Cotton College State University
Physics
Undergraduate Syllabus

Semester	Paper Code	Paper Title
Sem-I	PHY101C	Mathematical Physics-I
	PHY102C	Mechanics
	PHY103C	Waves and Sound
	PHY104E	Mechanics, Waves & Sound
Sem-II	PHY201C	Mathematical Physics-II
	PHY202C	Optics
	PHY203C	Thermal Physics
	PHY204E	Electricity & Magnetism
Sem-III	PHY301C	Classical Mechanics and STR
	PHY302C	Electricity and Magnetism
	PHY303C	Numerical Analysis & Computer Programming
	PHY304E	Heat and Thermodynamics
Sem ï IV	PHY401C	Quantum Mechanics
	PHY402C	Atomic and Molecular Physics
	PHY403C	Current Electricity & Electronics-I
	PHY404E	Optics and Special Relativity
Sem-V	PHY501C	Mathematical Physics-III
	PHY502C	Electromagnetic Theory
	PHY503C	Digital Electronics
	PHY504E	Atomic, Nuclear & Quantum Mechanics

Sem-VI	PHY601C	Radiation Theory & Statistical Mechanics
	PHY602C	Condensed Matter Physics
	PHY603C	Nuclear and particle physics
	PHY604E	Electronics, EM waves & Condensed Matter Physics

Semester -I

Paper Code	paper title	L+T+P	Credit
PHY101C	Mathematical Physics-I	3+1+0	4
PHY102C	Mechanics	2+1+1	4
PHY103C	Waves and Sound	2+1+1	4
PHY104E	Mechanics, waves & Sound	2+0+1	3

Paper: PHY101C
Mathematical Physics- I
Lectures-48

Vector Calculus:

Vector Differentiation:- Scalar and Vector Fields, Ordinary and Partial Derivative of a vector, Space curves, Unit Tangent Vector and Unit Normal Vector, Directional Derivatives and Normal Derivatives. Gradient of a scalar field and its Geometrical Interpretation. Divergence and Curl of a Vector Field. Del and Laplacian Operators, Vector Identities.

(12 Lectures)

Vector Integration:

Ordinary Integral of vectors. Line, Surface and Volume integrals. Double and Triple Integrals, Applications of Multiple Integrals: (1) Area enclosed by plane curves, (2) Area of a Curved surface, (3) Volumes of Solids. Flux of a vector field. Gaussô Theorem of Divergence, Greenôs Theorem and Stokesô Theorem.

(20 Lectures)

Orthogonal Curvilinear Coordinates:

Orthogonal Curvilinear Coordinates, Derivative of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

(12 Lectures)

Theory of errors:

Systematic and random Errors, Propagation of errors. Normal Law of errors. Proportional errors, Standard and Probable errors.

(4 Lectures)

Recommended Books:

1. Vector Analysis by Murray R. Spiegel
2. Introduction to Mathematical Physics by Charlie Harper (P.H.I.,1995)

Paper: PHY102C
Mechanics
Lectures-32

Inertial and Non- Inertial Systems:

Reference Frames :- Inertial Frames and Galilean Transformations. Galilean Invariance and Conservation Laws. Non-inertial Frames and Fictitious Forces. Uniformly Rotating Frame. Physics Laws in Rotating Coordinate Systems. Centrifugal forces: Coriolis Force and its Applications.

(6 Lectures)

Fundamentals of Dynamics:

Dynamics of a System of Particles. Center of Mass. Calculation of center of mass of (i)non-uniform rod (ii)semicircular arc (iii)semicircular disc and (iii) solid hemisphere.

(2 Lectures)

Work and Energy Theorem : Work and Kinetic Energy Theorem. Conservative and Non-Conservative Forces. Potential Energy. Energy Diagram. Stable and Unstable Equilibrium. Elastic Potential Energy. Force as Gradient of Potential Energy. Work and Potential energy. Work done by Non conservative Forces. Law of Conservation of Energy.

(4 Lectures)

Elastic and Inelastic Collisions between particles. Center of Mass and Laboratory Frames.

(2 Lectures)

Rotational Dynamics :

Angular Momentum of a Particle and System of Particles. Torque. Conservation of Angular Momentum. Rotation about a Fixed Axis. Moment of Inertia. Calculation of Moment of Inertia for Rectangular, Cylindrical, and Spherical Bodies. Kinetic Energy of Rotation. Motion involving both Translation and Rotation. Compound Pendulum.

(5 Lectures)

Gravitation :

Law of gravitation. Inertial and Gravitational Mass. Potential and Field due to Spherical Shell and Solid Sphere. Determination of G by Cavendish method.

(3 Lectures)

Elasticity :

Origin of elasticity, stress and strain, moduli (constants) of elasticity, relation between elastic constants, adiabatic and isothermal bulk moduli of a gas. Twisting torque on a Cylinder or Wire, Cantilevers (fixed at one end and loaded at the other, Supported at two ends and loaded at the middle).

(4 Lectures)

Fluid Motion :

Kinematics of moving fluids, Poiseuilleôs equation for flow of a liquid through a capillary tube.

(2 Lectures)

Surface Tension:

Concept of surface tension in terms of molecular energy, excess pressure inside curved surface. Rise of liquid in a capillary tube. Jurin's law. Determination of surface tension by ripple method.

(4 lectures)

Recommended Books:

1. An introduction to mechanics by Daniel Kleppner, Robert J. Kolenkow (McGraw-Hill, 1973)
2. Mechanics Berkeley physics course, v.1: By Charles Kittel,Walter Knight, Malvin Ruderman,Carl Helmholz,Burton Moyer, (Tata McGraw-Hill, 2007)
3. Mechanics by D S Mathur (S. Chand & Company Limited, 2000)
4. Mechanics by Keith R. Symon (Addison Wesley; 3 edition, 1971) University Physics by F W Sears, M W Zemansky and H D Young (Narosa Publishing House,1982)

List of Experiments: (At least five experiments are to be performed)

1. To determine the Acceleration due to Gravity by a bar pendulum.

2. To determine the Moment of Inertia of a regular body about an axis by torsional oscillation and determine the rigidity modulus of the suspension wire.

3. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuilleôs method)

4. To determine the Young's Modulus of a Wire by Optical Lever Method.

5. To determine the Modulus of Rigidity of a Wire by static torsion method.

6. To determine the Elastic Constants of a Wire by Searleôs method.

7. To determine the surface tension of a liquid (water) by Jurin's method.

8. To determine Poisson's ratio of an indian rubber in the form of a tube.

Recommended Practical Books:

1. Geeta Sanon, BSc Practical Physics, 1st Edn. (2007), R. Chand & Co.
2. B. L. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.
3. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi.
5. B Ghosh and K G Mazumdar Advanced Practical Physics , Sreedhar Publishers, Kolkata

Paper: PHY103C

Waves and Sound

Lectures- 32

Simple Harmonic Motion:

Introductory idea of SHM, Motion of a Linear Harmonic Oscillator, Rotating Phasors, Energy of a Linear Harmonic Oscillator, Superposition of SHMs: (i) two SHMs with same frequency but different phases and amplitudes along the same straight line, (ii) two SHMs of the same frequency at right angles to each other, (iii) two SHMs of commensurate frequencies at right angles to each other, Lissajous figures, Generation of Uniform Circular Motion from two SHMs at right angles. Related problems. (5 lectures)

Free, Damped and Forced Vibrations:

Free vibration, Analytical treatment of Damped Vibrations, Energy relations, Forced vibration, Analytical treatment of Forced Vibration, Mechanical and Electrical Analogues, Amplitude and

Velocity Resonances. Power relations in Forced Vibration and resonance, Sharpness of Resonance, Coupled vibrations, Normal coordinates and Normal modes, Mathematical treatment of Coupled Vibrations, Energy of Coupled Vibrations, N Coupled Vibrations, Related problems. (7 lectures)

Fourier Analysis:

Fourierôs theorem, Fourier Coefficients, Even-function and Odd-function Symmetry , Half-wave Symmetry, Exponential Form of Fourier Series, Fourier Series of (i) Square waveform, (ii) Triangular waveform (iii) Saw-tooth waveform. (4 lectures)

Wave Motion:

Wave motion in an Elastic medium, Progressive wave and its characteristics, mathematical representation of plan progressive wave, Differential wave equation in one dimension, solution of wave equation (method of separation of variables), Energy density of plane progressive wave.

