Thermodynamics. Unattainability of Absolute Zero, Thermodynamic Potentials : Enthalpy, Helmholtz Free Energy, Gibbs Free Energy: Properties and applications, Maxwell's Thermodynamic Relations - Derivations and applications of Maxwell's Relations such as Clausius-Clapeyron Equation, Cp-Cv, TdS Equations,

Semester - IV

Course Title - Lab 4 - Basic Electronics II

Course Type – Multidisciplinary Lab

Course Code - 24-PHY-D-270

Course Level – 200

Total Credits – 01

Classes /week – 04

Max. Marks: 25

Prerequisite – Electronics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Analyze and interpret electrical and electronic circuits' behavior.
2. Apply theoretical knowledge to practical experiments.
3. Demonstrate understanding of semiconductor devices' characteristics.
4. Design and test simple electronic circuits.
5. Measure and calculate electrical parameters accurately.

List of Experiments :

1. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
2. To study Half wave rectifier and find their ripple factor with various filters.
3. To study Full wave rectifier and find their ripple factor with various filters.
4. To verify the network theorems - Norton and Thevenin theorem
5. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.

Semester - V

Course Title – Wave Optics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-333

Course Level – 300

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite – Physics in class XII & Mechanics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Understand wave motion, interference, diffraction, and polarization principles.
2. Apply mathematical models to describe wave phenomena.
3. Analyze optical systems and instruments.
4. Explain electromagnetic nature of light.
5. Demonstrate problem-solving skills in wave optics.

Reference Books:

1. Optics : A. K.Ghatak
2. Fundamentals of Optics : Jenkins and White
3. Principles of Optics : Max Born andf Emil Wolf
4. Optics : Eugene Hecht

Course Syllabus

Unit I: Wave Motion

Wave Equation. Solutions of wave equation. Wave front. Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave, Energy Transport, Intensity of Wave, Water Waves: Ripple and Gravity Waves. Superposition of Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free ends, Phase and Group Melde's experiment. Longitudinal Standing Waves and normal modes, Open and Closed Pipes.

Unit II: Interference :

Electromagnetic nature of light. Definition and properties of wave front, Huygens Principle. Temporal and Spatial Coherence.Division of amplitude and wavefront. Young's double slit experiment. Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings, Michelson Interferometer, Fabry-Perot interferometer. Applications.

Unit III: Diffraction :

Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

Unit IV: Polarization :

Polarisation of light by reflection – Brewster's – law; Double refraction – ordinary and extraordinary ray; Optic axis; Huygen's construction for uniaxial crystals; Nicol prism, polaroids; Production and analysis of (i) plane polarized, (ii) circularly polarized and (iii) elliptically polarized light; Double refraction, Wave plates, Optical activity, Babinet's compensator.

Semester - V

Course Title - Lab 5 - Optics I

Course Type – Multidisciplinary (Lab)

Course Code - 24-PHY-D-340

Course Level – 300

Total Credits – 01

Classes /week – 02

Max. Marks - 25

Prerequisite – Wave Optics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Measure optical properties of materials and systems.
2. Apply principles of optics to experimental techniques.
3. Analyze data from optical experiments.
4. Demonstrate understanding of diffraction, refraction, and polarization.
5. Develop problem-solving skills in optics.

List of Experiments :

1. Focal length of two lenses by Nodal Slide method and verification of Newton's formula.
2. To determine wavelength of Na source using plane diffraction grating
3. Determination of refractive Index and dispersive power of a prism using spectrometer.
4. Determination of wavelength of LASER using plane transmission diffraction grating.
5. Determination of wavelength of sodium light by Newton's Rings method.

Semester - VI

Course Title – Electricity Magnetism I

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-376

Course Level – 300

Total Credits – 3

Classes /week – 3

Max. Marks – 75

Prerequisite – Mathematical Physics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Apply mathematical techniques to solve problems in electromagnetism.
2. Analyze and interpret physical phenomena using vector calculus.
3. Demonstrate understanding of fundamental laws and principles in electromagnetism.
4. Apply theoretical knowledge to solve practical problems.
5. Develop problem-solving skills using analytical and numerical methods

Reference Books:

1. Introduction to Electrodynamics : D.J. Griffiths
2. Electricity and Magnetism : A.S. Mahajan and A.A. Rangwala
3. Electricity and Magnetism : Berkeley Physics Course ed. E.M. Purcell
4. Physics (Vol. 2) : Halliday and Resnick
5. Feynman Lectures in Physics (Vol II)

Course Syllabus

Unit I: Vector Analysis

Vector Algebra, Triple products, Differential calculus, gradient, divergence and curl, Product rules, Vector identities, Line, surface and volume integrals, Fundamental theorems, curvilinear coordinates, Helmoholz theorm.

Unit II: Electrostatics

Coulomb's law, Electric field, Continuous charge distribution, Divergence of Electric field, Electric flux. Gauss' Law with applications, Curl of Electric field, Electrostatic potential,. Conservative nature of Electrostatic Field, Laplace's and Poisson equations, Work and energy, Conductors, Surface charge and force on a conductor. Capacitors,

Unit III: Magnetostatics

Magnetic effect of steady current, Equation of continuity and steady current, Lorentz force and concept of magnetic induction, force on linear current element, Biot-Savart law and its simple applications: straight wire and circular loop, Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Divergence and curl of magnetic field, Vector potential. Boundary conditions.

