FYUP 2024
PHYSICS

Seme-ster	Major		SEC		MD		Minor	AEC	VAC	Sum Inten/ Project	Credits /sem
I	Mathematical Physics I Mechanics I Lab 1	3 3 2	Analog Systems	3	Properties of Matter	3	4	2	2		22
II	Electricity Magnetism I Thermal Physics Lab 2	3 3 2	Digital Systems	3	Experi-mental Techniques	3	4	2	2		22
III	Elements of ModernPhys Wave-Optics Lab 3	3 3 2			Numerical Analysis	3	4	2	2		19
IV	Electricity Magnetism II Mathematical Physics II Quantum Mechanics I Lab 4	3 3 3 3					4	2	2		20
V	Electro Magnetic Theory Mechanics II Solid State Physics Lab 5	3 3 3 3	Comput-ational Physics	3			4				19
VI	Classical Mechanics Electro Dynamics Nuclear & Particle Phys Lab 6	4 4 4 4					4			2-4	22-24
VII	Atomic &MolecularPhys Mathematical Physics III Quantum Mechanics II Lab 7	4 4 4 4					4				20
VIII	Condensed Matter Phys Quantum Mechanics III Semiconductor Devices Statistical Mechanics	4 4 4 4					4				20
OR											
VIII	Core course (Any one)	4					4			12	20

Total Credits – 164-166

Courses for common pool of AEC and VAC :

Course Type	Course Name	Credits	Semester
AEC	Logical Reasoning	2	3
AEC	Scientific Writing and Ethics	2	4
VAC	Environmental Awareness and Social Responsibility	2	3
VAC	Non Conventional Energy Sources	2	4

PHYSICS- MAJOR

Sl.No.	Course Title	Course Type	Course Code	Credits	Classes/week
SEMESTER I					
1	Mathematical Physics I	Core (Major)	24-PHY-C-111	3	3
2	Mechanics I	Core (Major)	24-PHY-C-112	3	3
3	Lab 1	Lab	24-PHY-C-110	2	4
4	Analog Systems	SEC	24-PHY-S-115	3	3
5	Properties of Matter	MD	24-PHY-T-116	3	3
SEMESTER II					
6	Electricity & Magnetism I	Core (major)	24-PHY-C-151	3	3
7	Thermal Physics	Core (major)	24-PHY-C-152	3	3
8	Lab 2	Lab	24-PHY-C-150	2	4
9	Digital Systems	SEC	24-PHY-S-155	3	3
10	Experimental Techniques	MD	24-PHY-T-156	3	3
SEMESTER III					
11	Elements of Modern Phys	Core (major)	24-PHY-C-211	3	3
12	Wave &Optics	Core (major)	24-PHY-C-212	3	3
13	Lab 3	Lab	24-PHY-C-210	2	4
14	Numerical Analysis	MD	24-PHY-T-216	3	3
15	Logical Reasoning	AEC	24-PHY-A-217	2	2
16	Environmental Awareness and Social Responsibility	VAC	24-PHY-V-218	2	2
SEMESTER IV					
17	Electricity & Magnetism II	Core (major)	24-PHY-C-251	3	3
18	Mathematical Physics II	Core (major)	24-PHY-C-252	3	3
19	Quantum Mechanics I	Core (major)	24-PHY-C-253	3	3
20	Lab 4	Lab	24-PHY-C-250	3	6
21	Scientific Writing & Ethics	AEC	24-PHY-A-257	2	2
22	Non Conventional Energy Sources	VAC	24-PHY-V-258	2	2
SEMESTER V					
23	Electromagnetic Theory	Core (major)	24-PHY-C-311	3	3
24	Mechanics II	Core (major)	24-PHY-C-312	3	3
25	Solid State Physics	Core (major)	24-PHY-C-313	3	3

26	Lab 5	Lab	24-PHY-C-310	3	6
27	Computational Physics	SEC	24-PHY-C-315	3	3
SEMESTER VI					
28	Classical Mechanics	Core (major)	24-PHY-C-351	4	4
29	Electrodynamics	Core (major)	24-PHY-C-352	4	4
30	Nuclear &Particle Physics	Core (major)	24-PHY-C-353	4	4
31	Lab 6	Lab	24-PHY-C-350	4	6
Semester VII					
32	Atomic & Molecular Physics	Core (major)	24-PHY-C-411	4	4
33	Mathematical Physics III	Core (major)	24-PHY-C-412	4	4
34	Quantum Mechanics II	Core (major)	24-PHY-C-413	4	4
35	Lab 7	Lab	24-PHY-C-410	4	8
Semester VIII					
36	Condensed Matter Physics	Core (major)	24-PHY-C-451	4	4
37	Quantum Mechanics III	Core (major)	24-PHY-C-452	4	4
38	Semiconductor Devices	Core (major)	24-PHY-C-453	4	4
39	Statistical Mechanics	Core (major)	24-PHY-C-454	4	4

PHYSICS- MINOR

Semester	Course Title	Course Code	Total Credit	Breakup Credit	Classes/week
I	Mechanics I Lab1	24-PHY-M-112 24-PHY-M-110	4	Lecture -3 Lab -1	Lecture - 3 Lab - 2
II	Math Physics Lab2	24-PHY-M-161 24-PHY-M-160	4	Lecture -3 Lab -1	Lecture - 3 Lab - 2
III	Thermal Physics Lab3	24-PHY-M-221 24-PHY-M-220	4	Lecture -3 Lab -1	Lecture - 3 Lab - 2
IV	Elect-Magnetism I Lab 4	24-PHY-M-261 24-PHY-M-260	4	Lecture -3 Lab -1	Lecture - 3 Lab - 2
V	WaveOptics Lab 5	24-PHY-M-321 24-PHY-M-320	4	Lecture -3 Lab -1	Lecture - 3 Lab - 2
VI	Ele of Modern Phys Lab 6	24-PHY-M-361 24-PHY-M-360	4	Lecture -3 Lab -1	Lecture - 3 Lab - 2
VII	Mechanics II Lab 7	24-PHY-M-421 24-PHY-M-420	4	Lecture -3 Lab -1	Lecture - 3 Lab - 2
VIII	Solid State Physics Lab 8	24-PHY-M-461 24-PHY-M-460	4	Lecture -3 Lab -1	Lecture - 3 Lab - 2

B.Sc (Multidisciplinary)
DSC 1- PHYSICS

Seme -ster	Course Title	Course Code	Credit	Total Credit	Classes/week
I	Mechanics I Lab	24-PHY-D-112 24-PHY-D-110	3 1	4	Lecture - 3 Lab - 2
II	Mathematical Physics I Lab	24-PHY-D-171 24-PHY-D-170	3 1	4	Lecture - 3 Lab - 2
III	Thermal Physics Lab	24-PHY-D-231 24-PHY-D-230	3 1	4	Lecture - 3 Lab - 2
IV	Electricity Magnetism I Elem of Modern Phys. Lab	24-PHY-D-271 24-PHY-D-272 24-PHY-D-270	3 3 2	8	Lecture - 3 Lecture - 3 Lab - 4
V	Mathematical Physics II Wave Optics Lab	24-PHY-D-331 24-PHY-D-332 24-PHY-D-330	3 3 2	8	Lecture - 3 Lecture - 3 Lab - 4
VI	Electricity Magnetism II Mechanics II Quantum Mechanics I Lab	24-PHY-D-371 24-PHY-D-372 24-PHY-D-373 24-PHY-D-370	3 3 3 3	12	Lecture - 3 Lecture – 3 Lecture - 3 Lab - 6
VII	Electro-Magnetic Theory Nuclear Particle Physics Solid State Physics Lab	24-PHY-D-431 24-PHY-D-432 24-PHY-D-433 24-PHY-D-430	3 3 3 3	12	Lecture - 3 Lecture – 3 Lecture - 3 Lab - 6
VII	Classical Mechanics Cond Matter Physics Semiconductor Devices Lab	24-PHY-D-471 24-PHY-D-472 24-PHY-D-473 24-PHY-D-470	3 3 3 3	12	Lecture - 3 Lecture – 3 Lecture - 3 Lab - 6

PHYSICS COURSES

SEMESTER I

Course Name	Course Type	Course Code	Available to
Mathematical Physics I	Major	24-PHY-C-111	Physics (Major)
Mechanics I	Major	24-PHY-C-112	Physics (Major)
Lab 1	Lab	24-PHY-C-110	Physics (Major)
Analog Systems	SEC	24-PHY-S-115	All
Properties of Matter	MD	24-PHY-T-116	All
Mechanics I	Minor	24-PHY-M-112	Minor
Lab 1	Lab	24-PHY-M-110	Minor
Mechanics I	DSC1	24-PHY-D-112	BSc Multidisciplinary
Lab 1	Lab	24-PHY-D-110	BSc Multidisciplinary

Semester - I

Course Title - **Mathematical Physics I**

Course Type – Major (Core)

Course Code – 24-PHY-C-111

Course Level – 100

Total Credits – 3

Classes /week – 3

Max. Marks - 100

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 :

Matrix algebra; Different types of matrices; Quotient space; Inner Product; Abstract Systems; Binary Operations; Groups; Fields; Linear Vector Spaces; Subspaces; Linear Independence and Dependence; Basis; Dimensions; Change of basis; Homomorphism, Isomorphism, Linear and Non-singular Transformations, completeness and closure properties, linear operators system of linear equations, eigen values and eigen vectors, similarity transformation and diagonalization.