(4 lectures)

Velocity of Waves:

Velocity of longitudinal waves in a solid bar, Intensity of sound, units of intensity. (4 lectures)

Superposition of waves:

Stationary waves, analytical treatment, phase and group velocities, Equation of transverse vibration of stretched string. Eigen functions and Eigen frequencies, energy of vibrating string, plucked string, struck string

(8 lectures)

List of Experiments: (At least five experiments are to be performed)

1. To determine the ultrasonic velocity in different liquid by ultrasonic interferometer.
2. To find the frequency of a tuning fork using sonometer.
3. To determine the unknown frequency using Meldeôs apparatus.
4. To use Lissajous figures to take phase and frequency measurements.
5. To determine velocity of sound in air by standing wave method using speaker, microphone and CRO.
6. To determine velocity of sound in solid rod by Knudt's tube
7. Determine velocity of wave over a string

Recommended Textbooks:

1.Text book of Sound: A. B. Wood

2.Vibrations, Waves, and Acoustics: D. Chattopadhyay and P. C. Rakshit
3.Text book of Sound: K. Bhattacharjee
4.Waves and Acoustics: P. K. Chakrabarti and S. Choudhury
5.A Text book on Oscillations, Waves and Acoustics: M. Ghosh and D. Bhattacharya
6.The Physics of Waves and Oscillations: N. K. Baja
7.Acoustics: Waves and Oscillations: S. N. Sen

Paper: PHY104E
Mechanics, waves and sound
Lectures - 32

A. Mechanics:

1.Work -Energy Theorem: Work and kinetic energy theorem, Conservative and non-conservative forces, force as gradient of potential.

(2 Lectures)

2.Rotational motion, Torque, angular momentum, conservation of angular momentum, work and power in rotational motion, KE of rotation, moment of inertia, theorems of moment of inertia, moment of inertia of rectangular plate, circular disc, cylinder, sphere (solid and hollow), body rolling without slip. (4 Lectures)

3.Kepler's law of planetary motion, Newton's law of gravitation from Kepler's law, Determination of G by Cavendish method, gravitational field and potentials due to solid sphere and spherical shell, artificial satellites, geostationary satellite, eccentricity of orbit of a satellite, escape velocity.

(4 Lectures)

4.Compound pendulum: equivalent simple pendulum, centers of suspension and oscillation, four positions of equal time period, condition for minimum time period.

(2 Lectures)

5.Hook's law, different kinds of elastic constants, work done in deforming a body, Relation among the elastic constants. Bending of beam fixed at one end and loaded at the other end (massless beam), torsion of a rod.

(4 Lectures)

6.Surface tension, excess pressure inside soap bubble and liquid drop, rise of liquid in a capillary tube, Jurinôs law, Determination of surface tension by capillary method.

(2 Lectures)

7.Streamline and turbulent flow, critical velocity, viscosity of fluids, Poiseuille's equation, its derivation and applications.

(2 Lectures)

B. Waves and Sound:

1.Simple harmonic motion, differential equation of S.H.M., total energy of a particle executing S.H.M., oscillation of loaded spring. Free, damped and forced vibrations, resonance, sharpness of resonance, equation of wave motion, superposition of SHMs (i) two SHMs along the same line and (ii) at right angles to each others, beats, stationary wave and Dopplerôs effect.

(6 Lectures)

2.Velocity of sound in a homogeneous medium, effect of temperature and pressure on velocity of sound in air, intensity level of sound and its unit (bel and decibel).

(4 Lectures)

3.Ultrasonic waves ï production of ultrasonic waves, application of ultrasonic waves, principle of SONAR system. (2 Lectures)

Recommended Books:

1. Mechanics - D.S. Mathur

2. Physics Part-I - Halliday and Resnick

3. A Text Book of Sound - N. Subramanyam and Brij Lal

List of Experiments: (At least five experiments to be performed)

1. To study the elongation of a wire by different pulling forces using Searleôs apparatus and find the value of Youngôs modulus.
2. To determine the value of g by bar pendulum.
3. To determine velocity of sound in moist air by resonant air column method.
4. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuilleôs method).
5. To determine the moment of inertia of a cylinder or a rectangular parallelopiped about two different axes of symmetry by torsional oscillation method.

(Few more will be added by the Department)

Semester -II

Paper Code	paper title	L+T+P	Credit
PHY201C	Mathematical Physics-II	3+1+0	4
PHY202C	Optics	2+1+1	4
PHY203C	Thermal Physics	2+1+1	4
PHY204E	Electricity & Magnetism	2+0+1	3

Paper: PHY201C
Mathematical Physics II
Lectures- 48

Matrices :

Addition and multiplication of matrices, Null matrices, Diagonal, Scalar and Unit matrices. Upper-Triangular and lower- Triangular matrices. Transpose of a matrix. Symmetric and Skew- Symmetric Matrices. Conjugate of a matrix. Hermitian and Skew-Hermitian matrices. Singular and Non-singular matrices. Adjoint of a matrix. Inverse of a matrix by adjoint method. Similarity transformations. Orthogonal and Unitary Matrices. Trace of a Matrix. Inner product. (6 lectures)

Eigen values and eigen vectors. Cayley-Hamilton Theorem. Diagonalization of matrices. Solutions of coupled Linear Ordinary differential equations. Bilinear and quadratic forms. Functions of a matrix.
(6 Lectures)

Differential equations :

Classification: Ordinary and partial, order and degree, linear and nonlinear, homogeneous and non-homogeneous. Solution: Explicit and Implicit, Number of arbitrary constants.
(3 Lectures)

Linear Ordinary Differential equations:

First order : (1) Separable equations. Initial Value problem. (2) Exact equations, Integrating factor.
(3) Linear equations, Lagrangeôs method of variation of parameters.
(5 Lectures)

Second Order: Homogeneous equations with constant coefficients. Wronskian and general solution.

Statement of existence and uniqueness Theorem for initial value problems. Solution of inhomogeneous equations by D operator method. Particular Integral. Method of undetermined coefficients and variation of parameters. Equations reducible to those with constant coefficients.

(10 Lectures)

Series solution of linear second Order Ordinary Differential equations: Singular points of Second Order Differential equations and their importance. Series Methods (Frobenius): Legendre, Bessel, Hermite and Laguerre Differential equations.
Legendre and Hermite Polynomials: Generating functions, Recurrence relations, Orthogonality.

(18 lectures)

Recommended Books:

1. Matrices and Tensors in Physics by A.W.Joshi. (New Age Int. Pub. 1995)
2. Advanced Engineering Mathematics by Erwin Kreyszig. (Wiley Eastern Limited,1985)
3. Special Functions for Scientists and Engineers by W.W. Bell (Dover Publishers, 1968)

Paper: PHY202C
Optics
Lectures - 32

Geometrical Optics:

Fermatôs principle: Optical path, Fermatôs principle of least Time or Extremum path, its applications in establishing the laws of reflection and refraction at spherical and plane boundaries. (3 Lectures)

Lenses: conjugate foci relation for refraction of paraxial rays at a Spherically Refracting Surface. Spherical aberration and its minimization by using suitable lens of different radii of curvatures and by aplanatic surface, Chromatic aberration, circle of least confusion, achromatism of two thin lenses separated by a distance. (6 Lectures)

Translation matrix and refraction Matrix, use of matrix method in refraction at a spherical surface and refraction through thin lens. (4 Lectures)

Interference: Division of Amplitude and Division of Wave front. Youngôs double slit Experiment. Lloydôs Mirror and Fresnelôs Biprism. Phase Change on Reflection: Stokeôs treatment. Interference in Thin Films: Parallel and Wedge-shaped Films. Fringes of Equal Inclination (Haidinger Fringes) and Fringes of Equal Thickness (Fizeau Fringes). Newtonôs Rings: Measurement of Wavelength and

Refractive Index.

(6 Lectures)

Michelsonôs Interferometer: (1) Idea of form of fringes (No Theory required), (2) Determination of Wavelength, (3) Wavelength Difference.

(2 Lectures)

Diffraction:

Fresnel diffraction: Fresnelôs Assumptions. Fresnelôs Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Comparison of a Zone Plate with a Convex lens. Diffraction due to (1) a Straight Edge and Slit, (2) a Small Circular Aperture .

(7Lectures)

Fraunhofer diffraction: Diffraction due to (1) a Single Slit, (2)a Double Slit and (3) a Plane Transmission Grating. Rayleighôs criterion of resolution. Resolving Power and Dispersive Power of a Plane Diffraction Grating.