Unit IV: Electromagnetic Induction

Electromagnetic induction: Integral and differential forms. Induced electric field and emf. Mutual and self-inductance. Transformers. Magnetic field energy. Electromotive Force, Motional e.m.f.-simple problems, Electromagnetic induction, Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Calculation of self and mutual inductance in simple cases, Energy stored in a Magnetic Field. Charge Conservation and Displacement current. Introduction to Maxwell's Equations.

Semester - VI

Course Title – Elements of Modern Physics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-377

Course Level – 300

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite – Physics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Explain the principles of wave-particle duality and uncertainty.
2. Apply quantum mechanics to atomic and nuclear phenomena.
3. Describe the structure and properties of atomic nuclei.
4. Analyze radioactive decay and nuclear reactions.
5. Understand the principles of nuclear energy production.

Reference Books:

1. A. Beiser : Concepts of Modern Physics
2. H. S. Mani and G. K. Mehta : Modern Physics
3. I.Kaplan : Nuclear Physics
4. Cohen : Concepts of Nuclear Physics

Course Syllabus

Unit I: Introduction to Modern Physics

Blackbody Radiation, Planck radiation formula, Planck's quantum hypothesis, Planck's constant and light as a collection of photons; Photo-electric effect, Compton scattering, X-ray diffraction.

Unit II: Wave Particle Duality

Wave-particle duality, De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Energy-time uncertainty principle, Application.

Rutherford scattering, Atomic model. Atomic spectra, energy levels, Bohr theory, quantum numbers, Frank Hertz experiment, Qualitative idea of spin and Pauli exclusion principle.

Unit III: Atomic Structure

Rutherford scattering, Atomic model. Atomic spectra, energy levels, Bohr theory, quantum numbers, Frank Hertz experiment, Qualitative idea of spin and Pauli exclusion principle.

Unit IV:Nuclear Structure

Size and structure of atomic nucleus and its relation with atomic weight, Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy,

Semester - VI

Course Title - Lab 6 - Optics II

Course Type – Multidisciplinary (Lab)

Course Code - 24-PHY-D-380

Course Level – 300

Total Credits – 02

Classes /week – 04

Max. Marks - 50

Prerequisite – Wave Optics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Measure optical properties of materials and systems.
2. Apply principles of optics to experimental techniques.
3. Analyze data from optical experiments.
4. Demonstrate understanding of diffraction, refraction, and polarization.
5. Develop problem-solving skills in optics.

List of Experiments :

1. Determination of specific rotation of sugar solution by Laurent's Half-Shade Polarimeter
2. Verification of Hartman's dispersion formula
3. To determine wavelength of spectral lines of Hg source using plane diffraction grating.
4. To determine dispersive power and resolving power of a plane diffraction grating
5. To determine the wavelength of Sodium light by using Fresnel's Biprism.

Semester - VII

Course Title – Electricity & Magnetism II

Course Type – Multidisciplinary (Core)

Course Code - 24-PHY-D-436

Course Level – 400

Total Credits – 3

Classes /week – 3

Max. Marks: 75

Prerequisite – Electricity & Magnetism I

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Analyze electrostatic and magnetic fields in matter.
2. Apply multipole expansion techniques.
3. Understand dielectric and magnetic properties of materials.
4. Solve AC circuit problems using complex analysis.
5. Design and analyze electrical systems.

Reference Books:

1. Introduction to Electrodynamics : D.J. Griffiths
2. Electricity and Magnetism : A.S. Mahajan and A.A. Rangwala
3. Electricity and Magnetism : Berkeley Physics Course ed. E.M. Purcell
4. Physics (Vol. 2) : Halliday and Resnick

Course Syllabus

Unit I: Multipole expansion

Multipole Expansion of a charge distribution at large distance, Monopole and Dipole Terms, Electric Field of a Dipole, Force and Torque on a electric dipole, Multipole Expansion of the Vector Potential, Current Loop as a Magnetic Dipole and its Dipole Moment, Force and Torque on a magnetic dipole, Magnetic dipole moment for rotating charge bodies, Gyro-magnetic ratio.

Unit II: Electrostatic fields in matter

Dielectrics, Induced Dipoles, Polarization, Bound Charges, Physical Interpretation, Field Inside a Dielectric , Gauss's Law in the Presence of Dielectrics, Boundary Conditions, Susceptibility, Permittivity, Dielectric Constant, Capacitor (parallel plate, spherical, cylindrical) filled with dielectric Forces on Dielectrics

Unit III: Magnetic fields in matter

Magnetization vector (M). Dia, para and ferromagnetism. The field of a magnetized object. Bound currents, Physical Interpretation, Magnetic field inside matter, Magnetic Intensity H, Ampere's law in magnetized medium. Boundary conditions. Magnetic susceptibility and permeability. Ferromagnetism. Hysteresis and the B-H curve.

Unit IV: Boundary Value Problems

Poisson's equation, Laplace's equation, boundary conditions, uniqueness theorem. Method of images, Different image problems; Boundary value problems with linear dielectric materials and linear magnetic materials.

Semester - VII

Course Title – Quantum Mechanics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-C-434

Course Level – 400

Total Credits – 3

Classes /week – 3

Max. Marks: 75

Prerequisite – Elements of Modern Physics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Understand quantum mechanics principles and applications.
2. Solve time-dependent and time-independent Schrödinger equations.
3. Analyze bound states in various potentials.
4. Explain quantum theory of hydrogen-like atoms.
5. Understand atomic structure, electron spin, and magnetic properties.

