PHYSICS HONOURS (Full Marks : 800)

1st Semester	Total Marks: 100 (Th: 100)	Paper I: Unit-I : Mathematical Methods – I Unit-II: Classical Mechanics – I Paper II: Unit-I : Waves and optics – I Unit-II: Electronics – I	25 Marks Do Do Do
2nd Semester	Total Marks: 100 (Th: 75, Pr: 25)	Paper III: Unit-I: Thermal & Statistical Physics–I Unit-II: Thermodynamics Paper IVA: Mathematical Methods – II Paper IVB: Lab (Practical)	25 Marks Do Do Do
3rd Semester	Total Marks: 100 (Th: 75, Pr:25)	Paper V: Unit-I : Electrostatics Unit-II: Electricity and Magnetism Paper VIA: Quantum Mechanics – I Paper VIB: Lab (Practical)	25 Marks Do Do Do
4th Semester	Total marks:100 (Th:75, Pr:25)	Paper VII: Unit-I : Classical Mechanics – II Unit-II: Quantum Mechanics – II Paper VIIIA: Electromagnetic Theory Paper VIIIB: Lab (Practical)	25 Marks Do Do Do
5th Semester	Total Marks: 200 (Th:150, Pr:50)	Paper IX: Unit-I : Waves & Optics – II Unit-II: Atomic & Molecular Physics Paper X: Unit-I : Special Theory of Relativity Unit-II: Thermal & Stat Physics – II Paper XI: Unit-I : Solid State Physics – I Unit-II: Nuclear and Particle Physics-I Paper XII: Lab (Practical)	25 Marks Do Do Do Do Do 50 Marks
6th Semester	Total Marks: 200 (Th: 75, Pr:100 Project: 25)	Paper XIII: Unit-I : Solid State Physics – II Unit-II: Electronics-II Paper XIV: Unit-I : Nuclear and Particle Phys-II Unit-II: Project work Paper-XV: lab (Practical) Paper-XVI: Computer Lab.	25 Marks Do Do Do 50 Marks Do

Theory Total: 100+75+75+75+150+75 = 550
Practical Total: 0+25+25+25+50+100 = 225
Project: 25

In 1st Semester, students will be asked to perform some basic experiments in Physics. Also there will be some Demonstration Classes in the Laboratory to make them familiar with various circuit components and electronic devices. There will be an Internal Assessment on their performance in the Laboratory.

1st SEMESTER

Paper I

Unit-I: Mathematical Methods-I (25 Marks) **Lecture: 30 + Tutorial: 5**

1. Vector Analysis: Definitions, Rotation of coordinate axes, Scalar and Vector product, Triple scalar product, Triple vector product, Gradient, Divergence, Curl, Successive applications of vector integration: Gauss' Theorem, Continuity equation, Stokes Theorem, Green's Theorem, Potential Theory, Gauss' Law, Poisson's Equation. (**8**)

2. Curvilinear Coordinates: Orthogonal coordinate systems, Differential vector operators, Special coordinate systems: Rectangular Cartesian coordinates, Cylindrical coordinates, Spherical Polar coordinates. (**4**)

Text: Mathematical Methods for Physicists by Arfken and Weber (5th Ed) Chapter 1, 2
Ref: Mathematical Methods for Physics and Engineering by K F Riley M. P. Hobson, S. J. Bence (3rd Ed) Chapter 7, 10, 11
Mathematical Methods for Physicists by Tai L. Chow Chapter-1.
Problem Book: Vector Analysis by M.R. Spiegel.

3. Ordinary Differential Equations:
First-order differential equations: Separable variables, Exact equations, Integrating factors, Bernouli's equation.
Second-order equations with Constant coefficients: Nature of the solution of linear equations, General solutions of the second-order equations, Finding the complementary function, Finding the particular integral, Particular integral and the operator D(=d/dx), Rules for D operators. The Euler linear equation,
Solutions in power series: Ordinary and singular points of a differential equation, Frobenius and Fuchs theorem, Simultaneous equations, gamma and beta functions. (**10**)

Text: Mathematical Methods for Physicists by Tai L. Chow Chapter-2.
Reference: Mathematical Methods for Physicists by Arfken and Weber (5th Ed) Chapter 9.