(4 Lectures)

List of Experiments: (At least five experiments are to be performed)

1. Determine the refractive index of water using plane mirror and a convex lens.
2. Determine the focal length of a combination of a convex lens by displacement method.
3. Determine focal length of a convex mirror with the help of a convex lens.
4. To calibrate a spectrometer with spectral lines of known wavelength and hence determine unknown wavelength of spectral lines emitted by a given source.
5. To determine the wavelength of a monochromatic light emitted by given source using biprism.
6. To find the resolving power of a plane transmission grating using a monochromatic radiation.
7. To determine the wavelength of monochromatic radiation using Newton's rings.
8. To find the width of a single slit using a spectrometer and a monochromatic radiation and compare the result by measuring the width with the help of a travelling microscope.

Recommended Books:

1. Fundamentals of Optics by Francis Arthur Jenkins and Harvey Elliott White (McGraw-Graw Hill, 1976)

2.Optics by Ajoy Ghatak (Tata McGraw Hill, 2008)

3. Optics by Eugene Hecht and A R Ganesan (Pearson Education, (2002)

4. Light and Optics: Principles and Practices By Abdul Al-Azzawi (CRC Press, 2007)

5. Contemporary Optics by A. K. Ghatak and K. Thyagarajan (Plenum Press, 1978)

6. Introduction to Optics by Khanna and Gulati
7. Optics by B. K. Mathur
8. Optics by P. K. Chakraborty
9. Text Book of Light by B. Ghosh and K.G. Mazumder

Paper: PHY203C
Thermal Physics
Lectures-32

Thermodynamics:

Zeroth and First Law of Thermodynamics ï Thermodynamic Equilibrium. Zeroth Law of Thermodynamics and Concept of Temperature. Work and Heat Energy. State Functions. First Law of Thermodynamics. Differential form of the first law, Internal Energy and various thermodynamic processes. Applications of first law : general relation between Cp and Cv. Work Done during Isothermal and Adiabatic Processes.

(4 Lectures)

Second Law Thermodynamics : Reversible and Irreversible Changes. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot Engine and its Efficiency. Second Law of Thermodynamics : Kelvin and Clausius statements. Carnot Theorem. Application of Second Law of Thermodynamics : Thermodynamic Scale of Temperature and its Equivalence to the Perfect Gas Scale. Entropy : Change in Entropy. Entropy of a State. Clausius Theorem. Clausius Inequality. Second Law of Thermodynamics in terms of Entropy. Entropy of a Perfect Gas. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature-Entropy Diagrams.

(8 Lectures)

Thermodynamic Potentials : Thermodynamic Potentials U, H, F and G : Their Definitions, Properties and Applications: Magnetic Work, Cooling due to Adiabatic Demagnetization.

(3 Lectures)

Maxwell's Thermodynamic Relations : Derivation of Maxwell's Relations. Applications of Maxwell's Relations. Applications of Maxwell's Relations : (1) Clausius-Clapeyron equation, (2) Values of Cp-Cv, (3) TdS Equations, (4) Joule-Kelvin Coefficient for Ideal and van der Waal Gases, (5) Energy Equations.

(4 Lectures)

Kinetic Theory of Gases:

Distribution of Velocities : Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and

its Experimental Verification. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy. Specific Heats of Gases.

(4 Lectures)

Molecular Collisions : Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases : (1) Viscosity (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

(4 Lectures)

Real Gases

Behaviour of Real Gases : Deviations from the Ideal Gas Equation. Andrew's Experiments on CO2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule- Thomson Cooling.

(5 Lectures)

List of Experiments: (At least five experiments are to be performed)

1. Determine the co-efficient of linear expansion by optical lever method.
2. Determine the value of Stefanôs constant.
3. Determine the boiling point of a liquid with the help of a platinum resistance thermometer.
4. Determine the thermal conductivity of glass in the form of a tube.
5. Determine the melting point of a given substance (say, paraffin) with the help of a thermo-couple.

(Few more will be added by the Department)

Recommended Books:

1.Heat and Thermodynamics : An Intermediate Textbook by Mark Waldo Zemansky and Richard Dittman (McGraw-Hill 1981)

2.Thermodynamics, KineticTheory and Statistical Thermodynamics by Francis W. Sears and Gerhard L. Salinger (Narosa 1986)

3. A Treatise on Heat : Including Kinetic Theory of Gases, Thermodynamics and Recent Advances in Statistical Thermodynamics by Meghnad Saha and B. N. Srivastava (Indian Press 1958)

Paper: PHY204E
Electricity & Magnetism
Lectures-32

Electrostatics: Total Lecturers (L) = 14

1. Gauss's theorem and its applications to determine field due to linear, plane and spherical charge distribution, potential due to dipole, derivation of field due to a dipole, mutual potential energy of two dipoles.

2. Capacity of parallel plate capacitor, spherical and cylindrical capacitor, effect of dielectric on capacity of capacitor, mechanical force on charged conductor, energy stored in a charged capacitor.

3. Dielectrics, Electric polarisation of dielectrics, polarizability, Relation between D, E, & P, Gauss's law in dielectric. Electrostatic boundary conditions in dielectric medium.

Current Electricity: Total Lecturers (L) = 18

1. Electric current density, continuity equation, Ohmôs law as J = ůE, Applications of Kirchhoffôs law to solve electrical network problem.
2. Electric current as source of magnetic field, Equivalent magnetic dipole produced by a current flowing though a circular conductor, magnetic dipole moment, force and couples on dipole placed in a uniform magnetic field, magnetic shell, potential due to magnetic shell, magnetic intensity.

3. Moving coil ballistic galvanometer its sensitivity and uses.

4. Electromagnetic induction: Self and mutual induction, coefficient of coupling, reciprocity theorem, self induction of a long solenoid, mutual induction of two solenoids.

5. Transient growth and decay of current in LR, CR and LCR circuits.

6. Alternating current: Generation of alternating current, current and potential across resistive, inductive and capacitive elements and their phase relationships, power factor, LCR series circuit, concept of rotating magnetic field. A.c. motor, transformer, reflected impedance in transformer.

7. Classification-Dia, para and ferro magnetism, Atomic dipole moment, Langevinôs Classical theory of para magnetism, Induction and intensity of magnetization, magnetic susceptibility, permeability, hysteresis and hysteresis loss

Recommended Books:

1. Electricity and Magnetism - D.Chattopadhyay and P.C.Rakshit.
2. Electricity and Magnetism ï D.N. Vasudeva
3. Electricity and Magnetism - Berkeley Series
4. Electrostatics and Magnetostatics - B.B.Laud

List of Experiments: (At least five experiments to be performed)

1. To determine the specific resistance of the material of the given wire by Meter Bridge and then find the length of wire necessary to construct an one ohm coil
2. To determine the emf of a cell using a cell of known emf with the help of potentiometer
3. To determine the resistance per unit of the length of meter bridge wire by Carey-Foster method .
4. To convert a given galvanometer into a voltmeter of given range and then calibrate it with standard resistance and ammeter.
5. To determine the value of a low resistance by drop of potential method using meter bridge.
6. To determine the internal resistance of a cell with the help of a potentiometer.
7. To determine the electrochemical equivalent of copper by using an ammeter and copper voltameter.
8. To determine the horizontal component of earthôs magnetic field with the help of a tangent galvanometer and copper voltameter.
9. To determine the horizontal component of earthôs magnetic field using deflection and vibration magnetometer.

Semester -III

Paper Code	paper title	L+T+P	Credit
PHY301C	Classical Mechanics and STR	3+1+0	4
PHY302C	Electricity & Magnetism	2+1+1	4
PHY303C	Numerical Analysis & Computer Programming	2+1+1	4
PHY304E	Heat & Thermodynamics	2+0+1	3

Paper: PHY301C
Classical Mechanics and STR
Lectures-48

Classical Mechanics:

1. Central forces: general features of central forces, two-body problem, motion of a particle under

central force, equations of motion and first integrals, equivalent one-dimensional problem and classification of orbits, differential equation for the orbit, power-law Kepler problem: inverse square law of force. (8 Lectures)

2. Lagrangian formulation: constraints and their classifications, generalized co-ordinates, virtual work, principle of virtual work, D'Alembert's principle and Lagrangeôs equations, generalized momentum, cyclic co-ordinates, Lagrangian for non-conservative force. (7 Lectures)

3. Variational principles: Hamilton's principle, principle of least action, Jacobi's form of the least action principle, Lagrangeôs equations from Hamilton's principle. (6 Lectures)

4. Hamiltonian formulation : Legendre transformations and the Hamilton equations of motion, homogeneity of time and conservation of energy, homogeneity of space and conservation of linear momentum, isotropy of space and conservation of angular momentum. (5 Lectures)

Special Theory of Relativity:

1. Background: Space and time in Newtonian mechanics, inertial frames, the Galilean transformations, electromagnetism and Galilean transformations. Michelson-Morley experiment and its outcome. Attempts to preserve the concept of preferred ether frame, attempts of modify electrodynamics.