Unit II: Vector and Multivariate Calculus :

Vector algebra; Fields; Directional derivatives; normal derivative; Gradient; Divergence; Curl; Laplacian, Vector identities, Ordinary Integrals of Vectors, Multiple integrals, Jacobian, 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. Differentiation of composite functions. Implicit functions. Taylor series expansion of function of more than one variable. Maxima and minima. Integrating factor, Constrained Maximization using Lagrange Multipliers.

Unit III: Ordinary Differential Equations :

FODE homogeneous and nonhomogeneous with variable coefficients, Integrating factors, Second Order Differential equations: Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems, Second-Order homogeneous and nonhomogeneous equations with constant and variable coefficients Particular Integral.

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 - I

Course Title - Mechanics I

Course Type – Major (Core)

Course Code – 24-PHY-C-112

Course Level – 100

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 – 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, variable mass system.
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; Elastic and inelastic collisions between particles, centre of mass and laboratory frame. 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: 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

Unit IV: Small Oscillations

Problem of Small Oscillations, Example of Two coupled Oscillator, General Theory of Small Oscillations, Normal Coordinates and Normal Modes of Vibration, Free Vibrations of a Linear Tri-atomic Molecule.

Semester - I

Course Title - Lab I - Mechanics & Oscillation

Course Type – Major (Lab)

Course Code – 24-PHY-C-110

Course Level – 100

Total Credits – 2

Classes /week – 4

Max. Marks – 100

Prerequisite – Mechanics I

Course Advisor's Name :

Course Advisor's Email :

List of Experiments :

1. Measurements of length (or diameter) 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)
4. To determine the Moment of Inertia of a Flywheel. (4)
5. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method). (2)
6. To determine the Young's Modulus of a rod by bending by Optical Lever Method. (1)
7. To determine the value of g using Bar Pendulum. (4)
8. To determine the value of g using Kater's Pendulum. (4)
9. To determine surface tension of a fluid by capillary rise method. (3)
10. To determine the coefficient of viscosity of a liquid by Stoke's law. (3)
11. To determine the surface tension of a liquid by Jaeger's method.(2)
12. To determine the modulus of rigidity of material of a wire by Maxwell's needle. (1)

Semester - I

Course Title – Analog Systems

Course Type – Skill Enhancement Course

Course Code - 24-PHY-S-115

Course Level – 100

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 – 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. h-parameter Equivalent Circuit. Hybrid model of single-stage CE amplifier, RC-coupled amplifier and its frequency response.

Oscillators : Barkhausen criterion for self-sustained oscillations, Hartley oscillator, Colpitts oscillator, RC phase shift oscillator, multivibrators, crystal oscillator.

Unit IV: Operational Amplifier

Principle of Operational Amplifier, Properties of ideal OPAMP, Open-loop and closed loop gain, Frequency response, CMMR, Slew rate, Virtual ground, Applications of operational Amplifiers : inverting, non-inverting, adder, subtractor, integrator, differentiator, Log amplifier, Zero crossing detector, Schmitt trigger, Wein bridge oscillator

Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion

Semester - I

Course Title – Properties of Matter

Course Type – Multidisciplinary Course

Course Code - 24-PHY-T-116

Course Level – 100

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 – The objective of this course is to make students understand different physical properties of matter. The knowledge of these properties for different matter is very important for the usage of the matter for different applications or purposes.

Reference Books:

1. General properties of Matter : Newman and Searle
2. Properties of Matter : Newman and Searle
3. Treatise on General Properties of matter : Newman and Searle

Course Syllabus -

Unit I: Elasticity

Hooke’s law, Relation between elastic constants, Torsion of a cylinder, Bending moment, Cantilever, Beam supported at both ends, Beams clamped at both ends, Reciprocity theorem, Elastic energy in different types of deformation, Rigidity modulus, Modulus of rigidity, Poisson’s ratio, relation connecting different elastic- constants, twisting couple of a cylinder(solid and hollow), Statical method (Barton’s method), Dynamical method (Maxwell’s needle) for determining the modulus of rigidity, Bending moment, Cantilever (neglecting mass), Young modulus by bending of beam,

Unit II: Surface Tension

Surface Tension and Surface energy, Surface Tension determination by Jaeger's & Quincke's Methods, Angle of contact, Variation of surface tension with temperature, Excess of pressure over a curved surface, Shape of liquid drops, Application to spherical and cylindrical drops and bubbles.

Unit III: Viscosity

Viscosity, Rate flow of liquid in a capillary tube, Poiseuille’s formula, Streamlined and turbulent motion, Reynolds number, Poiseuille's formula, Determination of coefficient of viscosity, capillary flow method, Stoke's formula, viscosity of highly viscous liquids, Variation of viscosity of a liquid with temperature

Unit IV: Fluid Mechanics

The equation of continuity, Euler’s equation for ideal fluids, Hydrostatics, Bernoulli’s theorem, Potential flow, Incompressible fluids, Newtonian fluids, Navier-Stokes equation and its applications. Poiseuille’s formula, Couette flow, Turbulent flow and Reynold’s number, Modern Applications

PHYSICS COURSES

SEMESTER II

Course Name	Course Type	Course Code	Available to
Electricity & Magnetism I	Major	24-PHY-C-151	Physics (Major)
Thermal Physics	Major	24-PHY-C-152	Physics (Major)
Lab 2	Lab	24-PHY-C-150	Physics (Major)
Digital Systems	SEC	24-PHY-S-155	All
Experimental Techniques	MD	24-PHY-T-156	All
Mathematical Physics	Minor	24-PHY-M-161	Minor
Lab 1	Lab	24-PHY-M160	Minor
Mathematical Physics	DSC1	24-PHY-D-171	BSc Multidisciplinary
Lab 1	Lab	24-PHY-D-170	BSc Multidisciplinary

Semester - II

Course Title – Electricity Magnetism I

Course Type – Major (Core)

Course Code - 24-PHY-C-151

Course Level – 100

Total Credits – 3

Classes /week – 3

Max. Marks – 100

Prerequisite – Mathematical Physics I

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, Uniqueness Theorems, Boundary conditions, Method of images and application, Separation of variables. Problems.

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, Problems.

Unit IV: Faraday's law

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 - II

Course Title – Thermal Physics

Course Type – Major (Core)

Course Code - 24-PHY-C-152

Course Level – 100

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. 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 CO2 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. Law of Corresponding States. Joule-Thomson Effect for Real and Van der Waal Gases.

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, First and second order Phase Transitions, Clausius-Clapeyron Equation and Ehrenfest criterion. Maxwell's Thermodynamic Relations - Derivations and applications of Maxwell's Relations such as Clausius-Clapeyron Equation, Cp-Cv, TdS Equations, Joule-Kelvin coefficient for Ideal and Van der Waal Gases, Energy equations, Change of Temperature during Adiabatic Process.

Semester - II

Course Title - Lab 2 – Analog Systems & Thermal Physics

Course Type – Major (Lab)

Course Code - 24-PHY-C-150

Course Level – 100

Total Credits – 2

Classes /week – 4

Max. Marks – 100

Prerequisite – Analog Systems

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 V-I characteristics of PN junction diode (4)
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator. (4)
3. To study the characteristics of a Bipolar Junction Transistor in CE configuration. (4)
4. To study growth and decay of charge on a condenser in RC circuit. (4)
5. To study Half wave and Full wave rectifier and find their ripple factor with various filters. (4)
6. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee’s disc method. (2)
7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier. (2)
8. To verify the network theorems. (2)
9. To determine Stefan’s constant (2)

10. To determine the frequency of the mains with Melde's experiment.(3)

Semester - II

Course Title – Digital Systems

Course Type – Skill Enhancement Course

Course Code - 24-PHY-S-155

Course Level – 100

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 - II

Course Title – Experimental Techniques

Course Type – Multidisciplinary Course

Course Code - 24-PHY-T-156

Course Level – 100

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. 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.