Reference

1. Concepts in Modern Physics: Beiser
2. Quantum Mechanics: Zettili
3. Quantum Mechanics: Griffiths
4. A text book on Quantum Mechanics : M.C.Jain

Course Syllabus

Unit I: Schrodinger equations

Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions, Hamiltonian, stationary states and energy eigenvalues; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Ehrenfest theorem. Time independent Schrodinger equation.

Unit II: One dimensional potentials

Continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential (infinite and finite), Potential barrier problems - step potential and rectangular potential. Quantum mechanics of simple harmonic oscillator-energy levels and eigen states.

Unit III: Angular momentum and Hydrogen atom

Time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wave functions; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells,

Unit IV: Atomic Structure

SternGerlach Experiment, Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Normal and Anomalous Zeeman Effect. Gyromagnetic Ratio and Bohr Magneton. Pauli's Exclusion Principle. Symmetric & Antisymmetric Wave Functions. Periodic table.

Semester - VII

Course Title - Lab 7 - Electromagnetism I

Course Type – Multidisciplinary (Lab)

Course Code - 24-PHY-M-440

Course Level – 400

Total Credits – 02

Classes /week – 04

Max. Marks - 50

Prerequisite – Electromagnetism

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Measure electrical quantities using various instruments and techniques.
2. Analyze electrical circuits and determine circuit parameters.
3. Understand electromagnetic principles and applications.
4. Apply measurement techniques to electrical systems.
5. Develop problem-solving skills in electricity & magnetism.

List of Experiments:

1. Determination of E.C.E. of copper using a Copper Voltameter and checking the accuracy of ammeter.
2. Determination of Self Inductance of a coil using Anderson's Bridge.
3. Determination Self Inductance of a coil by Owen's Bridge.
4. Study of LCR circuit and determination of impedence.
5. Determination of magnetic field by Helmholtz coil.

Semester - VIII

Course Title – Digital Electronics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-476

Course Level – 400

Total Credits – 3

Classes /week – 3

Max. Marks – 75

Prerequisite – Physics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Understand number systems, codes, and Boolean algebra.
2. Design and analyze digital logic circuits.
3. Apply arithmetic and data processing concepts to digital circuits.
4. Design and analyze sequential logic circuits.
5. Convert between analog and digital signals.

Reference Books:

1. Digital Electronics : Gothman
2. Digital Principals & Applications : Malvino & Leach
4. Digital Computer Electronics : A.P.Malvino
5. Analog and Digital Electronics : Peter.H.Beards.
6. Integrated Electronics : Millman & Halkias

Course Syllabus

Unit I: Number system and codes

Introduction to decimal, binary, octal, hexadecimal number system, Inter conversion of binary, decimal, BCD, Octal and hexadecimal, BCD codes, Excess-3, grey codes. Simple binary arithmetic, binary addition, binary subtraction, 1`s and 2`s compliment of a binary number.

Unit II: Boolean algebra

Boolean laws, OR, AND and NOT operations (realization using Diodes and Transistor), NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. De Morgan's theorems, simplification of logic circuit using Boolean algebra, sum-of-products (SOP) and product-of-sums (POS), idea of minterms and maxterms, conversion of a truth table into equivalent logic circuit by SOP and POS method, Karnaugh Map.

Unit III: Arithmetic and Data Processing Circuits

Half adder, Full adder, Half and Full subtractors, Adder-subtractor, Digital comparators, Multiplexers, Demultiplexers, Decoders, Encoders, Parity checker and Generator

Unit IV: Sequential Logic Circuits

Clock and timer : clock parameters, propagation delay, IC 555 block diagram, working principle, astable multivibrator, monostable multivibrator.
Flip-flops : RS flip-flops, D flip-flop and JK flip-flop, the use of clock, racing, edge triggering, pulse triggering, master-slave flip-flop, preset and clear operations.
Shift Register : serial-in-serial-out, serial-in-parallel-out, parallel-in-serial-out and parallel-in - parallel-out shifting operations, applications of shift register
Counter : asynchronous counter, synchronous counter, decade counter, applications
D/A and A/D Conversions : Weighted resistor D/A converter, R-2R ladder D/A converter, accuracy and resolution, A/D Conversion

Semester - VIII

Course Title – Solid State Physics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-475

Course Level – 400

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite – Quantum Mechanics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Understand crystal structures and bonding in solids.
2. Analyze lattice dynamics and thermal properties.
3. Apply band theory to electronic structures in solids.
4. Explain transport properties in metals and semiconductors.
5. Model real-world phenomena using solid-state physics principles.

<u>Reference Books:</u>

1. Solid State Physics : Hook and Hall : Hook and Hall
2. Introduction to Solid State Physics : Kittel
3. Solid State Physics : Ibach and Luth
4. Introduction to the Theory of Solids : H. M. Rosenberg
5. Solid State Physics : Blakemore
6. Solid State Physics : Ashcroft and Mermin
7. Solid State Physics : M.A. Wahab

Course Syllabus

Unit I: Bonding in crystals

Covalent, ionic (including Madelung constant), metallic, hydrogen bond, van der Waal's bond. Orbital symmetry and crystal structure. Crystalline solids, unit cell, primitive cell, Bravis lattices, closed packed structures. Atomic radius, lattice constant, packing fraction, density, Miller indices. Scattering from periodic structures, Bragg's law, X-ray diffraction, atomic form factor, structure factor, Laue's equation, reciprocal lattice, Brillouin zones.