(4 Lectures)

2. The new concepts of space and time, postulates of special theory of relativity, the Lorentz transformations, consequences of the Lorentz transformations ï length contraction, relativity of simultaneity, time dilation, relativistic transformation of velocity, frequency and wave number, relativistic addition of velocities, relativistic optical Doppler effect. (8 Lectures)

3. Mechanics and relativity, the need to redefine momentum, rest mass, variation of mass with velocity, the relativistic force law and dynamics of a single particle, mass-energy equivalence and its experimental support. (5 Lectures)

4. Minkowski space-time continuum, space-time diagrams, simultaneity, contraction and dilation, Lorentz transformations as rotations in Minkowski space-time, light cone, space-like and time-like intervals, four vectors, energy-momentum four vector.

(5 Lectures)

Recommended books:

Classical Mechanics:

1. Classical Mechanics, by H. Goldstein (Addison-wesley/Narosa), Narosa Publishing House, New Delhi
2. Theoretical Mechanics (Schaum's outline series) by M R Spiegel, McGraw-Hill

International Book Company, Singapore
3. Introduction to classical mechanics, by David Morin, Cambridge Univ Press
4. Introduction to classical mechanics, by R G Takwale and P S Puranik, Tata McGraw Hill Publishing Company Ltd. New Delhi
5. Classical Mechanics by S N Biswas, Books and allied (P) Ltd, Calcutta

Special relativity:

1. Introduction to special relativity by R Resnick, Wiley Eastern Ltd, New Delhi
2. The special theory of relativity by David Bohm, Routledge, New York, USA
3. Perspectives of modern physics by A Beiser, McGraw Hill Book Company, New Delhi

Paper: PHY302C

Electricity and Magnetism

Lectures-32

Electric field and potential:

Electric field, Electric field due to a uniformly charged straight wire, ring and disc.

Divergence of Electric field, Gaussôs law in integral and differential form, Applications of Gaussôs law.

Curl of an electric field, Electric potential, electric potential due to a uniformly charged
(a) wire, (b) ring and (c) disc.

Electrostatic boundary conditions. Electrostatic energy of an assembly of point charges and uniformly charged sphere. Conductors, the surface charge on a conductor, the force on a surface charge.

Electric dipole, Potential and field due to a dipole, dipole in a uniform external electric field, dipole dipole interaction. Multipole expansion of electrostatic potential due to a volume distribution of charge.

Laplaceôs and Poissonôs equations, boundary conditions and Uniqueness theorem, Solutions of Laplaceôs equation in one and two dimensions.

Method of electrical image with examples of an infinite grounded conducting plane and a grounded conducting sphere.

(16 lectures)

Dielectric Properties of Matter:

Induced dipoles, atomic polarisability, polar and nonpolar molecules, polarization. The electric field of a polarized object, bound charges, The electric field inside a dielectric, Gaussôs law in the presence of dielectrics, Electric displacement, Relations between the three electric vectors. linear dielectrics,

susceptibility, permittivity and dielectric constant. Clausius-Mosotti Equation.

(4Lectures)

Magnetic Field:

Magnetic field, Lorentz force, Cyclotron motion, cycloid motion, magnetic force on a current carrying wire. Torque on a current loop in a magnetic field. Biot-Savart law, Magnetic field due to a steady current in a straight conductor and a circular coil. Current loop as a magnetic dipole and its dipole moment (analogy with electric dipole). Ampereôs circuital law (integral and differential forms): B due to a Solenoid and a Toroid.
Properties of B. Curl and Divergence of B. Vector Potential.

(8 lectures)

Magnetic Properties of Matter:

Gaussôs law of magnetism (Integral and Differential Forms). Magnetization current. Relative permeability of a material. Magnetic susceptibility. Magnetization vector (M). Magnetic intensity (H). Relation between B. M and H. Stored magnetic energy in matter. Magnetic circuit. B-H Curve and Energy Loss in Hystersis. (4 Lectures)

List of Experiments: (At least five experiments are to be performed)

1. Deflection and vibration magnetometers: determination of H.
2. Determination of susceptibility: Quinckeôs method.
3. Determination of dielectric constant.
4. To study Biot-Savart Law
5. To study magnetic field along the axis of a circular current loop
6. To study the dependency of magnetic field on coil diameter
7. Permeability and permittivity of air experiments.

Recommended Books:

1. Electricity and Magnetism By Edward M. Purcell (McGraw-Hill Education, 1986)

2. Fundamentals of Electricity and Magnetism By Arthur F. Kip (McGraw-Hill Education, 1968)

3. Electricity and Magnetism by J.H. Fe4wkes & John Yarwood. Vol. I (Oxford Univ. Press, 1991)

4. Electricity and Magnetism. By D Tayal (Himalaya Publishing House, 1988)

5. Introduction to Electrodynamics, David J. Griffiths, 3rd Edn, (Benjamin Cummings, 1998)

6. Electricity and Magnetism - D.Chattopadhyay and P.C.Rakshit

Paper: PHY303C

Numerical Analysis and Computer Programming

Lectures- 32

Numerical Analysis:

Truncation and Round-off errors. Floating point computations. Overflow and underflow, Single precession and double precession arithmetic. (2 Lectures)

Solution of Algebraic and Transcendental Equations:

Fixed point iteration method. Bisection method. Regula Falsi method, Newton-Raphson method. Comparison of different methods and error estimation. (4 Lectures)

Matrices and Linear System of Equations:

Solutions of Linear equations: (1) Gauss elimination method (2) Gauss Seidel iterative method.

(3 Lectures)

Curve Fitting:

Curve fitting by least Square methods: Fitting a straight line . Non-linear Curve Fitting:
(1) power function (2) polynomial of nth degree. (3) exponential function.

(4 Lectures)

Interpolation and Polynomial Approximation:

Introduction to interpolation, Lagrange approximation, Newton approximation, Padv approximations.

(5 Lectures)

Numerical Integration:

General quadrature formula. Composite Trapezoidal rule. Composite Simpsonôs 1/3 rule and 3/8 rule.

Gauss quadrature formula. Gauss Legendre Formulae. (8 Lectures)

Solution of Ordinary Differential Equations (ODE'S):

First order ODE: Eulerôs method, Modified Eulerôs method, Runge-Kutta method of 4th order, error estimation

2nd order ODE: Finite difference method (6 Lectures)

Recommended Books:

1. Numerical Methods for Mathematics, Science and Engineering by John H Mathews (Second Edition) Prentice-Hall India 2003
2. An Introduction to Numerical Analysis by K. E. Atkinson (Second Edition) Willy, 1988
3. Numerical Methods for Scientists and Engineers by K. Sankar Rao (Second Edition) Prentice-Hall India 2009

Computer Programming (Practical):

Basic fortran programming.

1. To find the root of an equation f(x)=0 using
   Bisection Method (given an initial interval (a, b)) Newton-Raphson method
   (given an initial approximation P0)
2. To find the value of a given integration using

   (a) Trapezoidal rule
   (b) Simpsonôs 1/3 rule
   (c) Simpsonôs 3/8 rule

3. To construct

   (a) the least square straight line that fits the given data points.

   (b) the least square polynomial of degree M that fits the given data points

4. To solve a given differential equation using Runge-kutta^4 method / finite difference method

Paper: PHY304E
Heat and Thermodynamics
Lectures-32

Heat: Total Lectures (L) = 16

1. Platinum resistance thermometer and thermocouple thermometer.
2. Kinetic theory of gases, expression of Maxwell's law of velocity distribution, RMS and most probable speed, degree of freedom, law of equipartition of energy, mean free path, Brownian motion.
3. Andrew's and Amagat's experiment, equation of state, Van-der-Waals' equation of state,

reduced equation of state, critical constants.

4. Joule-Thomson effect, liquefaction of gases by Joule-Thomson effect.

5. Radiation: Kirchhoffôs law and its applications, relation between radiation pressure and energy density, Black body radiation, expressions of Stefan- Boltzmann law, Wien's displacement law, Rayleigh-Jean's law and Planck's law of black body radiation.

Thermodynamics: Total Lectures (L) = 16

1. Zeroth law of themodynamics and concept of temperature.

2. Heat and work and their equivalence, First law of thermodynamics and concept of internal energy, its Applications.
3. Inadequacy of first law of thermodynamics, Second law of thermodynamics, reversible and irreversible processes, isothermal and adiabatic processes, work done by perfect gas under isothermal and adiabatic expansion, Carnot engine and Carnot cycle, Thermodynamic scale of temperature.