Reference Books:

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)

PHYSICS COURSES

SEMESTER III

Course Name	Course Type	Course Code	Available to
Elements of Modern Phys	Major	24-PHY-C-211	Physics (Major)
Wave &Optics	Major	24-PHY-C-212	Physics (Major)
Lab 3	Lab	24-PHY-C-210	Physics (Major)
Numerical Analysis	MD	24-PHY-T-216	All
Logical Reasoning	AEC	24-PHY-A-217	All
Environmental Awareness and Social Responsibility	VAC	24-PHY-V-218	All
Thermal Physics	Minor	24-PHY-M-221	Minor
Lab 3	Lab	24-PHY-M-220	Minor
Thermal Physics	DSC1	24-PHY-D-231	BSc Multidisciplinary
Lab 1	Lab	24-PHY-D-230	BSc Multidisciplinary

Semester - III

Course Title – Elements of Modern Physics

Course Type – Major (Core)

Course Code - 24-PHY-C-211

Course Level – 200

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. 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: Wave Particle duality

Planck's quantum hypothesis, Planck's constant and light as a collection of photons; Blackbody Radiation, Planck radiation formula, Photo-electric effect, Compton scattering, X-ray diffraction.
De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions.Wave-particle duality.

Unit II: Uncertainty Principle

Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Energy-time uncertainty principle, Application, Matter waves and wave amplitude; 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: 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,

Unit IV: 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

Semester - III

Course Title – Wave Optics

Course Type – Major (Core)

Course Code - 24-PHY-C-212

Course Level – 200

Total Credits – 3

Classes /week – 3

Max. Marks - 100

Prerequisite – Physics in class XII & Mechanics I

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 - III

Course Title - Lab 3 - Optics

Course Type – Major (Lab)

Course Code - 24-PHY-C-210

Course Level – 200

Total Credits – 2

Classes /week – 4

Max. Marks - 100

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.

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 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 - III

Course Title – Numerical Analysis

Course Type – Multidisciplinary Course

Course Code - 24-PHY-T-216

Course Level – 200

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. Apply numerical methods to solve mathematical problems.
2. Analyze errors and propagate errors in numerical calculations.
3. Implement interpolation and approximation techniques.
4. Solve equations (linear, polynomial etc.) numerically.
5. Model real-world problems using numerical methods

Reference Books:

1. Numerical Analysis: C F Gerald, P O Wheatly
2. Numerical Analysis for Scientists and Engineers Theory and C Programs : Madhumangal Pal.
3. Fortran 95/2003 for Scientists and Engineers : Stephen J Chapman
4. Numerical Methods for Scientific and Engineering Computation : Jain, Iyengar and Jain
5. Numerical Analysis: Richard L Burden and J Douglas Faires
6. Computational Physics : J M Thijssen .
7. Numerical Recipes in C : The Art of Scientific Computing : Press, Teukolsky, Velleling and Flannery

Course Syllabus

Unit I:

Errors and propagation of errors, finite difference operators, forward and backward difference, central difference, series, summation of series, Lagrange’s interpolation polynomial, errors, Newton’s forward and backward difference interpolation formula, Gaussian interpolation formula, Spline interpolation, cubic spline

Unit II:

Roots of polynomial and transcendental equations, graphical location of roots, root finding by bisection, Regula-Falsi, Iteration method or fixed point iteration, Newton-Raphson, error estimation, roots of polynomial equations

Unit III:

Solution of system of linear equations, direct method, full and partial pivoting, Gauss-Jordan method for finding inverse of matrix, solving consistent system of linear equations : Gauss elimination method, Gauss-Jordan elimination method

Unit IV:

Numerical integration : Trapezoidal rule, Simpson’s 1/3 rule, Simpson’s 3/8 rule, Monte Carlo method, Ordinary differential equations : Euler’s method, Runge-Kutta method (second and fourth order), RK method for pair of equations, RK4 method for second order differential equation

Semester – III

Course Title – Logical Reasoning

Course Type – Ability Enhancement Course (AEC)

Course Code - 24-PHY-A-217

Course Level – 200

Total Credits – 2

Classes /week – 2

Max. Marks - 50

Prerequisite – Class XII (English, Physics and Maths)

Course Advisor’s Name :

Course Advisor’s Email :

Expected Learning Outcome –

- Determine the nature and kinds of logical reasoning
- Understand the nature of argument from analogy
- Recognize different fallacies involved in arguments
- Identify and evaluate argument from analogy and fallacies of language
- Apply the skill of logical reasoning to avoid prejudices of thinking

Reference Books:

1. Introduction to Logic : Copi & Cohen
2. Critical Thinking : Parker & Moore
3. An Introduction to Critical Thinking : Sen, Madhuchanda
4. A Concise Introduction to Logic : Patrick J. Hurley
5. Logic: Informal, Symbolic and Inductive : Chakraborty, C.
6. A Concise Introduction to Logic: Patrick J. Hurley

Course Content-

Unit 1:

1. Meaning of Logical Reasoning
2. Nature of Deductive and Inductive Reasoning
3. Relation of Logical Reasoning to Scientific and Philosophical Reasoning
4. Nature of Abductive Reasoning, Verbal and Nonverbal Reasoning

Unit 2:

1. Inductive Reasoning: Generalizing from a Sample, Statistical Syllogism, Argument from Analogy, Causal Argument
2. Logical Fallacy: Distinction between Formal and Informal Fallacy
3. Formal Fallacy: Affirming the Consequent, Denying the Antecedent, Undistributed Middle
4. Informal Fallacy: Fallacies of Defective Induction

Semester – III

Course Title – Environmental Awareness and Social Responsibilities

Course Type – Value Added Course (VAC)

Course Code - 24-PHY-V-218

Course Level – 200

Total Credits – 2

Classes /week – 2

Max. Marks - 50

Prerequisite – Class XII (Physics and Maths)

Course Advisor’s Name :

Course Advisor’s Email :

Expected Learning Outcome –

1. The student should have developed awareness on issues of climate change, environmental pollution, their effects and possible solutions.
2. Gained knowledge of natural resources, their significance, and the effects of human activity on resources.
3. Be familiar with biodiversity conservation and its significance.
4. Understand the need of sustainable development for the future and become a competent and socially responsible citizen.

Reference Books:

1. Gadgil, M., & Guha, R. 1993. This Fissured Land: An Ecological History of India.
2. Environmental Studies – UGC- Text Book for Undergraduate Courses for all Branches of Higher Education – Erach Bharucha, Bharti Vidyapeeth Institute of Environment Education and Research, Pune.
3. Odum, E.P., Odum, H.T. & Andrews, J. 1971. Fundamentals of Ecology. Philadelphia: Saunders
4. Sengupta, R.: Ecology and economics: An approach to sustainable development. OUP.

Course Content-

Unit 1 : : Introduction to environmental concerns: Climate change, global warming, ozone layer depletion, acid rain. Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution, e-waste and plastic waste. Nuclear hazards and human health risks.Control measures: Concept of sustainability and sustainable development, solid waste management : urban and industrial waste. Pollution case studies.

Unit 2 : Human Communities and the Environment: Human population growth: Impacts on environment, human health and welfare, Resettlement and rehabilitation of project affected persons; case studies. Disaster management : floods, earthquake, cyclones and landslides. Environmental movements : Chipko, Silent valley, Bishnois of Rajasthan. Environmental ethics: Role of different cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi). Environment Laws: Environment Protection Act; Air ,Water, Wildlife Forest Conservation Act. Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

PHYSICS COURSES

SEMESTER IV

Course Name	Course Type	Course Code	Available to
Electricity & Magnetism II	Major	24-PHY-C-251	Physics (Major)
Mathematical Physics II	Major	24-PHY-C-252	Physics (Major)
Quantum Mechanics I	Major	24-PHY-C-253	Physics (Major)
Lab 4	Lab	24-PHY-C-250	Physics (Major)
Scientific Writing & Ethics	AEC	24-PHY-A-257	All
Non Conventional Energy Sources	VAC	24-PHY-V-258	All
Electricity & Magnetism I	Minor	24-PHY-M-261	Minor
Lab 3	Lab	24-PHY-M-260	Minor
Electricity & Magnetism I	DSC1	24-PHY-D-271	BSc Multidisciplinary
Elements of Modern Phys.	DSC1	24-PHY-D-272	BSc Multidisciplinary
Lab 1	Lab	24-PHY-D-270	BSc Multidisciplinary

Semester - IV

Course Title – Electricity & Magnetism II

Course Type – Major (Core)

Course Code - 24-PHY-C-251

Course Level – 200

Total Credits – 3

Classes /week – 3

Max. Marks: 100

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 Boundary Value Problems with Linear Dielectrics, Energy in a dielectric system, 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: 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.