4. Fourier Series Expansion:
The Fourier Series: Periodic functions, Euler-Fourier formulae, Summation of Fourier series, Gibb's Phenomena, Convergence of Fourier series and Dirichlet conditions, Half-range Fourier series, Change of interval, Parseval's identity, Integration and differentiation of Fourier series. Orthogonal functions, Multiple Fourier series. **(8)**

Text: Mathematical Methods for Physicists by Tai L. Chow Chapter-4.
Reference: Mathematical Methods for Physicists by Arfken and Weber.

Unit-II: Classical Mechanics-I (25 Marks) **Lecture: 30 + Tutorial: 5**

Mathematical Prerequisite: Matrices and vector spaces
Introduction to Vectors: Vectors and Linear combinations, Lengths and dot products, Matrices.
Solving Linear Equations: Vectors and Linear Equations, The idea of Elimination, Elimination using Matrices, Rules for Matrix operations, Inverse Matrix, Factorization: A=LU, Transposes and permutations.
Vector spaces and subspaces: Spaces of vectors, The Null space of A: solving AX=0, Complete solution to AX=b, Independence, Basis and Dimension, Dimensions of the Four Subspaces.
Orthogonality: Projections; Orthogonal Bases and Gram-Schmidt.
Eigen values and Eigenvectors: Introduction to Eigen values and Eigenvectors of a Normal Matrix; Hermitian and Anti-hermitian Matrix; Orthogonal Matrix; Unitary Matrix; Rotation Matrices; General square matrix, Degenerate eigen values. Cayley-Hamilton Theorem.
Linear Transformations: The matrix of a Linear Transformation, Orthogonal and Unitary Transformations, Similarity Transformations; Diagonalization of a matrix; Trace of a matrix.
Complex Vectors and Matrices: Complex Numbers, Hermitian and Unitary Matrices, Inner product of vectors in Complex vector spaces, Elementary idea about Hilbert space. Function spaces. **(8)**
Text: Introduction to Linear Algebra by Gilbert Strang (4^{th} Ed.) Chapter: 1, 2, 3, 4, 6 (Part), 7(Part), 10(Part).
Reference: Mathematical Methods for Physics and Engineering by K.F. Riley, M.P. Hobson, S. J. Bence (3^{rd} Ed).

Classical Mechanics:
1. Survey of the elementary principle: Mechanics of a particle: Conservation theorem for the linear momentum, conservation theorem for the angular momentum, Energy conservation theorem. Mechanics of a system of particles: Conservation theorem for the linear momentum; total angular momentum and energy, Internal forces do no work in a rigid body, Constraints. **(4)**
2. The kinematics of Rigid body motion: The independent coordinates of the rigid body, orthogonal transformations, The Euler angles, Euler's theorem on the motion of a rigid body: Chasle's Theorem, Finite rotations, Infinitesimal rotations (Qualitative discussions only), rate of change of a vector, The coriolis force, centrifugal force. **(8)**

3. The Rigid body Equations of motion: Angular momentum and Kinetic energy of motion about a point, Tensors and dyadics, The inertia tensor and the moment of inertia, the eigenvalues of the inertia tensor and the principal axis transformation, Moment of inertia about an axis passing through origin, Ellipsoid of inertia, Methods of solving rigid body problems and the Euler equations of motion, Force free motion of a spherical top. **(10)**

Text: Classical Mechanics (2^{nd} Ed.) by H. Goldstein, Chapter-1, 4, 5.
Reference: Classical Mechanics by N.C. Rana and P. S. Joag.