4. Entropy, change of entropy in reversible and irreversible processes, Clausius inequality relation.

5. Maxwell's thermodynamic relations and their applications.

Suggested Books:

1. Heat and Thermodynamics ï W Zemansky and R Dittman (McGraw-Hill,1981)
2. A treatise on Heat - Saha and Srivastava
3. Thermal Physics ï Garg, Bansal and Ghosh (Tata McGraw-Hill 1993)

List of Experiments: (At least five experiments to be performed)

1. To determine the coefficient of linear expansion of a rod by optical lever method.
2. To determine the value of `Jô the mechanical equivalent of heat by Jouleôs calorimeter.
3. To determine the thermal conductivity of the material of an Indian Rubber Pipe.
4. To study the variation of resistance of a thermistor with temperature and then to measure an unknown temperature of a liquid with it.
5. Determination of thermal conductivity of a metal bar by Searlies thermal conductivity apparatus.
6. Determination of Planck's constant by spectrometer and photovoltaic cell.
7. Determination of Stefan's constant.

Semester -IV

Paper Code	paper title	L+T+P	Credit
PHY401C	Quantum Mechanics	3+1+0	4
PHY402C	Atomic & Molecular Physics	2+1+1	4
PHY403C	Current Electricity & Electronics-I	2+1+1	4
PHY404E	Optics & STR	2+0+1	3

Paper: PHY401C

Quantum Mechanics

Lectures - 48

Particles and waves:

Development of quantum mechanics: black body radiation, failure of classical idea, Planck's quantum hypothesis, photoelectric effect, Compton effect, Franck-hertz experiment.

Wave nature of matter: de Broglie's hypothesis, wave particle duality, Davisson Germer's experiment.

Wave description of particles by wave packets, group and phase velocities and relation between them.

Complementary principle of Neils Bohr, Heisenberg's uncertainty principle, derivation from wave packets, gamma ray microscope experiment, application of Uncertainty principle.

(12 Lectures)

Quantum Mechanics:

Basic postulates and Formalism: Energy, Momentum and Hamiltonian operators. Schroedinger's wave equation: time dependent and time independent ones. Wave equation and its probabilistic interpretation as probability amplitude; continuity equation, probability density and probability current density J; normalization condition and normalized wave function; properties of well-behaved wave function in quantum mechancics. Linearity and superposition principle. Eigenvalues and Eigenfunctions. Expectation value, Ehrenfest's theorem. Wave function for a free particle.

(11 Lectures)

Applications of Schroedinger's wave equation:

Scattering problems in one dimension: one dimensional finite step potential, reflection and transmission co-efficients; one-dimensional potential barrier and tunneling effect.

(10 Lectures)

Bound state problems: General features of a bound system

1. A particle in a one-dimensional potential well of infinite depth; 2. one-dimensional simple harmonic oscillator, energy levels and wave function, zero point energy; 3. quantum theory of hydrogen atom: particle in a spherically symmetric potential, Schroedinger equation, separation of variables, radial solutions and principal quantum number, orbital and magnetic quantum numbers, quantization of energy and angular momentum, space quantization, electron probability density, radiative transitions, selection rules.

(15 Lectures)

Recommended books:

1. Introduction to quantum mechanics, by Griffiths D.J.
2. Perspectives of modern physics, by Beiser A.
3. Quantum mechanics, by Schiff L.
4. Quantum mechanics, by Mathews and Venkatesan

References

1. Theory and problems of quantum mechancis ï Schaum Series
2. Introduction to quantum theory, by Park D

Paper: PHY402C
Atomic and Molecular Physics
Lectures-32

Atomic Physics:

Determination of e/m of the electron. Thermionic emission. Isotopes and Isobars.

(2 Lectures)

X-rays:- Ionizing Power, x-ray Diffraction, Braggôs Law. Bohr Atomic model, Critical Potentials, X-ray Spectra: Continuous and Characteristic X-rays, Moseleyôs Law.

(4 Lectures)

Atoms in Electric and Magnetic Fields:- Electron Angular momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmorôs Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.

(5 Lectures)

Atoms in External Magnetic Fields:- Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Description only).

(2 Lectures)

Many Electron Atoms:- Pauliôs Exclusion Principle, explanation of Period Classification of elements. Fine Structure. Spin orbit coupling. Spectral Notations for Atomic States. Total Angular Momentum. Vector Model. L-S and J-J couplings. Hundôs Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc).

(6 Lectures)

Molecular Spectra:

Rotational Energy Levels, Selection Rules and Pure Rotational Spectra of a Molecule. Vibrational Energy Levels, Selection Rules and Vibration Spectra. Rotation-Vibration Energy Levels, Selection Rules and Rotation-Vibration Spectra. Determination of Internuclear Distance.

(5 Lectures)

Raman Effect:- Quantum Theory of Raman Effect. Characteristics of Raman Lines. Stokeôs and Anti-Stokeôs Lines. Complimentary Character of Raman and Infrared Spectra.

(4 Lectures)

Lasers:- Einsteinôs A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Optical Amplification. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser.

(4 Lectures)

List of Experiments: (At least five experiments are to be performed)

1. Franck-Hertz experimental verification to prove the existence of atomic energy levels.
2. Determine the specific charge e/m of an electron using a magnetron method.
3. ESR : determination of Lande's g factor.
4. Study the emission spectrum of hydrogen and to determine Rydberg constant using plane transmission grating.

5. Millikan oil drop experiment for measurement of charge of an electron.

6. Draw the plateau of GM tube using a radioactive source and hence calculate the operating voltage of the GM tube.

7. Experimental determination of the Boltzmann constant using optical spectroscopy. Also to determine the magnitude and the uncertainty of K.

Recommended Books:

1. Concepts of Modern Physics by Arthur Beiser (McGraw-Mill Book Company, 1987)
2. Atomic Physics by J. B. Rajam and foreword by Louis De Broglie (S. Chand & Co., 2007)
3. Atomic Physics by J. H. Fewkes & John Yarwood. Vol. II (Oxford Univ. Press, 1991)
4. Physics of Atoms and Molecules, Bransden and Joachein.
5. Molecular Spectroscopy, Banwell.
6. Optoelectronics by Ghatak and Thyagrajan.
7. Principles of Lasers by Svelto.
8. Lasers and Non-Linear Optics by B. B. Laud, Wiley Eastern Ltd.

Paper: PHY403C
Current Electricity & Electronics-I
Lectures-32

Current Electricity:

Application of Kirchhoffôs laws to solve electrical network problem. moving coil ballistic galvanometer. electromagnetic induction: self and mutual induction, co-efficient of coupling. Transient growth and decay of current in LR, CR and LCR circuits, oscillatory discharge. Thermo-electricity: co-efficients of thermo-emf, thermo electric power. (6 Lectures)

Alternating current : generation of alternating current, phasor (complex number method) of analysing ac circuits, LR, CR and LCR (series & parallel) circuits, quality factor. Rotating magnetic field, AC motor, transformers, reflected impedance in transformer.

(8 lectures)

Electronics I:

Network theorem: Thevenin's theorem, Nortonôs theorem, maximum power transfer theorem. Wheatstone bridge and its application to Wein bridge and Andersion bridge.

(3 Lectures)

Two-terminal device and their application :- (1) Rectifier diode, half-wave rectifiers, centre-tapped and

bridge full-wave rectifiers, calculation of ripple factor and rectification efficiency. qualitative idea of filters. (2) Zener diode and voltage regulation. (3) Photo diode, (4) Tunnel diode, (5) LED (6) Varactor diode.

(4 Lectures)

Bipolar junction transistor:- n- p-n and p- n- p Transistors, Characteristics of CB, CE, CC configurations. Current gains alpha (Ŭ), beta (ϐ) and relations between them. Load line analysis of transistors. DC load line and Q-point.

(3 Lecture)

Amplifiers:- Transistor biasing and stabilization circuits. Fixed bias and voltage divider bias. Transistor as 2-port network. h-parameter equivalent circuit. Coupled amplifiers :- RC- coupled amplifier and its frequency response of voltage gain.

(2 Lectures)

Feedback in amplifiers, effects of positive and negative feedback on input impedance, output impedance and gain, stability, distortion and noise, basic idea of oscillators.

(2Lectures)

Three- terminal devices (UJT and FETs): (1) UJT: Its characteristics and equivalent circuit.

(2 Lectures)

Modulation and Demodulation: Types of modulation. Amplitude modulation. Modulation index. Analysis of amplitude modulated wave. Side band frequencies in AM wave.