Semester - IV

Course Title – Mathematical Physics II

Course Type – Major (Core)

Course Code - 24-PHY-C-252

Course Level – 200

Total Credits – 3

Classes /week – 3

Max. Marks: 100

Prerequisite – Mathematical Physics I

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Apply integral transforms (Fourier, Laplace) to solve problems.
2. Analyze partial differential equations using separation of variables.
3. Understand special functions (Legendre, Bessel, Hermite, Laguerre).
4. Apply complex analysis techniques (Cauchy-Riemann, contour integration).
5. Understand tensor and its applications in physics.

Reference Books:

1. Mathematical Methods for Physicists: Arfken and Weber
2. Advanced Engineering Mathematics : Erwin Kreyszig
3. Fourier Analysis : M.R. Spiegel.
4. Differential Equations : G. Simmons.
5. Mathematical methods for Scientists & Engineers : D.A. McQuarrie.

Course Syllabus

Unit I: Integrals Transforms

Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms. Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application

Unit II: Partial Differential Equations and Special Functions

Classification of partial differential equations (PDEs). Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry.
Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions and Orthogonality. Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions.

Unit III: Complex Analysis:

Review of complex number; Graphical representation; Euler’s formula; De-Moivre’s theorem; Roots of complex numbers; Functions of complex variables; Limits, Continuity, Differentiation, Analytic function, Multiple Valued Functions; Analyticity; Cauchy-Riemann conditions; Singular functions; Poles, branch points, singularities; Cauchy integral theorem; Cauchy integral formula; Cauchy’s inequality; Derivative as integral; Morera’s Theorem; Liouville’s Theorem; Residues, Contour Integration, line integral, simply and multiply connected domains.

Unit IV: Tensors

Transformation properties of vectors, covariant and contra-variant vectors; Tensors: Definition, algebraic properties; Numerical tensors (Kronecker delta and Levi-Civita symbols), metric tensor, index raising, lowering, contraction; Electromagnetic field tensor; Covariant differential; Affine connection; Covariant derivative; metric connection; Riemann curvature tensor, Bianchi identity; Ricci tensor; Einstein equation and curvature tensor.

Semester - IV

Course Title – QUANTUM MECHANICS I

Course Type – Major (Core)

Course Code - 24-PHY-C-253

Course Level – 200

Total Credits – 3

Classes /week – 3

Max. Marks: 100

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; expansion of an arbitrary wave function as a linear combination of energy eigen functions General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wave function; Position momentum uncertainty principle. Ehrenfest theorem. Time independent Schrodinger equation.

Unit II: General discussion of bound states in arbitrary 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 energy eigen functions using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle

Unit III: Quantum theory of hydrogen-like atoms

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 from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells, introduction to spin

Unit IV: Atomic Structure

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

Semester - IV

Course Title - Lab 4 - Electricity & Magnetism

Course Type – Major (Lab)

Course Code - 24-PHY-C-250

Course Level – 200

Total Credits – 3

Classes /week – 6

Max. Marks: 100

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 – IV

Course Title – Scientific Writing & Ethics

Course Type – Ability Enhancement Course (AEC)

Course Code - 24-PHY-A-257

Course Level – 200

Total Credits – 2

Classes /week – 2

Max. Marks: 50

Prerequisite – Class XII (English, Physics and Maths)

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

- Ability to think and express in comprehensive and logical way
- Use of relevant resources to consolidate the argument
- Presenting the idea distinct and clear
- Prepare scientific proposals without using AI writing tools
- Introduce the major moral theories and the tools to answer moral questions
- Develop the ability to analyze, evaluate, and use reason to craft your own responses to philosophical arguments.

Reference Books:

1. The Craft of Scientific Writing : Michael Alley
2. Concepts in Scientific Writing : Clifford Jones
3. Writing Science in Plain English : Anna E Greene
4. Science and Technical Writing : Philips Rubens
5. Moral Philosophy: A Reader - Louis P. Pojman
6. Ethics for Beginners: Big Ideas from 32 Great Minds : Peter Kreeft
7. Ethical Theory: An Anthology : Shafer-Landau, Russ
8. Science and Ethics : Bernard E. Rollin,

Course Content-

Unit 1: Writing an article- Introduction- Principles of basic writing : Inquiry-learning through questioning- Rhetoric : effective language used for persuasive academic argumentation- Rhetorical situation: audience, purpose, context – Writing process : draft, reflection, feedback, revision – research and critical reading: sources, methods and documentation
Implementation : framing the objectives- choosing a title- drafting an abstract – motivating the topic – stating material and methods - prepare tables and figures – linking tables and figures to the text - framing the scientific arguments – conclusion – acknowledgement and references- Awareness of plagiarism and avoidance of AI writing tools.

Unit 2 : Introduction to ethics - the philosophy of morality : how to live from a moral point of view - Moral Questions of both practice (Is lying wrong? Must we keep our promises?) and theory (What makes an action wrong? Is it only humans who worry about morality? How do we apply moral theory to society?) - Four important ethical theories (Aristotle's virtue ethics, Kant's deontology, Hume's expressivism and Mill's utilitarianism). Rules, truths and theories: an introduction to ethical reasoning, Freedom, knowledge and society: the preconditions of ethical reasoning, Virtue ethics: virtue, values and character, Humean ethics: Non-cognitivism, the passions and moral motivation, Deontology: Kant, duty and the moral law, Utilitarianism: Mill and the utility calculus
Ethics in practice of science-Moral and ethical principles and responsibilities for a scientist Current ethical standards and practices and their origins.

Semester – IV

Course Title – Non-Conventional Energy Sources

Course Type – Value Added Course (VAC)

Course Code - 24-PHY-V-258

Course Level – 200

Total Credits – 2

Classes /week – 2

Max. Marks: 50

Prerequisite – Class XII (Physics and Maths)

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

1. Understand conventional and non-conventional energy sources.
2. Explain the need for renewable energy sources and energy conservation.
3. Analyze various renewable energy sources (solar, wind, geothermal, biomass).
4. Apply principles of energy conversion and storage.
5. Evaluate the advantages and disadvantages of different energy sources.
6. Understand the need of sustainable development for the future and become a competent and socially responsible citizen.

Reference Books:

1. Renewable Energy Systems: Siegfried Heier
2. Energy and the Environment : David A. Davenport
3. Alternative Energy Systems: Design and Analysis : Frank Kreith and D. Yogi Goswami
4. Solar Energy Engineering : Richard J. Kreider and Jan F. Kreider
5. Wind Energy Systems : Gary L. Johnson

Online resources:

1. https://mnre.gov.in/
2. International Energy Agency (IEA)
3. United Nations Development Programme (UNDP) - Energy and Environment

Course Content-

Unit 1: Conventional energy sources, Non conventional energy sources, Need of non conventional energy sources, Renewable Sources of Energy, Principles of energy conservation. Familiarization with the different, energy conservation, Solar energy, Types of solar energy collectors , solar energy storage systems and their application, Wind Energy and Basic principles of wind energy conversion, classification of WEC systems, applications of wind energy, Geothermal sources, hydrothermal resources, applications of geothermal energy, advantages and disadvantages of geothermal energy. Energy from Biomass, Biomass conversion technologies, photosynthesis, biogas generation, factors affecting biogas generation, utilization of biogas;

Unit 2 : Wind Energy, Basic principles of wind energy conversion, basic components of Wind Energy Conversion System (WECS), wind energy collectors, applications of wind energy, Geothermal Energy, Geothermal sources, hydrothermal resources, applications of geothermal energy, advantages and disadvantages of geothermal energy, Chemical Energy, Fuel cells – principle of operation of fuel cell, types of fuel cells advantages, disadvantages and conversion efficiency of fuel cells, applications of fuel cells. Oceans energy, Ocean thermal energy conversion-open cycle and closed cycle systems, energy from tides – basic principle of tidal power, ocean waves – wave energy conversion systems.