Paper II

Unit-I: Waves & Optics - I (25 Marks) **Lecture: 30 + Tutorial: 5**

1. Superpositions of periodic motion: SHO, Superposition principle, Lissajous figure. **(3)**

2. Forced vibrations and resonance: Undamped oscillator with harmonic forcing, The complex exponential method for forced oscillations, Forced oscillations with damping, Effect of varying the resistive term, Transient phenomena, The power absorbed by a driven oscillator, Examples of resonance: Electrical resonance; Optical resonance; Anharmonic oscillators. **(6)**

3. Progressive waves: Normal modes and travelling waves, Progressive waves in one direction, Wave speeds in specific media, Superpositions, Wave pulses, Motion of wave pulses of constant shape, Superposition of wave pulses, **Dispersion**: Phase and group velocities, The energy of a mechanical wave, The transport of energy by a wave, Momentum flow and mechanical radiation pressure, Waves in two and three dimensions. **(6)**

4. **Geometrical Optics**:
Fermat's Principle : its application on plane and curved surfaces. **(4)**

Cardinal points of an optical system: Two thin lenses separated by a distance, equivalent lens, different types of magnification: Helmholtz and Lagrange's equations, Paraxial approximation, Introduction to matrix methods in paraxial optics-simple applications. **(5)**

Aberrations: Monochromatic aberrations, chromatic aberrations and its remedy. **(3)**

5. **Fiber optics:** Optical fibre – core and cladding, total internal reflection, optical fibre as waveguide : step index and graded index fibre, communication through optical fibres, energy loss. **(3)**

Text: Vibrations and waves by A.P. French.
Advanced Acoustics by D.P. Raychaudhuri
Optics by A. Ghatak
Ref: Optics by Hecht.

Unit-II: Electronics - I (25 Marks) **Lecture: 30 + Tutorial: 5**

1. Network Analysis

Thevenin Theorem, Norton theorem, Maximum power transfer theorem, Superposition principle, Concept of three phase, T and π networks. **(3)**

2. Semiconductor diodes

Type of semiconductor, doping, Different carrier transport in semiconductor (Drift, Diffusion, Recombination Generation, tunneling), Unbiased p-n junction (Built in potential, Depletion width), I-V characteristics, Rectifiers and filters, ripple factor, Zener diode and its applications, optoelectronic diodes: LED, photo diodes. **(8)**

3. Bipolar junction transistors (BJT)

pnp and npn structures; active and saturation regions, characteristics of BJT, common emitter configuration, input and output characteristics, α and β of a transistor and their interrelation, common base configuration, output characteristics. Two port analysis of a transistor, definition of h-parameters, loadline concept, emitter follower, biasing methods, stability factor, low frequency model. Comparison of CB, CC and CE amplifiers. Transistor as a switch. **(5)**

4. Field effect transistors (FET)

Type of various types of FETs, Construction of junction FET, biasing and characteristics, operating region, pinch-off voltage. MOSFET, Type of MOSFET (principle of operation and characteristics). Elementary ideas of CMOS and NMOS. **(5)**

5. Digital electronics

Boolean theorem, Boolean identities, OR, AND, NOT, NAND, NOR gates, Ex-OR, Ex-NOR gates, universal gate, de-Morgan’s theorem, 1’s and 2’s complement, binary number addition, subtraction and multiplication using 1’s and 2’s complement method, functional completeness, S-O-P and P-O-S representation, Karnaugh map, half adder, full adder, subtractor, concept of Latch, Flip flops. **(9)**

Text: Electronics fundamental and application by Chattopadhyay and Rakshit
Intergtared Electronics by Millman Halkias
Digital circuit Vol 1 Combinational circuits by D. Roychaudury
Digital circuit Vol 2 Sequential circuits by D. Roychowdury.

Ref: Solid State Electronic Devices by Ben G. Streetman and Sanjay Banerjee
Electronic Circuits (Sie) 3E by Neamen , Digital Electronics by Morris Mano
Digital Systems : Principles & Applications by Ronald J Tocci.

Following few basic experiments to be performed in 1st Semester (Hons.)

1. Measurements with slide calipers, screw-gauge and spherometer.

2. Determination of modulus of rigidity of the material of a wire by dynamical method.

3. Determination of Young's modulus of the material of a beam by the method of flexure.

4. Determination of the coefficient of viscosity of water by Poiseuille's method (the diameter of the capillary tube to be measured by travelling microscope).

5. Determination of the pressure coefficient of air.

6. Determination of the resistance of a suspended coil galvanometer by the method of half deflection and to calculate the figure of merit of the galvanometer (using the same data).

7. Determination of the horizontal component of earth's magnetic field using a deflection and an oscillation magnetometer.