(2 Lectures)

List of Experiments: (At least five experiments are to be performed)

Current electricity:

1. To study the variation of potential drops with frequency across inductor, capacitor and resistor of a series LCR circuit for an ac signal and hence find the resonant frequency. Compare it with theoretical value.
2. To determine the value of self induction of a coil with the help of Andersonôs bridge.
3. To draw the characteristics of a photo-cell and find the maximum velocity of the emitted electrons.

Electronics I

1. To draw the characteristics curve of a semiconductor diode and hence determine the DC and AC resistance for a given current when the diode is forward biased. (Using Breadboard).
2. To draw the characteristics curve of a Zener diode and determine its DC and AC resistance for a given current. Also determine the breakdown voltage of the Zener diode. (Using Breadboard).
3. To draw the output characteristics curves of a transistor in CB or CE mode and find its sort

circuit current gain. (Using Breadboard).

4. Draw the frequency response of RC- Coupled Amplifier and find its bandwidth
5. OPAMP-Addition, Subtraction
6. OPAMP-Differentiation, Integration.

Recommended Books:

1. Electricity and magnetism ï Berkeley series
2. Electricity and magnetism- D Chattopadhyay and P C Rakshit
3. A textbook of Electronics by Santanu chattopadhy, NCBA.
4. Electronics Theory and Applications by Dr. S.L. Kakani and K.C. Bhandari, New Age.
5. Electronic Principles by A.P. Malvino, Tata McGrawHill.
6. Robert Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 8th Edition, Pearson Education, India, 2004.
7. A. P. Malvino, Electronic Principals, Glencoe,1993.
8. John Morris, Analog Electronics.
9. Allen Mottershead, Electronic Circuits and Devices, PHI, 1997.
10. Solid State Electronic Devices by Ben G. Streetman & Sanjay Banerjee, Pearson Prentice Hall, 2006.
11. Basic Electronics & Linear Circuits by N.N. Bhargava, D. C. Kulshreshtha & SC Gupta, Tata McGrawHill, 2006.

Paper: PHY404E
Optics & STR
Lectures-32

Optics:

1. Fermat's principle: application to reflection and refraction at plane, dispersion produced by lens, spherical and chromatic aberration and their remedies, achromatic combination of lenses, Ramsdenôs and Huygenôs eye piece, aplanatic foci.

(6 lectures)

2. Huygen's wave theory: Formula for refraction at a spherical surface, formula for thin convex and concave lenses.

(3 lectures)

3. Interference of light: Fresnel biprism, colour of thin films, Newton's ring phenomenon.

(3 lectures)

4. Diffraction of light: Fresnel and Fraunhofer classes of diffraction, diffraction at a straight edge and single slit.

(4 lectures)

5. Polarisation of light: plane polarised light, polarisation on reflection, Brewster's law, double refraction, Nicol prism, rotation of plane of polarization by optically active substances, specific rotation, polarimeter. production of polarised light, retarded plate.

(8 lectures)

6. Introductory idea of Laser and its characteristics, spontaneous and stimulated emission, population inversion, basic elements of laser, Ruby laser.

(2 lectures)

Special Theory of Relativity (STR):

1. Galilean transformations, Michelsonï Morley experiment, postulates of special theory of relativity, Lorentz transformation equations (derivation not necessary), time dilation, length contraction, mass variation, mass energy relation, velocity addition theorem.

(6 lectures)

Recommended Books:

1. Text book of Light ï K.G. Mazumdar
2. A Text book of Light - B Gosh and K G Mazumdar.
3. Optics ï A. Ghatak (McGraw-Hill,2008)
4. Fundamentals of Optics ï Jenkins and White (McGraw-Hill, 1976)
5. Introduction to Optics ï Khanna and Gulati
6. Concept of Modern Physics ï A. Beiser

List of Experiments: (At least five experiments to be performed)

1. To determine the focal length of a convex mirror with the help of a convex lens.
2. To determine the refractive index of a liquid by using plane mirror and convex lens.
3. To determine the focal length of two lenses and their combination by displacement method.
4. To adjust and focus the given spectrometer using Schusterôs method and then determine the refractive index of the material of the prism.
5. To draw I-D curve for the given prism with the help of a spectrometer and hence find the angle of minimum deviation.
6. To determine the wavelength of sodium light by Newtonôs ring.

Semester -V

Paper Code	paper title	L+T+P	Credit
PHY501C	Mathematical Physics-III	3+1+0	4
PHY502C	Electromagnetic Theory	2+1+1	4
PHY503C	Digital Electronics	2+1+1	4
PHY504E	Atomic, Nuclear & Quantum Mechanics	2+0+1	3

Paper:PHY501C
Mathematical Physics -III
Lectures-48

Complex Variables:

Importance of complex numbers and their graphical representation. De-Moivreôs Theorem. Roots of complex numbers. Eulerôs formula. Functions of complex variables. Examples.

(2 lectures)

Cauchy-Riemann conditions. Analytic Functions. Singularities. Differention and Integral formula. Moreraôs Theorem. Cauchyôs Inequality. Liouvilleôs Theorem. Fundamental

Theorem of algebra. Multiple valued functions. Simple ideas of branch points and Reimann surfaces.

(10 Lectures)

Power Series of a complex variable. Taylor and Laurent series.

(2 lectures)

Residues and residue Theorem. Contour Integration and its applications to evaluation of integrals.

(8 lectures)

Intergral Transforms and Some Special Integrals:

Beta and Gamma Functions and the relation between them. Integral form of Gamma functions. Dirac delta function, definition, representation, properties, Fourier and Laplace transforms.

(11 lectures)

Tensors:

Transformation of Co-ordinates. Contravariant and Covariant vectors. Contravariant, Covariant and Mixed Tensors. Kronecker delta and Permutation Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-Symmetric Tensors. Metric Tensor. Reciprocal Tensors. Associated Tensors. Christoffel Symbol of the First and Second Kind and their Transformation Laws. Covariant Derivative. Tensor Form of Gradient, Divergence and Curl. (15 lectures)

Recommended books:

1.Schaumôs Outline of Complex Variables by Murray R. Spiegel (McGraw-Hill, 1999)
2. Complex Variables: Introduction and Applications, 2ed by Mark J. Ablowitz, A.S.Fokas (Cambridge University Press, 2000)
3. Matrices and Tensors in Physics by A.W.Joshi. (New Age Int. Pub. 1995)

Paper: PHY502C

Electromagnetic Theory

Lectures-32

Maxwell equations: Displacement current. Vector and Scalar potentials, Gauge transformations. Lorentz and Coulomb Gauge. Boundary conditions at interface between different media. Wave equations. Plane wave in dielectric media. Poynting theorem and Poynting vector. Physical concept of EM field energy density. Momentum density. Angular momentum density.

(8 Lectures)

Reflection and Refraction of EM waves:

Reflection and Refraction of a plane wave at a plane interface between two dielectrics. Fresnelôs formulae. Total internal reflection. Brewsterôs angle. waves in conducting media. Metallic reflection, Skin depth.

(6 Lectures)

Polarization of EM waves:

Description of linear,circular and elliptical polarization. Propagation of EM waves in Anisotropic media. Symmetric nature of dielectric Tensor. Fresnelôs formulae. Uniaxial and Biaxial crystal. Light propagation in Uniaxial crystal. Double refraction. Polarization by double refraction. Nicol Prism.

Ordinary and extra ordinary refractive indices. Production and 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.

(8 Lectures)

Rotatory polarization, Optical rotation. Biotôs law of rotatory polarization. Fresnelôs theory of optical rotation. calculation of Angle of rotation. experimental verification of Fresnelôs theory. Specific rotation, Laurent Half shade polarimeter.

(4 Lectures)

Wave guides:

Planer optical wave guides, Planer dielectric waveguide, Condition of Continuity at interface, Phase shift on total reflection, Eigen value equations, Phase and group velocity of guided waves. Field energy and power transmission.

(4 Lectures)

Optical Fibers:

Numerical Aperture. Step index and graded index fiber, Single and Multimode fibers (concept and Definitions only)

(2 Lectures)

Recommended Books:

1. Introduction to Electrodynamics by D. J. Griffith, (3^{rd} Edition) Pearson 2003
2. Electromagnetics by B B Laud (2^{nd} Edition) New Age Publishers 1987

List of Experiments: (At least five experiments are to be performed)

1. To find the refractive index of a transparent bar using diode laser.
2. Determination of the wavelength of a diode laser using a diffraction grating.
3. To find the refractive index of a transparent material by measuring Brewster Angle.
4. To determine the Numerical Aperture of a given optical fibre from the measurement on the far field of fibre and Acceptance Angle.
5. To calibrate a polarimeter and hence to determine the Specific Rotation of sugar solution.
6. To study variation of light intensity from a polarizer and analyzer. (by Photo-resistor) combination.
7. To determine absorption and transmission coefficients of various optical filters. (by photo-resistor)

Paper: PHY503C
Digital Electronics
Lectures - 32

Introduction to CRO:

Block Diagram of CRO, Electron Gun, Deflection System and Time Base, Deflection Sensitivity, Application of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency and Phase Difference.