Unit II: Lattice Dynamics

Lattice dynamics of atoms in crystals, vibrations of monoatomic and diatomic linear chains, acoustic and optical phonon modes, density of states, thermal properties of crystal lattices, thermal energy of the harmonic oscillator, specific heat capacity of the lattice, Debye theory of specific heats.

Unit III: Band Theory

Free electrons in solids, density of states, Fermi surface, Fermi gas at T=0 K, Fermi statistics, specific heat capacity of electrons in metals, thermionic emission of electrons from metals. Electronic band structure in solids, Electrons in periodic potentials, Bloch's Theorem, Kronig-Penney model, Nearly free electron model, Insulator, semiconductor and metals. Tight-binding model: density of states, examples of band structures. Fermi surfaces of metals and semiconductors.

Unit IV: Transport properties

Motion of electrons in bands and the effective mass, currents in bands and holes, scattering of electrons in bands, Boltzmann equation and relaxation time, electrical conductivity of metals, thermoelectric effects, the Wiedemann-Franz Law. Intrinsic and Extrinsic Semiconductors, Carrier

Semester - VIII

Course Title - Lab 8- Electromagnetism II

Course Type – Multidisciplinary (Lab)

Course Code - 24-PHY-D-480

Course Level – 400

Total Credits – 02

Classes /week – 04

Max. Marks - 50

Prerequisite – Electromagnetism

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Measure electrical quantities using various instruments and techniques.
2. Analyze electrical circuits and determine circuit parameters.
3. Understand electromagnetic principles and applications.
4. Apply measurement techniques to electrical systems.
5. Develop problem-solving skills in electricity & magnetism.

List of Experiments:

1. To draw the B-H curve for the iron and to determine the energy loss due to hysterisis.
2. To determine the temperature coefficient of resistance by Platinum Resistance Thermometer (PRT).
3. Conversion of a moving coil galvanometer into an ammeter and voltmeter.
4. To determine the dielectric constants for solids.
5. Study of the Wien bridge oscillator and determine the frequency of the oscillator.

B.Sc (Multidisciplinary)
DSC 3 - PHYSICS
&
DSC 2 - PHYSICS

(With 1 course in all semester)

Semester	Course Title	Course Code	Breakup Credit	Classes /week	Total Credit
I	Mechanics Lab1	24-PHY-D-112 24-PHY-D-110	Lecture -3 Lab -1	Lecture - 3 Lab - 2	4
II	Math Physics Lab2	24-PHY-D-171 24-PHY-D-170	Lecture -3 Lab -1	Lecture - 3 Lab - 2	4
III	Basic Electronics Lab3	24-PHY-D-232 24-PHY-D-230	Lecture -3 Lab -1	Lecture - 3 Lab - 2	4
IV	Thermal Physics Lab 4	24-PHY-D-273 24-PHY-D-270	Lecture -3 Lab -1	Lecture - 3 Lab - 2	4
V	Wave Optics Lab 5	24-PHY-D-333 24-PHY-D-340	Lecture -3 Lab -1	Lecture - 3 Lab - 2	4
VI	Electromagnetism I Lab 6	24-PHY-D-376 24-PHY-D-381	Lecture -3 Lab -1	Lecture - 3 Lab - 2	4
VII	Elem of Modern Phys. Lab 7	24-PHY-D-437 24-PHY-D-441	Lecture -3 Lab -1	Lecture - 3 Lab - 2	4
VIII	Digital Electronics Lab 8	24-PHY-D-476 24-PHY-D-481	Lecture -3 Lab -1	Lecture - 3 Lab - 2	4

Semester - I

Course Title - Mechanics

Course Type – Multidisciplinary (DSC)

Course Code – 24-PHY-D-112

Course Level – 100

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite – Physics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome – The objective of this course is to impart the fundamental knowledge on mechanics. The course first teaches the fundamentals of linear and rotational motions to understand any dynamical systems. The laws of motion, the laws of conservations and other fundamental ideas will be given. The students will also learn about different kind of oscillations.

Reference Books:

1. An introduction to mechanics : Kleppner & Kolenkow.
2. Feynman Lectures-Volume I,
3. Newtonian Mechanics : A.P.French,
4. Mechanics : Berkeley Physics Course
5. Vibrations and Waves : A. P. French.
6. The Physics of Waves and Oscillations : N.K. Bajaj

Course Syllabus -

Unit I: Fundamentals of Dynamics

Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Newton's Laws of motion, dynamics of a system of particles, centre of mass, conservation of momentum, impulse, Work-energy theorem, potential energy, conservative and non-conservative forces, force as gradient of potential energy. Stable and unstable equilibrium, Work done by non-conservative forces. Law of conservation of Energy and momentum.

Unit II: Rotational Dynamics

Angular momentum of a system of particles, torque and conservation of angular momentum, rotation about a fixed axis, moment of inertia tensor: its calculation for regular bodies, kinetic energy of rotation; Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

Unit III: System of particles

Collisions : Elastic and inelastic collisions between particles, Elastic scattering : centre of mass and laboratory frame. Kinematics of elastic scattering in the laboratory system, Bouncing balls and other problems, Inelastic scattering : cross-section, The Rutherford formula, Problems. Variable mass problems : Rockets and other problems with things fall apart, Avalanche and other problems with stuff gathering.