8. To draw the I-V characteristics of i) resistor and ii) a P-N junction diode in forward biased condition. (Plot both the characteristic curves on the same graph paper.) Estimate from the graphs i) the resistance of the resistor and ii) the dynamic resistance of the diode for three different currents. One current should correspond to the intersecting point of the two curves.

2nd SEMESTER

Paper III

Unit-I: Thermal & Statistical Physics – I (25 Marks) Lecture: 30 + Tutorial: 5

1. Probability Theory: Probability of occurrence of event, theorem on total probability and compound probability, Binomial, Poisson and Gaussian distribution, mean value, variance and standard deviation. Random walk. **(5)**

2. Kinetic Theory of Gases: Basis assumptions of kinetic theory, Ideal gas approximation, deduction of perfect gas laws. Maxwell's distribution law (both in terms of velocity and energy) in 2D and 3D, r. m. s and most probable speeds. Finite size of molecules: Collision probability, Distribution of free paths and mean free path from Maxwell's distribution. Degrees of freedom, equipartition of energy. **(7)**

3. Transport Phenomena: Viscosity, thermal conduction and diffusion in gases. Brownian motion: Einstein's theory, perrin's work, Determination of Avogadro number. (4)

4. Real Gases: Nature of Intermolecular interaction: isotherm of real gases. Vander-waals equation of state, Other equation of state (mention only), critical constants of a gas, law of corresponding states; Virial coefficients, Boyle temperature. **(4)**

5. Conduction and Radiation of Heat: Fourier's equation for heat conduction-its solution for rectilinear and radial (spherical and cylindrical) flow of heat. Energy density, radiation pressure, Stephan Boltzmann law. Newton's Law of cooling. **(4)**

6. Introduction to Statistical Physics: Macro states, microstates, phase space and Phase trajectories, ensembles. Ergodic hypothesis- equality of ensemble average and time average, counting of number of microstates in Phase space. **(6)**

TEXT: Heat & Thermodynamics by Roy & Gupta
Kinetic Theory of gases by Loeb
Fundamentals of Statistical and Thermal Physics by F. Reif

Unit-II: Thermodynamics (25 Marks) **Lecture: 30 + Tutorial: 5**

1. **Basic Concepts**
Microscopic and macroscopic points of view : thermodynamic variables of a system, State function, exact and inexact differentials. (**2**)

2. **First Law of Thermodynamics**
Thermal equilibrium, Zeroth law and the concept of temperature. Thermodynamic equilibrium, internal energy, external work, quasistatic process, first law of thermodynamics and applications including magnetic systems, specific heats and their ratio, isothermal and adiabatic changes in perfect and real gases. **(5)**

3. **Second Law of Thermodynamics**
Reversible and irreversible processes, indicator diagram. Carnot's cycle - efficiency, Carnot's theorem. Kelvin's scale of temperature, relation to perfect gas scale, second law of thermodynamics – different formulations and their equivalence, Clausius inequality, entropy, change of entropy in simple reversible and irreversible processes, entropy and disorder; equilibrium and entropy principle, principle of degradation of energy. Application of thermodynamics to thermoelectric circuits. **(12)**

4. **Thermodynamic Functions**
Enthalpy, Helmholtz and Gibbs' free energies; Legendre transformations, Maxwell's relations and simple deductions using these relations; thermodynamic equilibrium and free energy. (**4**)

5**. Change of State**
Equilibrium between phases, triple point, Gibbs' phase rule (statement only) and simple applications. First and higher order phase transitions, Ehrenfest criterion. Clausius-Clapeyron's equation. Joule- Thomson effect. (**5**)

6. **Third Law of Thermodynamics**: Cooling by Adiabatic demagnetization, Nernst heat theorem, Unattainability of absolute temperature. (**2**)

TEXT: Heat & Thermodynamics by Roy & Gupta
A Treatise on Heat by Saha & Sribastava
REF: Heat & Thermodynamics by Zemansky & Ditman