PHYSICS COURSES

SEMESTER V

Course Name	Course Type	Course Code	Available to
Electromagnetic Theory	Major	24-PHY-C-311	Physics (Major)
Mechanics II	Major	24-PHY-C-312	Physics (Major)
Solid State Physics	Major	24-PHY-C-313	Physics (Major)
Lab 5	Lab	24-PHY-C-310	Physics (Major)
Computational Physics	SEC	24-PHY-S-315	All
Wave Optics	Minor	24-PHY-M-321	Minor
Lab 5	Lab	24-PHY-M-320	Minor
Mathematical Physics II	DSC1	24-PHY-D-331	BSc Multidisciplinary
Wave optics	DSC1	24-PHY-D-332	BSc Multidisciplinary
Lab 1	Lab	24-PHY-D-330	BSc Multidisciplinary

Semester - V

Course Title – Electro-Magnetic Theory

Course Type – Major (Core)

Course Code - 24-PHY-C-311

Course Level – 300

Total Credits – 3

Classes /week – 3

Max. Marks - 100

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: EM Wave Propagation in Unbounded Media

Review of Maxwell’s equations. 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 II: 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 III: Polarization of Electromagnetic Waves

Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel’s Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light

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 - V

Course Title – Mechanics II

Course Type – Major (Core)

Course Code - 24-PHY-C-312

Course Level – 300

Total Credits – 3

Classes /week – 3

Max. Marks - 100

Prerequisite – Mechanics I

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

After completing this course, the students will be able to -
1. Understand fundamental concepts in special relativity and gravitation.
2. Analyze motion in central force fields and planetary orbits.
3. Explain vibrations in continuous systems (strings, air).
4. Apply dynamical systems theory to phase space analysis.
5. Model real-world phenomena using mathematical physics principles.

Reference Books:

1. Mechanics: L. D. Landau and E. M. Lifshitz
2. Theoretical Mechanics: Murray Spiegel.
3. An Introduction to Mechanics : Kleppner and Kolenkow
4. Vibrations and Waves : A. P. French.
5. Introduction to dynamics : Percival & Richards
6. Classical Mechanics : Kibble & Berkshire

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. Weightlessness. Basic idea of global positioning system (GPS).

Unit III: Vibrations in Continuous Systems

Transverse vibrations of stretched strings. Energy of a vibrating string, Normal modes of stretched strings. Pluck and struck strings. Longitudinal vibrations in air and other continuous medium. Newton's formula for Velocity of Sound. Laplace's correction.

Unit IV: Dynamical systems

Phase space and phase portraits, First order autonomous system – the phase line, second order systems – the phase plane, linear transformation of coordinates, transformation matrix, phase flows, various types of fixed points, equilibrium and stability, classification of fixed points based on eigenvalues of transformation matrix, linearization of phase flow equations, conservative systems with one degree of freedom, simple pendulum, Lotka-Volterra system, Limit cycles, bifurcation.

Semester - V

Course Title – Solid State Physics

Course Type – Major (Core)

Course Code - 24-PHY-C-313

Course Level – 300

Total Credits – 3

Classes /week – 3

Max. Marks - 100

Prerequisite – Quantum Mechanics I

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.

Reference Books:

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 - V

Course Title - Lab 5 – Digital Systems

Course Type – Major (Lab)

Course Code - 24-PHY-C-310

Course Level – 300

Total Credits – 3

Classes /week – 6

Max. Marks - 100

Prerequisite – Digital Systems

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.

List of Experiments :

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(RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs

Semester - V

Course Title – Computational Physics

Course Type – Skill Enhancement Course

Course Code - 24-PHY-S--315

Course Level – 300

Total Credits – 3

Classes /week – 6

Max. Marks - 100

Prerequisite – Numerical Analysis

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

PHYSICS COURSES

SEMESTER VI

Course Name	Course Type	Course Code	Available to
Classical Mechanics	Major	24-PHY-C-351	Physics (Major)
Electrodynamics	Major	24-PHY-C-352	Physics (Major)
Nuclear &Particle Physics	Major	24-PHY-C-353	Physics (Major)
Lab 6	Lab	24-PHY-C-350	Physics (Major)
Elements of Modern Physics	Minor	24-PHY-M-361	Minor
Lab 6	Lab	24-PHY-M-360	Minor
Electricity Magnetism II	DSC1	24-PHY-D-371	BSc Multidisciplinary
Mechanics II	DSC1	24-PHY-D-372	BSc Multidisciplinary
Quantum Mechanics	DSC1	24-PHY-D-373	BSc Multidisciplinary
Lab 6	Lab	24-PHY-D-370	BSc Multidisciplinary

Semester - VI

Course Title – Classical Mechanics

Course Type – Major (Core)

Course Code - 24-PHY-C-351

Course Level – 300

Total Credits – 4

Classes /week – 4

Max. Marks - 100

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: 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. Rayleigh' s dissipation function. Integrals of motion. Symmetries of space and time with conservation laws. Small oscillations.

Unit II: 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, Rout's Procedure, Δ-Variation, Principle of Least Action

Unit III: Canonical Transformation

Canonical Transformations. Generating functions. Poisson bracket. Poisson's Theorem. Invariance of PB under canonical transformations. Infinitesimal canonical transformations; Conservation theorem in Poisson bracket formalism; Jacobi's identity, Angular momentum PBs. Hamilton-Jacobi equation. Connection with canonical transformation. The harmonic oscillator and Kepler's problem by Hamilton-Jacobi Method, Hamilton's characteristic function; Action angle variables. Kepler's problem in action angle variable.

Unit IV: Rigid Body Dynamics

The Independent of Co-ordinates of a Rigid Body, Orthogonal Transformations. The Euler's angles. The Cayley-Klein parameters; Euler's Theorems on the Motion of a Rigid body, Infinitesimal Rotations, Rate of Change of a Vector, The Coriolis Force. Rigid Body Dynamics: Angular Momentum and Kinetic Energy of Motion about a Point. The Inertia Tensor and Moment of Inertia, Eigen values of Inertial Tensor and the Principal Axis Transformation. The Euler Equations of Motion, Torque-free motion of a rigid body. Symmetrical Top.

Semester - VI

Course Title – Electrodynamics

Course Type – Major (Core)

Course Code - 24-PHY-C-352

Course Level – 300

Total Credits – 4

Classes /week – 4

Max. Marks - 100

Prerequisite – Electricity Magnetism

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

To understand and work out energy, momentum and angular momentum densities of electromagnetic fields. To understand retarded potential formalism to work out time dependent electric and magnetic fields of moving charges. To understand various types of special cases of radiations to understand real life situations. To work out covariant equations of E-M fields to understand electrodynamics is inherently a relativistic theory.

Reference Books:

1. Classical Electrodynamics : J.D.Jackson,
2. Classical Theorey of Fields : Landau & Lifshitz
3. Introduction to Electrodynamics: D. J. Griffiths
4. Foundations of Electromagnetic Theory : Reitz, Milford and Christy
5. Classical Charged Particle : Rohrlich

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: Potentials and Fields

Solution to Inhomogeneous wave equations for continuous distributions, Green's functions for Poisson and Wave equations. Retarded and Advanced solutions for Maxwell's equations. Jefimenko formulas for electric and magnetic field, Potentials and electromagnetic fields for moving point charge, Lienard-Wiechert Potentials.

Unit III: Radiation

Radiation from localized oscillating charges. Dipole and quadrupole radiation (electric and magnetic), Radiation from an arbitrary source, Multipole expansion, Radiation from moving point charge, Larmor's formula and Lienard's generalization (relativistic); Angular distribution of radiated power for linearly (Bremsstrahlung) and circularly accelerated charges, , (Synchrotron), radiation from uniformly moving charge : Cherenkov radiation (qualitative treatment only). Radiation reaction from energy conservation, Abraham-Lorentz formula, Self force.