(2 lectures)

Analog Circuits :

Operational Amplifiers (Use Black Box Approach): Basic Characteristics of Op-Amps, Characteristics of an Ideal Op-Amp, Feedback in Amplifiers, Open ï loop and Closed-loop Gain, Frequency Response, CMRR, Virtual ground. Application of Op-Amps; (1) Inverting and Non-inverting Amplifiers,(2) Adder, (3) Subtractor, (4) Unity Follower, (5) Differentiator,(6) Integrator,(7) Zero Crossing Detector.

(6 lectures)

Digital Circuits :

Difference Between Analog and Digital Circuits, Binary Numbers, Decimal to Binary and binary to Decimal Conversion, Octal number, Hexadecimal, AND, OR and NOT Gates (Realization using Diodes and Transistors), NAND and NOR Gates and applications, Exclusive OR and Exclusive NOR Gates.

(3 lectures)

Boolean algebra :

De Morganôs Theorems, Boolean Laws, Simplification of Logic Circuit using Boolean algebra, Fundamental Products, Minterms and Maxterms, Conversion of a Truth Table in to an equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

(4 Lectures)

Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders, Parity Checkers

(3 lectures)

Arithmetic Circuits:- Binary Addition, Binary Subtraction using 2ôs Compliment Method, Half Adders and Full Adders and Subtractors (only up to eight Bits).

(2 lectures)

Sequential Circuits:- RS, D , and JK Flip-Flops, Level Clocked and Edge Triggered Flip-Flops, Preset and Clear Operations, Race around Conditions in JK Flip-Flop, Master-slave JK Flip-Flop (As Building Block of Sequential Circuits.

(5 lectures)

Shift Registers:- Serial-in-Serial-out, serial-in-parallel-out, Parallel-in-serial-out, and Parallel-in-parallel-out Shift Registers (only up to 4 bits).

(2 lectures)

Counters:Asynchronous and Synchronous Counters, Ring Counters, Decade Counters. (3 lectures)

D/A and A/D Conversion: D/A Converter- Resistive Network, Accuracy and Resolution. (2 lectures)

List of Experiments: (At least five experiments are to be performed)

1. Realisation of OR, AND, NOT, NOR, XOR (using Diodes and Transistors and Breadboard)
2. Realization of basic gates using NAND/NOR-gates.
3. Realization of De Morganôs Theorem using logic gates.
4. Multivibrator.
5. Combinational Logic Gate: Multiplexer
   (Few more will be added by the Department)

Recommended Books:

1. Digital principle and applications by Donald P. Leach & Albert Paul Malvino (Glencoe, 1995).
2. Digital Fundamentals, 3rd edition by Thomas L. Floyd (Universal Book Stall, India, 1998).
3. Digital Electronics by R. P. Jain.
4. Operational Amplifiers and Linear Integrated Circuits, 4th Edition by Robert F Coughlin and Frederick F Driscoll (P.H.I. 1992).
5. Op-Amps and Linear Integrated Circuits by R. A/ Gayakwad (Pearson Education Asia, 2000).

Paper: PHY504E
Atomic, Nuclear Physics & Quantum Mechanics
Lectures-32

Atomic Physics:

Positive rays: analysis of positive rays, Aston and Bainbridge mass spectrographs.

Bohr's theory of hydrogen spectra, energy level diagram, Ritz combination principle, excitation, critical and ionization potentials, fine structures of the spectral lines, Sommerfeld's extension of the Bohr's theory(Qualitative only).

Vector atom model, Bohr magnetron, spinning electron; quantum numbers; Pauli's exclusion principle, source of radiation in external fields- normal Zeeman effect.

X-rays: origin and production of x-rays, continuous and characteristic X-rays, Moseley's law; diffraction of X-rays by crystals, Bragg's law, Compton Effect.

Frank and Hertz experiment, matter wave, Davisson and Germer experiment.

(14 lectures)

Nuclear Physics:

Concept of a Nucleus ï its composition, mass, volume, density and temperature, units and dimension.

Mass defect and packing fraction, total binding energy, binding energy per nucleon, binding energy curve & its significance, nucleon separation energy, nuclear reactions, Q-value of a reaction, exothermic & endothermic reactions.

Type of radioactive decays, radioactive decay law, concept of half life and disintegration constant, natural radioactivity, radioactive dating, Activity of radioactive sources, its unit. Radioisotopes ï their production & uses.

Need of a particle accelerator, Linear Accelerator ï its construction & working principle. Need of nuclear Detectors. Ionization Chamber ï its construction & working principle.

Primary and secondary cosmic rays and their composition, EAS.

(12 lectures)

Quantum mechanics:

Development of quantum mechanics: Black body radiation, failure of classical idea, Plank's quantum hypothesis, photoelectric effect, Compton effect. Franck-Hertz experiment. Wave Nature of matter: de Broglie Hypothesis, Wave particle duality, Heisenberg's Uncertainty. Introduction to Schrodinger's equation.

(6 Lectures)

Recommended Books:

1. Atomic & Nuclear Physics - A. B. Gupta & D. Ghosh
2. Perspectives of Modern Physics ï A. Beiser

List of Experiments: (At least five experiments are to be performed)

1. To draw the characteristic curve of a photo cell and find the maximum velocity of emitted electron
2. To determine the value of Planckôs constant with the help of photo cell and monochromatic filter.
3. To study the use of GM counter with a beta emitter.
4. To study the detection of the cosmic ray on the earth surface using G.M. counter.
5. To determine the wavelength of Balmer series in the visible region from Hydrogen spectrum.
6. To determine the Rydberg constant.

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Semester -VI

Paper Code	paper title	L+T+P	Credit
PHY601C	Radiation Theory & Statistical Mechanics	3+1+0	4
PHY602C	Condensed Matter Physics	2+1+1	4
PHY603C	Nuclear & Particle Physics	2.5+.5+1	4
PHY604E	Electronics, EM Waves & Condensed Matter Physics	2+0+1	3

Paper: PHY601C
Radiation Theory & Statistical Mechanics
Lectures-48

A. Theory of radiation
Properties of radiant energy, emissive and absorptive power of a body, Kirchhoffôs law, radiation pressure, the Stefan-Boltzmann law, black body radiation and its spectral distribution, Rayleigh-Jeanôs law and Wienôs distribution law, Ultraviolet catastrophe, Wienôs displacement law, Planckôs Quantum postulates and Planckôs law of blackbody radiation, Deduction of Wienôs distribution law, Wienôs displacement law, Rayleigh-Jeanôs law and Stefan-Boltzmann Law from Planckôs law. (18 lectures)

B. Statistical mechanics
Macroscopic and microscopic states, phase space, distribution function in phase space, Liouville theorem, condition for statistical equilibrium, introductory idea of ensemble, ensemble average, ergodic hypothesis, contact between thermodynamics and statistics ï Boltzmann relation, the postulate of equal

a priori probability, application of classical statistical mechanics to an isolated system of a classical ideal gas, Gibbôs paradox, law of equipartition of energy. (15 lectures)

Probability of a distribution, most probable distribution, Maxwell- Boltzmann (MB) statistics : MB distribution law of speeds, momenta and energies and simple applications. Inadequacy of classical statistical mechanics. (5 lectures)

Bose-Einstein (BE) Statistics: BE distribution law, deduction of Planckôs radiation formula, specific heats of solids ï Debye theory, qualitative idea of Bose Einstein condensation. (6 lectures)

Fermi-Dirac (FD) statistics: FD distribution law, Fermi energy, electron gas in metals, specific heat of metals. Comparison of MB, BE and FD statistics. (4lectures)

Recommended Books:

1. Statistical Mechanics B. K. Agarwal and M. Eisner
2. Statistical Mechanics R.K. Pathria,
3. Perspectives of Physics by A. Beiser

Paper: PHY602C

Condensed Matter Physics

Lectures-32

Crystal Structure :

Amorphous and Crystalline Solids, Lattice translation vectors, Symmetry elements: rotation axis, reflection plane, inversion centre, Screw axis. Unit cell, types of crystal lattice, Miller indices. Diffraction of X-rays by crystals, Braggôs Law, Reciprocal Lattice. Types of bonds: Ionic Bond and Van der Waals Bond.