Unit IV: Harmonic Oscillations

Simple Harmonic Motion, Simple pendulum, Compound pendulum, Linearity and Superposition Principle, Superpositions of two and N collinear oscillations, Superposition of two perpendicular oscillations, Graphical and Analytical method, Lissajous Figures, Free Damped oscillation. Forced oscillations: Transient and steady states; Resonance, Power Dissipation and Quality Factor

Semester - I

Course Title - Lab 1 - Mechanics & Oscillation I

Course Type – Multidisciplinary Lab

Course Code – 24-PHY-D-110

Course Level – 100

Total Credits – 1

Classes /week – 2

Max. Marks – 25

Prerequisite – Mechanics

Course Advisor's Name :

Course Advisor's Email :

<u>List of Experiments :</u>

1. Measurements of length using vernier caliper, screw gauge and travelling microscope.
2. To determine **g** using simple pendulum.
3. To study the Motion of Spring and calculate Spring constant by static and dynamic method.
4. To determine the value of g using Bar Pendulum. (4)
5. To determine the value of g using Kater's Pendulum. (4)

Semester - II

Course Title - Mathematical Physics

Course Type – Multidisciplinary (DSC)

Course Code – 24-PHY-D-171

Course Level – 100

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite – Mathematics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome - Physics is generally referred as mathematical description of nature. To understand the underlying physical laws in nature one has to be equipped with proper mathematical training. In this mathematical physics course students will be exposed to different mathematical topics which they need to understand other areas of physics which they will read in their first year. It will also help them to understand the next level courses of mathematical physics as well.

Reference Books:

1. Vector Analysis : Schaum Series
2. Advanced Engineering Mathematics : Kreyzig
3. Linear Algebra : Schaum Series
4. Complex Variable : Spiegel
5. Linear Vector Spaces : M. C. Jain

Course Syllabus -

Unit I: Matrices and Linear Vector Space :

Different types of matrices; Matrix algebra, Applications of matrices in solving simple linear equations, Systems of Linear Equations, Eigenvalues and Eigenvectors, Geometric interpretation of vectors, Definition of a linear vector space, Examples of linear vector spaces Subspaces, Linear combination of vectors, Linear dependence and independence, Basis and dimension of a finite-dimensional vector space, Row space, column space, and null space, Coordinate representation of vectors with respect to a basis

Unit II: Vector Calculus :

Vector algebra; normal derivative; Gradient; Divergence; Curl; Laplacian, Vector identities, Ordinary Integrals of Vectors, Notion of infinitesimal line, surface, volume elements; Line, surface, volume integrals of vector fields. Flux of a vector field, Gauss theorem, Green's theorem and Stokes Theorems, Orthogonal curvilinear coordinates: Calculation of divergence, gradient, curl and Laplacian in spherical polar and cylindrical coordinates. Multiple Integrals, Jacobian. Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials.

Unit III: Ordinary Differential Equations :

Classifying equations by order, degree, and linearity; understanding general vs. particular solutions, Solving equations via separation of variables and the integrating factor method for linear equations. Applications, Homogeneous Equations: Solving second-order linear equations with constant coefficients using the characteristic equation., Non-Homogeneous Equations: Finding particular solutions using the method of undetermined coefficients.

Unit IV: Fourier Series and Dirac Delta Function:

Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function Properties and representation of Dirac delta function in 1D, 2D, 3D; integral representation; Fourier series: Periodic functions; Dirichlet Conditions; Fourier coefficients; complex form, Expansion of arbitrary period function, non-periodic function, even and odd functions; Half range expansions; Summing of infinite series; Parseval Identity.

Semester - II

Course Title - Lab 2 – Mechanics & Oscillation II

Course Type – Multidisciplinary Lab

Course Code - 24-PHY-D-170

Course Level – 100

Total Credits – 01

Classes /week – 02

Max. Marks – 25

Prerequisite – Mechanics

Course Advisor's Name :

Course Advisor's Email :

List of Experiments :

1. To determine the Moment of Inertia of a Flywheel.
2. To determine surface tension of a fluid by capillary rise method.
3. To determine the coefficient of viscosity of a liquid by Stoke's law.
4. To determine Coefficient of Viscosity of water by Capillary Flow Method .
5. To determine the Young's Modulus of a rod.
6. To determine the surface tension of a liquid by Jaeger's method.

Semester - III

Course Title – Basic Electronics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-232

Course Level – 200

Total Credits – 3

Classes /week – 3

Max. Marks – 75

Prerequisite – Physics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome – The objective of this course is to impart basic background in analog circuits. The course would use simple models; description of the semiconductors, different diodes and applications, transistors and applications and operational amplifiers will be covered. The broad behavioral description of the blocks in the op-amp will be used to explain the circuit operation.

Reference Books:

1. Basic Electronics : D C Tayal,.
2. Principles of Electronics : V. K. Mehta.
3. Electronic Devices and Circuit : Robert Boylestad, Louis Nashelsky,
4. Basic Electronics and Linear Circuits : N. N. Bhargava, D. C. KulShreshtha.

Course Syllabus -

Unit I: Circuits Analysis

Kirchhoffs Laws, Mesh and Node Analysis of Circuits. RC circuits, Networks, Equivalent Star (T) and delta Networks. Star to Delta and Delta to Star Conversion. Network Theorems, Superposition theorem, Thevenin Theorem, Norton theorem.