Unit V: Covariant formulation of Electrodynamics

Review of STR. Lorentz transformations. Four-vectors, Tensors. Lagrangian for a free relativistic particle, for a charged particle in an E.M. field, for free electromagnetic field, for interacting charged particles and fields. Covariance of Lorentz force equation and the equation of motion of a charged particle in an electromagnetic field; Electromagnetic field tensor, Lorentz transformation law for the electromagnetic fields and the fields due to a point charge in uniform motion, Maxwell's equations in co-variant form,; Field invariants; Hamiltonian of a charged particle in an electromagnetic field. Energy-momentum tensor and related conservation laws.

Semester - VI

Course Title – Nuclear &Particle Physics

Course Type – Major (Core)

Course Code - 24-PHY-C-353

Course Level – 300

Total Credits – 4

Classes /week – 4

Max. Marks - 100

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: 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 II: Energy deposition and Particle detection

Interaction of charged particles with matter. Stopping power and range. Detectors for energetic charged particles; Cerenkov detectors, Solid State or Semiconductor detector. Working principle of Cloud chamber, Bubble chamber, Ionisation chamber. Proportional counter. G.M. Counter. Scintillation Counter, spark chamber.

Unit III: Particle Accelerators

Need for accelerator of charged particles, Classification of types of accelerators, Cyclotron, Synchrotron, Betatron; Alternating gradient accelerator, Colliding beam accelerator.

Unit IV: Elementary particles

Classification and properties of elementary particles; Resonances ; Interactions and their mediating quanta, Conservation rules in fundamental interactions; Strangness and associated production, Isospin and its conservation. Parity and charge conjugation, Conservation of parity and its violation, Idea of eight fold way and quarks.

Semester - VI

Course Title - Lab 6 – Advanced Lab I

Course Type – Major (Lab)

Course Code - 24-PHY-C-350

Course Level – 300

Total Credits – 4

Classes /week – 8

Max. Marks - 100

Prerequisite –

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

This lab course familiarizes students with various advanced electronic circuits, their accuracy, precision, and behavior. Both analog and digital circuits are studied for their characteristics and functioning. Various real life situations are simulated through circuits and studied.

List of Experiments :

1. PN Junction : To find the band gap of the semiconductor
2. CE Amplifier (Bread Board) : To find bandwidth of capacitive coupled common emitter amplifier
3. Transistor Biasing : To study various biasing techniques, viz i) self bias ii) fixed bias, iii) voltage divider biasing, and to find the best biasing by observing the temperature effect on output waveform
4. FET : To find input and transfer characteristics of Field Effect Transistor
5. MOSFET : To find input and transfer characteristics of MOSFET
6. Op-Amp : To make inverting/non-inverting amplifiers, buffer, integrator and differentiator circuits using operational amplifier
7. To study Feedback in Transistors : a) series-series b) series-shunt c) shunt-series iv) shunt-shunt feedbacks
8. IC555 (BB) : To make astable and monostable vibrator using IC555
9. Phase Shift Oscillator (BB) : To make RC phase shift oscillator using 3 and 4 RC networks and compare experimental and theoretical frequencies
10. To study Amplitude Modulation & Demodulation and to calculate modulation index
11. To make Astable multivibrator using bipolar transistor
12. Optoelectronic kit : to study characteristics of i) Light Emitting Diode, ii) Temperature Dependent Resistance, iii) light dependent transistor
13. To study Analog to Digital conversion
14. To study Digital to Analog conversion
15. To study Frequency Modulation & Demodulation and to calculate modulation index
16. To study PAM (Pulse Amplitude Modulation) circuit
17. To study PCM (Pulse Code Modulation) circuit
18. To study PWM (Pulse Width Modulation) and PPM (Pulse Position Modulation) circuits

PHYSICS COURSES

SEMESTER VII

Course Name	Course Type	Course Code	Available to
Atomic & Molecular Physics	Major	24-PHY-C-411	Physics (Major)
Mathematical Physics III	Major	24-PHY-C-412	Physics (Major)
Quantum Mechanics II	Major	24-PHY-C-413	Physics (Major)
Lab 7	Lab	24-PHY-C-410	Physics (Major)
Mechanis II	Minor	24-PHY-M-421	Minor
Lab 7	Lab	24-PHY-M-420	Minor
Electro Magnetic Theory	DSC1	24-PHY-D-431	BSc Multidisciplinary
Nuclear Particle Physics	DSC1	24-PHY-D-432	BSc Multidisciplinary
Solid State Physics	DSC1	24-PHY-D-433	BSc Multidisciplinary
Lab 7	Lab	24-PHY-D-430	BSc Multidisciplinary

Semester - VII

Course Title – Atomic & Molecular Physics

Course Type – Major (Core)

Course Code - 24-PHY-C-411

Course Level – 400

Total Credits – 4

Classes /week – 4

Max. Marks - 100

Prerequisite – Quantum Mechanics I

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

Familiarisation with atomic spectral notation, splitting of various atomic transitions, coupling of momenta, molecular orbitals, study of spectra from molecules, rotational, vibrational and electronic spectra by molecules. Theoretical study of principle of LASER, working principal of few practical LASER systems.

Reference Books:

1. Physics of Atoms and Molecules : B.H. Bransden & C.J. Joachain
2. Elementary Atomic Structure : G.K. Woodgate
3. Introduction to Modem Physics : H.S. Mani & G.K. Mehta
4. Molecular Spectra : G. Herzberg
5. Fundamentals of Molecular Spectroscopy : C.N. Banwell
6. Laser Spectroscopy : W. Demtroder
7. Principle of Lasers : O. Svelto

Course Syllabus

Unit I : Atomic Physics

Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. LS and JJ coupling, Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms, Fine structure of hydrogenic atoms, Mass correction, spin-orbit term, Darwin term. Intensity of fine structure lines. The ground state of two-electron atoms – perturbation theory and variational methods. Many-electron atoms – Central Field Approximation-LS and jj coupling schemes, hyperfine structures, Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.), Thomas Fermi-potential, Lande interval rule. The Hartrec-Fock equations. The spectra of alkalis using quantum defect theory. Selection rules for electric and magnetic multipole radiation. Auger process.

Unit III: Molecular Structure

Born-Oppenheimer approximation for diatomic molecules, rotation, vibration and electronic structure of diatomic molecules. Spectroscopic terms. Centrifugal distortion. Electronic structure-Molecular symmetry and the states. Molecular orbital and valence bond methods for H_2^+ and H_2. Morse potential.

Unit III: Molecular Spectra

Rotational spectra of diatomic molecules-rigid and non-rigid rotors, isotope effect, Vibrational spectra of diatomic molecules- harmonic and anharmonic vibrators, Intensity of spectral lines, dissociation energy, vibration-rotation spectra, Electronic spectra of diatomic molecules-vibrational structure of electronic transitions (coarse structure)-progressions and sequences. Rotational structure of electronic bands (Fine structure)-P,Q,R branches. Intensities in electronic bands-The Franck Condon principle. The electron spin and Hund's cases. Raman Effect. ESR, NMR.

Unit IV: Lasers

Life time of atomic and molecular states. Multilevel rate equations and saturation. Coherence and profile of spectral lines. Rabi frequency. Laser pumping and population inversion. Simple description of Ammonia maser, $C0_2$ He-Ne Laser, Solid State laser, Free-electron laser. Non-linear phenomenon. Harmonic generation. Liquid and gas lasers, semiconductor lasers.

Semester - VII

Course Title – Mathematical Physics III

Course Type – Major (Core)

Course Code - 24-PHY-C-412

Course Level – 400

Total Credits – 4

Classes /week – 4

Max. Marks - 100

Prerequisite – Mathematical Physics II

Course Advisor’s Name :

Course Advisor’s Email :

Expected Learning Outcome –

To familiarize with application of complex analysis, Use of Green’s functions for inhomogeneous equations, basic probability theory and various common distribution functions to calculate everyday probabilities. Basic framework of group theory to understand various internal symmetries of systems and equations and related conserved quantities. Use of integral equations.

Reference Books:

1. Complex variables and applications by Churchill & Brown, IV Ed, MGH
2. Mathematical Physics, Sadri Hassani, II Ed., Springer
3. Mathematical methods for physicists, 6th Ed., Arfken& Weber, Elsevier
4. Tensors by De, Sheikh and Sengupta, Narosa

Course Syllabus

Unit I: Advanced complex analysis

Brief description, mappings, branch cut, Conformal mapping, application, Taylor and Laurent series : convergence, residues and poles, contour integrals, 2-dimensional Laplace equation, Integral representations for Hypergeometric, confluent Hypergeometric and related functions, Gamma function, Zeta function, Method of steepest descent.