(6 Lectures)

Elementary Lattice Dynamics :

Lattice Vibrations and Phonons:- Linear Monoatomic and Diatomic chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Soilds. Phase velocity and group velocity of harmonic waves.

(6 Lectures)

Magnetic Properties of Matter :

Dia-, Para-, Ferri-and Ferromagnetic Materials. Classical Langevin Theory of dia-and Paramagnetic Domains. Quatum Mechanical Treatment of Paramagnetic. Curieôs law, Weissôs Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

(6 Lectures)

Electrical Properties of Materials :

Free electron theory of metals, electronic specific heat, electrical and thermal conductivity of metals, Wiedemann-Franz law. Elementary Band Theory of solids. Bloch Theorem, Kronig-Penney Model, Crystal momentum and Effective mass, Concept of holes, Energy band diagram and classification of solids: Conductors, insulators, and semiconductors. Intrinsic and extrinsic semiconductors, p-and n-type Semiconductors, conductivity in semiconductors.

(8 Lectures)

Superconductivity :

Experimental results. Critical temperature, critical magnetic field. Meissner effect. Type I and type II Superconductors, Isotope effect. Idea of BCS theory (No derivation), Cooper Pair and Coherence length. Josephson Effect. Cryoelectronics: Concept of low temperature electronics.

(6 Lectures)

List of Experiments: (At least five experiments are to be performed)

1. Study of lattice dynamics
2. Determination of energy gap in a semiconductor by four probe method.
3. B-H curve experiment
4. Study of permeability curve.
5. Study of diode characteristics
6. Measurement of the magnetic susceptibility of a paramagnetic solids by Gouy's method/ Quincke's method.
7. Hall Effect (With Hall Effect SK006 apparatus INDOSAW, six experiments can be done on Hall Effect).
8. To measure the transition temperature of a high temperature superconductor.

Recommended Books:

1. Charles Kittel, Introduction to Solid State Physics, 7^{th} Edition, John Wiley and Sons, Inc.
2. A J Dekkar, Solid State Physics, Macmillan India Limited, 2000
3. J. S. Blackmore, Solid State Physics, Cambridge University Press, Cambridge.
4. N.W. Ascroft and N.D. Mermin, Solid State Physics, (Harcourt Asia, Singapore, 2003)
5. M. Ali Omar, Elementary solid state physics: principles and applications, (Pearson Education, 1999)
6. Solid State Physics by S. O. Pillai

Paper: PHY603C
Nuclear and Particle Physics
Lectures-40

Structure of the nuclei:

Basic properties of nuclei: (1) Mass (2) Radii (3) Charge (4) Angular momentum (5) Spin and parity (6) Magnetic moment (ε) (7) stability (8) Binding energy Radioactivity: Law of radioactive decay, Half-life. Theory of successive radioactive transformation, Ŭ-decay: Range of Ŭ particles, Geiger-Nuttal law and Ŭ-particle spectra, Gamow theory of alpha decay , Energy spectra of ɓ-decay and neutrino hypothesis Origin of gamma-rays, Nuclear isomerism and internal conversion.

(8 Lectures)

Nuclear Reactions:

Types of reactions and conservation laws, Concepts of compound and direct reactions. Compound nucleus. Scattering Problem in one dimension: Reflection and transmission by a finite potential step. Stationary solutions. Scattering cross-section, Q-value of nuclear reaction, Fission and Fusion,

(8 Lectures)

Nuclear Models:
Liquid drop model, Mass formula and its applications, Shell model . Properties of nuclear forces, Meson theory of nuclear forces and discovery of pion.

(5 Lectures)

Accelerators:
Linear accelerator, Cyclotron, Idea of colliding beam accelerators

(3 Lectures)

Detectors of Nuclear Radiations:
Interaction of energetic particles with matter, Ionisation chamber, GM counter, Scintillation detectors, Semi conductor detectors (qualitative discussion only), Solid state nuclear track detectors , An idea of detectors used in Large Hadron Collider

(3 Lectures)

Cosmic rays: Nature and properties

(1 Lectures)

Elementary Particles (Qualitative discussion only):

Fundamental interactions, Classification of elementary particles and their properties, Elementary Particle Quantum numbers: Baryon number, Lepton number, Strangeness, Electric Charge, Isospin and Hypercharge. Coservation laws and symmetry, The Eightfold way of classification of elementary particles, Supermultiplets of baryons and mesons, basic idea of SU(3) group. Gellman and Zweig's quark model, Quark contents of mesons and baryons, Idea of colour degree of freedom and gluon, Idea of the intermediate vector bosons, Basic idea of Standard Model, Higgs boson.

(12 Lectures)

List of Experiments: (At least five experiments are to be performed)

1. To study the variations of count rate with applied voltage and there by determine the plateau and operating voltage of a GM Tube.
2. Estimation of radioactive radon in air and soil using nuclear track detectors.
3. To study the intensity of γ-rays emitted from a radioactive source and to show that the intensity varies inversely as the square of the distance from the source using a GM Tube.
4. Franck-Hertz apparatus related experiments. (SK090, and SK087 INDOSAW)

   (Few more will be added by the Department)

Recommended Books:

1. Nuclear Physics by S. N. Ghosal (S. Chand & Company Ltd, New Delhi)
2. Introductory Nuclear Physics by Kenneth S. Krane (John Wiley & Sons)
3. Concepts of Modern Physics by Arthur Beiser (Mcgraw Hill Book Company, 1987)
4. Concepts of Nuclear Physics by Bernard L. Cohen (New Delhi: Tata Mcgraw Hill, 1998).
5. Nuclear Physics by Irving Kaplan (Oxford & IBH, 1962)
6. Introduction to High Energy Physics by D. H. Perkins.
7. Elementary Particles by I. S. Hughes.

Paper: PHY604E
Electronics, EM Waves & Condensed Matter Physics
Lectures-32

Electronics:

Semiconductors, P-N junction diode, unbiased and biased P-N junction, depletion layer, barrier potential, junction capacitance, volt-ampere relations (derivation not necessary), photo diode, Zener diode, LED and their uses. OR, AND, NOT, NOR and NAND Gates using diode and transistor.

Rectifier: half wave and full-wave, efficiency of rectification, ripple factor, idea of filter circuit.

Thevenin's and Norton's theorems, maximum power transfer theorem.

Transistor, different configurations and characteristics of transistor, alpha and beta of a transistor, transistor as amplifier.

Biasing and Q-point of a transistor, stability factors, biasing circuits.

Classification of amplifiers: class A, B, C, voltage and power amplifiers.

Two port four terminal device and z, y and h-parameters. Use of h-parameters to find input and output resistances, current, voltage and power gain of a small signal transistor amplifier.

Feedback and Barkhausen criterion for sustained oscillations, Tuned collector oscillator.

(18 Lectures)

Electromagnetic waves:

Electromagnetic wave spectrum, graphical representation of electromagnetic wave.

Maxwell's equations, wave equation in free space from Maxwell's equations, velocity of electromagnetic waves in free space, Pointing vector.

(6 Lectures)

Solid State Physics :

Crystalline and amorphous state of substances, single crystal and polycrystalline substances, basis, crystal lattice, unit cell, primitive unit cell, translation vectors, lattice parameters, directions, lattice planes, Miller indices, inter-planar spacing.

Crystallographic axes, Crystal systems and Bravais lattice.

Different types of bonding in solids, ionic, covalent, metallic and hydrogen bonding.

Classical free electron theory of metals.

(8 Lectures)

Suggested Books:

1. A Text Book of Electronics ï S.L. Kakani & K.C. Bhandari
2. Electromagnetic Theory Ritz and Milford
3. Solid State Physics by A J Dekker
4. Solid State Physics by S O Pillai

List of Experiments: (At least five experiments are to be performed)

1. To draw the characteristics of a given transistor with CB and CE configurations and determine the alpha and beta of the transistor
2. To study the ripple factor of a half-wave and full-wave rectifier using semiconductor diode and L and ł section filter.(Using Breadboard).
3. To assemble OR, AND and NOT gates using diode and transistor and verify their truth tables.
4. To draw the characteristics of- (i) a forward biased PN diode and (ii) reverse biased
5. Zener diode and hence determine the ac resistance of the PN diode and breakdown voltage of the Zener diode.
6. To trace the output wave form of a free running multivibrator for three different frequencies using CRO and hence measure the width of the output pulses and compare them with theoretical values. (Using Breadboard).