Unit II: Semiconductor Diodes

P and N Type Semiconductors. Energy Level Diagram. Conductivity and Mobility, Drift velocity, PN junction Diodes and its characteristics. Barrier Formation, Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode, Barrier Width and Current for Step Junction. PN junction Rectifier Diode, Half-wave Rectifier, Full-wave Rectifiers its Ripple Factor and Efficiency. Idea of Filters. Zener diode and voltage regulation,Photo diode, varactor diode, LED, solar cell.

Unit III: Transistors and Amplifiers

N-P-N and P-N-P Transistors, Characteristics of CB, CE and CC configurations. Active, Cut-off, and Saturation Regions. Load line and Q- point. Current gains and relation between them, Amplifiers and their classification, Class A, B, and C Amplifiers. Ideal amplifier, Voltage gain, current gain, Power gain, Input resistance, output resistance, load line. Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. RC-coupled amplifier and its frequency response.

Unit IV: AC circuits

AC Circuits: Alternating currents, mean and r.m.s. values, Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. phase diagrams, Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit. Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR. Oscillators : Barkhausen criterion for self-sustained oscillations, Hartley oscillator, Colpitts oscillator, RC phase shift oscillator, multivibrators, crystal oscillator.

Semester - III

Course Title - Lab 3 - Basic Electronics I

Course Type – Multidisciplinary lab

Course Code - 24-PHY-D-230

Course Level – 200

Total Credits – 01

Classes /week – 02

Max. Marks - 25

Prerequisite – Electronics

Course Advisor’s Name :

Course Advisor’s Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Analyze and interpret electrical and electronic circuits' behavior.
2. Apply theoretical knowledge to practical experiments.
3. Demonstrate understanding of semiconductor devices' characteristics.
4. Design and test simple electronic circuits.
5. Measure and calculate electrical parameters accurately.

<u>List of Experiments :</u>

1. To study V-I characteristics of PN junction diode
2. To study the V-I characteristics of a Zener diode
3. To study use of Zener diode as voltage regulator.
4. To study growth and decay of charge on a condenser in RC circuit.
5. To verify the network theorems - Superposition theorem and Maximum power transfer

Semester - IV

Course Title – Thermal Physics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-273

Course Level – 200

Total Credits – 3

Classes /week – 3

Max. Marks – 75

Prerequisite – Physics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Apply kinetic theory and thermodynamic principles to explain physical phenomena.
2. Analyze and interpret data related to gas behavior and thermodynamic processes.
3. Demonstrate understanding of fundamental laws and equations governing thermodynamics.
4. Apply mathematical models to solve problems in thermodynamics.
5. Develop problem-solving skills using analytical and numerical methods.

Reference Books:

1. A Text book of heat: M. N Saha and B.N Srivastava
2. Heat and Thermodynamics: Zemansky, Richard Dittman .
3. Thermal Physics : Garg, Bansal and Ghosh .
4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics: Sears, Salinger

Course Syllabus

Unit I: Kinetic theory of gases

Basic postulates of kinetic theory, Pressure of an ideal gas, Maxwell-Boltzmann Law of Distribution of velocities and energy of an Ideal Gas. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy and its applications, Specific heats of Gases Mean Free Path, Collision Probability, Distribution of Mean Free Paths,

Unit II: Ideal and Real gases

Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance. Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants.

Unit III: Thermodynamics

Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics, Concept of Temperature, Work and Heat, State Functions, Internal Energy, First Law of Thermodynamics, General Relation between Cp and Cv, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient. Reversible and Irreversible process, Conversion of Work and Heat. Heat Engines. Carnot's Cycle, Carnot engine and efficiency, Refrigerator and coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements, Carnot's Theorem. Thermodynamic Scale of Temperature

Unit IV: Entropy, Thermodynamic Potentials and Maxwell's relations

Entropy, Clausius Theorem, Clausius Inequality, Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes. Entropy of the Universe. Temperature–Entropy diagrams for Carnot's Cycle, Third Law of Thermodynamics. Unattainability of Absolute Zero, Thermodynamic Potentials : Enthalpy, Helmholtz Free Energy, Gibbs Free Energy: Properties and applications, Maxwell's Thermodynamic Relations - Derivations and applications of Maxwell's Relations such as Clausius-Clapeyron Equation, Cp-Cv, TdS Equations,

Semester - IV

Course Title - Lab 4 - Basic Electronics II

Course Type – Multidisciplinary Lab

Course Code - 24-PHY-D-270

Course Level – 200

Total Credits – 01

Classes /week – 02

Max. Marks: 25

Prerequisite – Electronics

Course Advisor’s Name :

Course Advisor’s Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Analyze and interpret electrical and electronic circuits' behavior.
2. Apply theoretical knowledge to practical experiments.
3. Demonstrate understanding of semiconductor devices' characteristics.
4. Design and test simple electronic circuits.
5. Measure and calculate electrical parameters accurately.

List of Experiments :

1. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
2. To study Half wave rectifier and find their ripple factor with various filters.
3. To study Full wave rectifier and find their ripple factor with various filters.
4. To verify the network theorems - Norton and Thevenin theorem
5. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.

Semester - V

Course Title – Wave Optics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-333

Course Level – 300

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite – Physics in class XII & Mechanics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Understand wave motion, interference, diffraction, and polarization principles.
2. Apply mathematical models to describe wave phenomena.
3. Analyze optical systems and instruments.
4. Explain electromagnetic nature of light.
5. Demonstrate problem-solving skills in wave optics.