Unit II: Inhomogeneous differential equations

Green's function : Method for boundary value problems, GF in one dimension, eigenfunction expansion of Green's function, multidimensional GF's, examples : elliptic, parabolic and hyperbolic equations

Unit III: Statistics

Basic concepts: Sample space and probability, Permutation, combination, average and standard deviation; Random Variables, Binomial, Poisson and Normal Distributions. Central Limit Theorem, Hypothesis Testing and Data Analysis in Statistics.

Unit IV: Group Theory

Abstract groups: subgroups, classes, cosets, factor groups, normal subgroups, direct product of groups; Examples, Homomorphism &isomorphism. Representations: reducible and irreducible, unitary representations, Schur's lemma and orthogonality theorems, characters of representation, direct product of representations. Introduction to continuous groups: Lie groups, rotation and unitary groups. Representation of SO(3), SU(2), SU(3)

Unit V: Integral equations

Integral equations : Classification, Fredholm and Volterra integral equations, Transformation of a differential equation into integral eq., Hermitian Kernel, degenerate kernels, Fredholm alternative, integral transforms, successive approximations, successive substitution, resolvent kernel, Hilbert-Schmitt theory

Semester - VII

Course Title – Quantum Mechanics II

Course Type – Major (Core)

Course Code - 24-PHY-C-413

Course Level – 400

Total Credits – 4

Classes /week – 4

Max. Marks - 100

Prerequisite – Quantum Mechanics I

Course Advisor’s Name :

Course Advisor’s Email :

Expected Learning Outcome –

Development of formalism of matrix mechanics. Different methods to study system evolution, study of quantization of angular momentum, addition of angular momenta, total angular momentum of an electron in orbit for small and large atomic numbers. Extra effects arising from identical particles in QM.

Reference Books:

1. Quantum Mechanics : N. Zettili
2. Quantum Mechanics : Franz Schwabl
3. Modern Quantum Mechanics : J.J.Sakurai
4. Priciples of Quantum Mechanics : P. A. M. Dirac
5. Quantum Mechanics : Bohm

Course Syllabus

Unit I: Abstract formulation of Quantum Mechanics

Mathematical properties of linear vector spaces. Dirac's bra and ket notation. Hermitian operators, eigenvalues and eigenvectors. Orthonormality, completeness, closure. Generalised uncertainty principle. Unitary transformations, change of basis.Matrix representation of operators. Position and momentum representations – connection with wave mechanics. Commuting operators. Change of basis and unitary transformation. Expectation values. Ehrenfest theorem. Postulates of quantum mechanics.

Unit II: Fundamental Concepts of Quantum Mechanics

Basic postulates of quantum mechanics. Measurement. Time evolution of system's state. Schr¨odinger, Heisenberg and interaction pictures. Density operator. Pure state and mixed state density operators. Discrete and continuous spectra in 1-D. Solution of 1-D harmonic oscillator using algebraic method.

Unit III: Angular Momentum

Orbital, Spin and total angular momentum operators. Commutation relations of angular momentum operators. Eigenvalues, eigenvectors. Ladder operators and their matrix representations, Pauli spin matrices, their Commutation relations. Angular momentum as generator of rotation. Addition of angular momenta. Clebsch-Gordon coeficients. L-S coupling. Wigner - Eckart theorem.

Unit IV: Identical Particles

Many particle systems, systems of identical particles, exchange degeneracy, symmetrization postulate, construction of symmetric and anti-symmetric wave functions from unsymmetrized functions. The Puli exclusion principle. Introduction to second quantization. Creation and annihilation operators for Fermions and Bosons. Fock states.

Semester - VII

Course Title - Lab 7 – Advanced Lab II

Course Type – Major (Lab)

Course Code - 24-PHY-C-410

Course Level – 400

Total Credits – 4

Classes /week – 8

Max. Marks - 100

Prerequisite –

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome

To familiarize with advanced experiments in Physics like molecular spectra, magnetic measurements, diodes etc.

List of Experiments :

1. Study of radioactivity by using a G.M. tube to (i) Determine background radiation and (ii) Study absorption in air of β and γ radiation from ^{137}Cs and ^{60}Co sources.

2. Hall effect : Study of the dependence of Hall coefficient on temperature.

3. Determination of the magnetic susceptibility of $Mncl_2$ by Quincke's tube method.

4. Study of magnetoresistance of doped semiconductors.

5. Study of magnetic hysteresis in various ferromagnetic materials using a Hysterisis loop tracer .

6. Frank- Hertz experiment.

7. Determination of the dissociation energy of Iodine molecule.

8. Fourier analysis of sinusoidal, triangular and square waveforms.

9. Determination of the Curie temperature of ferroelectric materials.

10. Determination of the forbidden energy gap of semiconductors.

11. Determination of the e/m ratio of electrons by Thomson's method using a fine beam electron tube and Helmholtz coils.

12. Determination of the dielectric constants of amorphous and crystalline solids.

13. Determination of the Landé g factor of electrons using ESR.

14. Determination of ultrasonic velocity in liquids.

15. Study of the temperature dependence of resistivity of semiconductors by the 4-probe method.

16. Study of I-V characteristics, and determination of the fill-factor and efficiency of a solar photovoltaic cell.

17. Study of Zener and avalanche breakdown in P-N junction diodes as a function of Temperature.

PHYSICS COURSES

SEMESTER VIII

Course Name	Course Type	Course Code	Available to
Condensed Matter Physics	Major	24-PHY-C-451	Physics (Major)
Quantum Mechanics III	Major	24-PHY-C-452	Physics (Major)
Semiconductor Devices	Major	24-PHY-C-453	Physics (Major)
Statistical Mechanics	Major	24-PHY-C-454	Physics (Major)
Solid State Physics	Minor	24-PHY-M-461	Minor
Lab 8	Lab	24-PHY-M-460	Minor
Classical Mechanics	DSC1	24-PHY-D-471	BSc Multidisciplinary
Condensed Matter Physics	DSC1	24-PHY-D-472	BSc Multidisciplinary
Semi Conductor Devices	DSC1	24-PHY-D-473	BSc Multidisciplinary
Lab 8	Lab	24-PHY-D-470	BSc Multidisciplinary

Semester - VIII

Course Title – **Condensed Matter Physics**

Course Type – Major (Core)

Course Code - 24-PHY-C-451

Course Level – 400

Total Credits – 4

Classes /week – 4

Max. Marks - 100

Prerequisite – **Solid State Physics**

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

To understand magnetic properties of different materials, to correlate magnetic and optical properties of solids, to understand various magnetic quasi particles to better understand magnetic phenomena. To know basics of superconductivity and superfluidity. Study of defects and disorder and study of order in liquid crystals.

Reference Books:

1. Introduction to Solid State Physics : C. Kittel
2. Solid State Physics : Rita John
3. Introduction to Solids : L.V. Azaroff
4. Solid State Physics : N.W. Ashcroft and N.D. Mermin
5. Solid State Physics : H. Ibach and H. Luth
6. Introduction to Nanotechnology : C.P. Poole Jr and F.J. Owens
7. Nanotechnology : R. Booker and E. Baysen
8. Nanostructures and Nanomaterials : Huozhong Gao
9. Principles of the Theory of Solids : J.M. Ziman

Course Syllabus

Unit I: Magnetism in Solids

Response of substance to magnetic fields, Dia, Para and Ferromagnetic materials, Absence of magnetic charge, Electric current in atoms, Electron spin and magnetic moment, Measurement of the susceptibility of paramagnetic substances, Langevin's theory of diamagnetic and paramagnetic substances, Curie- Weiss Law, Theory of ferromagnetism.

Unit II: Dielectric and Optical Properties of Solids

Polarization and Susceptibility, The local field, Dielectric Constant and Polarizability, Clausius-Mossotti Equation, Polar molecules, Sources of Polarizability (Electronic, Ionic, Dipolar Polarizability), Classical Theory of Electronic Polarizability, Frequency Dependence of Total Polarizability. Polarons, excitons, plasmons, Kramers-Kronig relations, Electronic, inter-band and intra-band transitions. Relation between optical properties and band structure. Band structure determination from optical spectra.

Unit III: Superconductivity and Superfluidity

Introduction and Historical Developments, Electrical Resistivity, Perfect Diamagnetism or Meissner Effect, Supercurrents and Penetration Depth, London Equations, Critical Field and Critical Temperature, Type I and Type II Superconductors, Thermodynamical properties, Flux Quantization, Josephson Effects and Tunneling, Cooper Pairing and Introduction to BCS Theory, High Temperature Superconductors. Superfluidity in Helium (He^4 and He^3).