Paper IVA

Mathematical Methods – II (25 Marks) **Lecture: 30 + Tutorial: 5**

1. Series and Limits
Convergence of infinite series: Absolute and conditional convergence; Series containing only real positive terms; Alternating series test. Operation with series.
Power series: Convergence of power series; operations with power series.
Taylor series: Taylor's Theorem; Approximation errors; Standard Maclaurin Series. Evaluation of Limits. **(5)**

Text: Mathematical Methods for Physics and Engineering by K.F. Riley, M.P. Hobson, S. J. Bence (3rd Ed) Chapter-4
Reference: Mathematical Methods for Physicists by Arfken and Weber (5th Ed) Chapter-5

2. Special Functions of Mathematical Physics:
Legendre's equation: Rodrigue's formula for $P_n(x)$, Generating function for Pn(x), Orthogonality for Legendre Polynomials.
The associated Legendre functions: Orthogonality of associated Legendre functions, Spherical harmonics.
Hermite's equation: Rodrigue's formula for $H_n(x)$, Recurrence relations for Hermite Polynomials, Generating function for $H_n(x)$, The orthogonal Hermite functions. **(10)**

3. Sturm-Liouville Theory: Self-Adjoint ODEs, Hermitian Operators, Gram-schmidt orthogonalization, Completeness of Eigen functions, Green's function-Eigen function Expansion. **(4)**

Text: Mathematical Methods for Physicists by Tai L. Chow Chapter-7
Ref: Mathematical Methods for Physicists by Arfken & Weber (5th Ed) Chapters -11, 12, 13.

4. Partial Differential Equations:
Linear second order partial differential equations; Solutions of Heat equation, Laplace's equation, wave equation, Schrodinger's equation: Separation of variables, Solution of Poisson's equation: Green's function. The delta function and Green's function method to solve partial differential equations. **(7)**

Text: Mathematical Methods for Physicists by Tai L. Chow. Chapter: 10.
Reference: Introduction to Mathematical Physics by Charles Harper.

5. Theory of Fourier Transforms:
Formal development of Complex Fourier Transform, Cosine and sine transform, Multiple dimensional Fourier transform, The transform of derivatives, The Fourier integral and delta function, Parseval's identity for Fourier integrals. **(4)**

Text: Introduction to Mathematical Physics by Charles Harper. Chapter-8
Reference: Mathematical Methods for Physicists by Tai L. Chow.

Paper IVB

Lab – S2 (Practical)   (25 Marks)

1. Verification of Thevenin, Norton and Maximum power transfer theorems using a resistive Wheatstone bridge and d.c. source.

2. To draw the forward and reverse characteristics of a Zener diode and to study its regulation characteristics. Estimate the a.c. resistances of the diode for different diode currents in both forward and reverse bias conditions.

3. To draw the regulation characteristics of a bridge rectifier: (i) without using any filter and (ii) using a filter. Determine the ripple factor in both cases by measuring the ripple voltage with the help of an ac meter.

4. To draw the characteristics of a transistor in C-E mode and hence to determine the hybrid parameters using dc and ac sources.

5. a) To draw the characteristics of a JFET and hence to determine the relevant parameters and b) to design an amplifier using JFET.

6. To verify truth tables of different gates using discrete components and IC.

3rd SEMESTER

Paper V

Unit-I: Electrostatics (25 Marks) **Lecture: 30 + Tutorial: 5**

1. **Gauss' law:** Coulomb's law of electrostatics, field intensity and potential; Gauss' theorem – its applications; Poisson and Laplace's equations; Superposition theorem, Application of Laplace's equation to simple cases of symmetric spherical charge distribution. (**6**)

2. **Electrostatic boundary value problem**: Uniqueness theorem, Laplace's equation in 1D, 2D, Spherical coordinates, Some typical boundary value problem. **(3)**

3**. Multipole expansion:** Multipole expansion of scalar potential – monopole, dipole and quadrupole terms; potential and field due to a dipole; work done in deflecting a dipole; dipole-dipole interaction (for both electric and magnetic dipoles); force on dipole in a non-homogeneous field, Quadrupole moment tensor. (**6**)

4. **Electrostatics in conductors:** Basic properties, Induced charges, surface charge and force on a conductor, Capacitors. **(2)**