Reference Books:

1. Optics : A. K.Ghatak
2. Fundamentals of Optics : Jenkins and White
3. Principles of Optics : Max Born andf Emil Wolf
4. Optics : Eugene Hecht

Course Syllabus

Unit I: Wave Motion

Wave Equation. Solutions of wave equation. Wave front. Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave, Energy Transport, Intensity of Wave, Water Waves: Ripple and Gravity Waves. Superposition of Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free ends, Phase and Group Melde's experiment. Longitudinal Standing Waves and normal modes, Open and Closed Pipes.

Unit II: Interference :

Electromagnetic nature of light. Definition and properties of wave front, Huygens Principle. Temporal and Spatial Coherence.Division of amplitude and wavefront. Young's double slit experiment. Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings, Michelson Interferometer, Fabry-Perot interferometer. Applications.

Unit III: Diffraction :

Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

Unit IV: Polarization :

Polarisation of light by reflection – Brewster's – law; Double refraction – ordinary and extraordinary ray; Optic axis; Huygen's construction for uniaxial crystals; Nicol prism, polaroids; Production and analysis of (i) plane polarized, (ii) circularly polarized and (iii) elliptically polarized light; Double refraction, Wave plates, Optical activity, Babinet's compensator.

Semester - V

Course Title - Lab 5 - Optics I

Course Type – Multidisciplinary (Lab)

Course Code - 24-PHY-D-340

Course Level – 300

Total Credits – 01

Classes /week – 02

Max. Marks - 25

Prerequisite – Wave Optics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Measure optical properties of materials and systems.
2. Apply principles of optics to experimental techniques.
3. Analyze data from optical experiments.
4. Demonstrate understanding of diffraction, refraction, and polarization.
5. Develop problem-solving skills in optics.

List of Experiments :

1. Focal length of two lenses by Nodal Slide method and verification of Newton's formula.
2. To determine wavelength of Na source using plane diffraction grating
3. Determination of refractive Index and dispersive power of a prism using spectrometer.
4. Determination of wavelength of LASER using plane transmission diffraction grating.
5. Determination of wavelength of sodium light by Newton's Rings method.

Semester - VI

Course Title – Electricity Magnetism I

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-376

Course Level – 300

Total Credits – 3

Classes /week – 3

Max. Marks – 75

Prerequisite – Mathematical Physics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Apply mathematical techniques to solve problems in electromagnetism.
2. Analyze and interpret physical phenomena using vector calculus.
3. Demonstrate understanding of fundamental laws and principles in electromagnetism.
4. Apply theoretical knowledge to solve practical problems.
5. Develop problem-solving skills using analytical and numerical methods

Reference Books:

1. Introduction to Electrodynamics : D.J. Griffiths
2. Electricity and Magnetism : A.S. Mahajan and A.A. Rangwala
3. Electricity and Magnetism : Berkeley Physics Course ed. E.M. Purcell
4. Physics (Vol. 2) : Halliday and Resnick
5. Feynman Lectures in Physics (Vol II)

Course Syllabus

Unit I: Vector Analysis

Vector Algebra, Triple products, Differential calculus, gradient, divergence and curl, Product rules, Vector identities, Line, surface and volume integrals, Fundamental theorems, curvilinear coordinates, Helmoholz theorm.

Unit II: Electrostatics

Coulomb's law, Electric field, Continuous charge distribution, Divergence of Electric field, Electric flux. Gauss' Law with applications, Curl of Electric field, Electrostatic potential,. Conservative nature of Electrostatic Field, Laplace's and Poisson equations, Work and energy, Conductors, Surface charge and force on a conductor. Capacitors,

Unit III: Magnetostatics

Magnetic effect of steady current, Equation of continuity and steady current, Lorentz force and concept of magnetic induction, force on linear current element, Biot-Savart law and its simple applications: straight wire and circular loop, Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Divergence and curl of magnetic field, Vector potential. Boundary conditions.

Unit IV: Electromagnetic Induction

Electromagnetic induction: Integral and differential forms. Induced electric field and emf. Mutual and self-inductance. Transformers. Magnetic field energy. Electromotive Force, Motional e.m.f.-simple problems, Electromagnetic induction, Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Calculation of self and mutual inductance in simple cases, Energy stored in a Magnetic Field. Charge Conservation and Displacement current. Introduction to Maxwell's Equations.

Semester - VI

Course Title - Lab 6 - Optics II

Course Type – Multidisciplinary (Lab)

Course Code - 24-PHY-D-381

Course Level – 300

Total Credits – 01

Classes /week – 02

Max. Marks - 25

Prerequisite – Wave Optics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Measure optical properties of materials and systems.
2. Apply principles of optics to experimental techniques.
3. Analyze data from optical experiments.
4. Demonstrate understanding of diffraction, refraction, and polarization.
5. Develop problem-solving skills in optics.

List of Experiments :

1. Determination of specific rotation of sugar solution by Laurent's Half-Shade Polarimeter
2. Verification of Hartman's dispersion formula
3. To determine wavelength of spectral lines of Hg source using plane diffraction grating.
4. To determine dispersive power and resolving power of a plane diffraction grating
5. To determine the wavelength of Sodium light by using Fresnel's Biprism.

Semester - VII

Course Title – Elements of Modern Physics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-437

Course Level – 400

Total Credits – 3

Classes /week – 3

Max. Marks - 75

Prerequisite – Physics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Explain the principles of wave-particle duality and uncertainty.
2. Apply quantum mechanics to atomic and nuclear phenomena.
3. Describe the structure and properties of atomic nuclei.
4. Analyze radioactive decay and nuclear reactions.
5. Understand the principles of nuclear energy production.