Unit IV: Dimensionality and Order

Size and dimensionality: thin films, nanowires, quantum dots (Density of States, excitons, band-gaps, electron transport, single-electron tunneling, quantum Hall effect). Translational and orientational order, defects and dislocations in solids, liquid crystalline order, quasi-crystals.

Semester - VIII

Course Title – Quantum Mechanics III

Course Type – Major (Core)

Course Code - 24-PHY-C-452

Course Level – 400

Total Credits – 4

Classes /week – 4

Max. Marks - 100

Prerequisite – Quantum Mechanics II

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

Time independent and time dependent perturbation theory in quantum mechanics. Scattering of particles from different potentials, S and T matrix approach, relativistic spin zero and spin half equations, application in few simple cases, antiparticles.

Reference Books :

1. Quantum Mechanics : Franz Schwabl
2. Quantum Mechanics : Eugen Merzbacher
3. Quantum Mechanics : N. Zettili
4. Quantum Mechanics : P. M. Mathews and K. Venkatesan
5. Priciples of Quantum Mechanics : P. A. M. Dirac

Course Syllabus

Unit I: Approximation methods for stationary systems

Time independent perturbation theory. Perturbation of non-degenerate states: first and second order perturbation. Perturbation of a harmonic oscillator. Perturbation of degenerate states, removal of degeneracy. Application to one-electron system – Relativistic mass correction, Spin-orbit coupling (L-S and j-j),Zeeman and Stark effects. Variational and WKB methods.

Unit II: Approximation methods for time-dependent pertrbations

Schrodinger, Heisenberg and interaction pictures, Equations of Motion. Constant and harmonic perturbation. Discrete and continuous case, transition probability. Time-dependent perturbation theory. Transition to a continuum of final states, Fermi golden rule. Application to constant and harmonic perturbations. Adiabatic and sudden approximations.

Unit III: Scattering Theory

Laboratory and centre of mass frames, The differential and total Cross section, Scattering amplitude, Scattering by spherically symmetric potentials; Partial waves and phase shifts. Scattering of a wave packet, The Lippmann Schwinger equation. Formal treatment of scattering by Green's function method. The Born approximation. Definition and properties of S-matrix, T matrix. Optical theorem

Unit IV: Relativistic Quantum Mechanics

Klein-Gordon equation, Feynman-Stuckelberg interpretation of negative energy states and concept of antiparticles; Dirac equation, covariant form, adjoint equation; Plane wave solution and momentum space spinors; Spin and magnetic moment of the electron; Nonrelativistic reduction of the Dirac equation; Helicity and chirality; Properties of γ matrices; Lorentz and CPT invariance of Dirac equation; Normalisation and completeness of spinors. Central forces and the hydrogen atom. Dirac electron in constant magnetic field, Foldy-Wouthuysen transformation, Hole theory, Time reversal symmetry, Non-hermitian open quantum system.

Semester - VIII

Course Title – Semiconductor Devices

Course Type – Major (Core)

Course Code - 24-PHY-C-453

Course Level – 400

Total Credits – 4

Classes /week – 4

Max. Marks - 100

Prerequisite – Analog Systems

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

Theory of semiconducting material. Functioning of various semiconductor devices like BJT, FET and MOSFET, and their applications. Negative feedback used for stabilizaing signal. Study of devices based on microwaves.

Reference Books:

1. Electronic Fundamentals and Applications : John D. Ryder
2. Electronic Devices and Circuits : Millman and Halkins
3. Solid State Electronic Devices : Ben G. Streetman
4. Electronics : Ramabhadran S.
5. Electronics Devices and Circuit theory : Boylested and Nashelsky
6. Pulse, Digital and Switching Waveforms : Millman and Taub
7. Fundamental of Transistor : S.W. Amos
8. Microwave Principle : W.J. Reich
9. Microwaves : K.L. Gupta
10. Introduction to Microwave : G.J.Wheeler;
11. Semiconductor Devices- Physics and Tecnology : S.M. Sze.

Course Syllabus

Unit I: Semiconductor Devices I

Semiconducting Materials, conduction in semiconductors, Charge densities in a semiconductors, PN junction, space charge and electric field distribution at junctions, forward and reverse biased conditions, Space charge capacitance, varactor diode, Zener and avalanche breakdowns, zener diode, tunnel diode, photodiode, LED, p-n-p-n devices and their characteristics, SCR.

Unit II: Semiconductor Devices II

Transistors: Bipolar junction Transistor (BJT), Ebers Moll Model, Analysis of CE amplifier using h-parameters, The T-network equivalent circuit, constants of CB and CE amplifier using emitter, base, collector resistance, Biasing technique to BJT, stabilization factor, temperature stabilization, operating point, fixed bias, emitter feedback bias, voltage feedback bias. Field-Effect Transistors (FET) and MOSFET: Structure, Working, Derivations of the equations for I-V characteristics under different conditions.

Unit III: Feedback Principle

Negative feedback, effect of negative feedback on input/output resistances and voltage gain, gain stabilization, effect of negative feedback on band width, voltage series feedback, voltage shunt feedback applied to BJT, current series feedback, current shunt feedback applied to BJT

Unit IV: Microwave Electronics

Microwaves, Principle of velocity modulation and bunching of electrons, Basic principles of two cavity klystrons and Reflex Klystrons, operation of magnetrons, characteristics of microwave diode.

Semester - VIII

Course Title – Statistical Mechanics

Course Type – Major (Core)

Course Code - 24-PHY-C-454

Course Level – 400

Total Credits – 4

Classes /week – 4

Max. Marks - 100

Prerequisite – Thermodynamics

Course Advisor's Name :

Course Advisor's Email :

Expected Learning Outcome –

Study of classical systems consisting of large number of particles. Distribution of particles. Various types of ensembles and their properties. Calculation of various thermodynamic properties. Study of quantum systems using indistinguishability of particles : B-E and F-D statistics. First and second order phase transition, scaling.

Reference Books:

1. Statistical and Thermal Physics : F. Reif
2. Statistical Mechanics : K. Huang
3. Statistical Mechanics : R K Pathria
4. Statistical Physics : Landau and Lifshitz
5. Thermodynamics and Statistical Mechanics : Greiner, Neise and Stocker
6. Statistical Physics : F. Mandl

Course Syllabus

Unit I: Statistical basis of thermodynamics

Objective of statistical mechanics. Central Limit Theorem, The macroscopic and the microscopic states, phase space, ensemble, trajectories and density of states, Ergodic hypothesis, postulate of equal a-priori probability and equality of ensemble average and time average. Boltzmann's postulate of entropy, Counting the number of microstates in phase space, Liouville's theorem, ensemble theory, the principle of maximum entropy, contact between statistical mechanics and thermodynamics, classical ideal gas, entropy of mixing Sackur-Tetrode equation and Gibb's paradox

Unit II: Canonical and grand-canonical ensembles

System in contact with a heat reservoir , Micro-canonical ensemble, Canonical ensemble, partition function, calculation of statistical quantities - entropy, Helmholtz free energy, Energy fluctuations. System in contact with a particle reservoir, chemical potential - The grand canonical ensemble, grand canonical partition function and grand potential, particle number fluctuation. Entropy in grand canonical ensemble, thermodynamic potentials. Chemical potential of ideal gas. Chemical equilibrium and Saha Ionisation Equation.

Unit III : Quantum Statistical Mechanics

Postulates of quantum statistical mechanics, density matrix, Quantum Liouville theorem; Density matrices for microcanonical, canonical and grand canonical systems; Simple examples of density matrices. Statistics of indistinguishable particles, Maxwell-Boltzmann, Fermi-Dirac and Bose Einstein distribution, properties of ideal Bose and Fermi gases, Equation of state; Fermi gas at finite Temperature, Bose-Einstein condensation.

Unit IV: Phase transitions

Type of phase transitions, first and second order phase transitions. Ising model, partition function for one dimensional case, mean-field theories of the Ising model in two and three dimensions. Connection of Ising model to lattice gas and binary alloy models. Chemical equilibrium and Saha ionisation formula. Phase transitions – first order and continuous, critical exponents and scaling relations. Landau theory of phase transition, Landau free energy for second and first order transitions, Calculation of exponents from Mean Field Theory and Landau's theory, universality classes.