Reference Books:

1. A. Beiser : Concepts of Modern Physics
2. H. S. Mani and G. K. Mehta : Modern Physics
3. I.Kaplan : Nuclear Physics
4. Cohen : Concepts of Nuclear Physics

Course Syllabus

Unit I: Introduction to Modern Physics

Blackbody Radiation, Planck radiation formula, Planck's quantum hypothesis, Planck's constant and light as a collection of photons; Photo-electric effect, Compton scattering, X-ray diffraction.

Unit II: Wave Particle Duality

Wave-particle duality, De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Energy-time uncertainty principle, Application.

Rutherford scattering, Atomic model. Atomic spectra, energy levels, Bohr theory, quantum numbers, Frank Hertz experiment, Qualitative idea of spin and Pauli exclusion principle.

Unit III: Atomic Structure

Rutherford scattering, Atomic model. Atomic spectra, energy levels, Bohr theory, quantum numbers, Frank Hertz experiment, Qualitative idea of spin and Pauli exclusion principle.

Unit IV:Nuclear Structure

Size and structure of atomic nucleus and its relation with atomic weight, Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy,

Semester - VII

Course Title - Lab 7 - Electromagnetism I

Course Type – Multidisciplinary (Lab)

Course Code - 24-PHY-M-441

Course Level – 400

Total Credits – 01

Classes /week – 02

Max. Marks - 25

Prerequisite – Electromagnetism

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Measure electrical quantities using various instruments and techniques.
2. Analyze electrical circuits and determine circuit parameters.
3. Understand electromagnetic principles and applications.
4. Apply measurement techniques to electrical systems.
5. Develop problem-solving skills in electricity & magnetism.

List of Experiments:

1. Determination of E.C.E. of copper using a Copper Voltameter and checking the accuracy of ammeter.
2. Determination of Self Inductance of a coil using Anderson's Bridge.
3. Determination Self Inductance of a coil by Owen's Bridge.
4. Study of LCR circuit and determination of impedence.
5. Determination of magnetic field by Helmholtz coil.

Semester - VIII

Course Title – Digital Electronics

Course Type – Multidisciplinary (DSC)

Course Code - 24-PHY-D-476

Course Level – 400

Total Credits – 3

Classes /week – 3

Max. Marks – 100

Prerequisite – Physics in class XII

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -

1. Understand number systems, codes, and Boolean algebra.
2. Design and analyze digital logic circuits.
3. Apply arithmetic and data processing concepts to digital circuits.
4. Design and analyze sequential logic circuits.
5. Convert between analog and digital signals.

Reference Books:

1. Digital Electronics : Gothman
2. Digital Principals & Applications : Malvino & Leach
4. Digital Computer Electronics : A.P.Malvino
5. Analog and Digital Electronics : Peter.H.Beards.
6. Integrated Electronics : Millman & Halkias

Course Syllabus

Unit I: Number system and codes

Introduction to decimal, binary, octal, hexadecimal number system, Inter conversion of binary, decimal, BCD, Octal and hexadecimal, BCD codes, Excess-3, grey codes. Simple binary arithmetic, binary addition, binary subtraction, 1`s and 2`s compliment of a binary number.

Unit II: Boolean algebra

Boolean laws, OR, AND and NOT operations (realization using Diodes and Transistor), NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. De Morgan's theorems, simplification of logic circuit using Boolean algebra, sum-of-products (SOP) and product-of-sums (POS), idea of minterms and maxterms, conversion of a truth table into equivalent logic circuit by SOP and POS method, Karnaugh Map.

Unit III: Arithmetic and Data Processing Circuits

Half adder, Full adder, Half and Full subtractors, Adder-subtractor, Digital comparators, Multiplexers, Demultiplexers, Decoders, Encoders, Parity checker and Generator

Unit IV: Sequential Logic Circuits

Clock and timer : clock parameters, propagation delay, IC 555 block diagram, working principle, astable multivibrator, monostable multivibrator.
Flip-flops : RS flip-flops, D flip-flop and JK flip-flop, the use of clock, racing, edge triggering, pulse triggering, master-slave flip-flop, preset and clear operations.
Shift Register : serial-in-serial-out, serial-in-parallel-out, parallel-in-serial-out and parallel-in - parallel-out shifting operations, applications of shift register
Counter : asynchronous counter, synchronous counter, decade counter, applications
D/A and A/D Conversions : Weighted resistor D/A converter, R-2R ladder D/A converter, accuracy and resolution, A/D Conversion

Semester - VIII

Course Title - Lab 8- Electromagnetism II

Course Type – Multidisciplinary (Lab)

Course Code - 24-PHY-D-481

Course Level – 400

Total Credits – 01

Classes /week – 02

Max. Marks - 50

Prerequisite – Electromagnetism

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Measure electrical quantities using various instruments and techniques.
2. Analyze electrical circuits and determine circuit parameters.
3. Understand electromagnetic principles and applications.
4. Apply measurement techniques to electrical systems.
5. Develop problem-solving skills in electricity & magnetism.

List of Experiments:

1. To draw the B-H curve for the iron and to determine the energy loss due to hysterisis.
2. To determine the temperature coefficient of resistance by Platinum Resistance Thermometer (PRT).
3. Conversion of a moving coil galvanometer into an ammeter and voltmeter.
4. To determine the dielectric constants for solids.
5. Study of the Wien bridge oscillator and determine the frequency of the oscillator.