5**. Dielectrics:** Dielectric polarization, electric displacement vector (**D**); Gauss' theorem in dielectric media; boundary conditions; electrostatic field energy; computation of capacitance in simple cases (parallel plates); spherical and cylindrical capacitors containing dielectrics – uniform and non-uniform. (**6**)

6. **Electrostatic Energy and Capacitor**: Electrostatic energy of an assembly of point charges, continuous charge distribution, self energy of point charge, Uniformly charged sphere, Capacitors. **(3)**

7**. Electrical Images:** Solution of field problems in case of point charge near a grounded conducting infinite plane. Boundary value problem: in uniform external field for (i) conducting spherical shell and (ii) dielectric sphere. (**4**)

TEXT: Introduction to Electrodynamics by D. J. Griffiths
Foundation of Electricity and Magnetism by B. Ghosh.

Unit-II: Electricity & Magnetism (25 Marks) **Lecture: 30 + Tutorial: 5**

1. Magnetic effect of steady current: Lorentz force and concept of magnetic induction; force on linear current element; Biot-Savart's law. $\nabla \cdot \mathbf{B} = \mathbf{0}$; magnetic vector potential; calculation of vector potential and magnetic induction in simple cases – straight wire, magnetic field due to small current loop; magnetic dipole; field due to a dipole; magnetic shell; Ampere's theorem; Ampere's circuital law – simple illustrations; force between long parallel current carrying conductors; $\nabla \times \mathbf{B} = \mu \mathbf{J}$; comparison between static electric and magnetic fields. **(9)**

2. Magnetic materials: Free current and bound current; surface and volume density of current distribution; magnetisation; non-uniform magnetization of matter; $\mathbf{J_b} = \nabla \times \mathbf{M}$; Ampere's law in terms of free current density and introduction of **H**; line integral of **H** in terms of free current; boundary conditions for **B** and **H**; permanently magnetized body; magnetic scalar potential; application of Laplace's equation to the problem of a magnetic sphere in uniform magnetic field; hysteresis and energy loss in ferromagnetic material; eddy current magnetic circuit; energy stored in magnetic field. **(9)**

3. Electromagnetic induction: Faraday's and Lenz's law; motional e.m.f. - simple problems; Calculation of self and mutual inductances in simple cases, inductances in series and parallel; reciprocity theorem. **(4)**

4. Transient Current: Growth and decay in LR, CR and LCR circuits. **(2)**

5. Alternating Current: LR, CR, LCR circuit, Resonance in series LCR circuit, parallel resonant circuit, ideal transformer, rotating magnetic field, Anderson bridge. **(6)**

TEXT: Classical Electrodynamics by J. D. Jackson
REF: Introduction to Electrodynamics by D. J. Griffiths.
Foundation of Electricity and Magnetism by B. Ghosh.

Paper VIA

Quantum Mechanics -I (25 Marks) **Lecture: 30 + Tutorial: 5**

1. Classical Mechanics and its inadequacies: Particles and waves in Classical Physics, Interference experiment with waves and particles (classical), double slit experiment with light, Matter waves (de Broglie waves). **(2)**

2. Fundamental concepts: The Stern-Gerlach experiment, sequential Stern-Gerlach experiments, Analogy with Polarization of light, Kets, Bras and operators, Base kets and matrix representations, Measurements, observables and the uncertainty relations, Change of basis, Position, momentum and translation, Wave functions in position and momentum space, Eigen value problem and function of operators. **(6)**

3. The postulates – a general discussion: Comparative study between quantum postulates and their classical counterpart (in the Hamiltonian formalism), Discussion of postulates I, II and III. **(2)**

4. Quantum dynamics: Time evolution and the Schrodinger equation- Time evolution operator; The Schrodinger equation; energy eigen kets, time dependence of expectation values, The Schrodinger versus the Heisenberg picture: Unitary operators; State kets and observables in the Schrodinger and the Heisenberg picture; The Heisenberg equation of motion; Free particle; Ehrenfest's theorem. **(5)**

5. Simple problems in one dimension: The free particle, the particle in a box-the bound state problem, the continuity equation for probability, Theorems (i) there is no degeneracy in one dimensional bound state, (ii) the eigen-functions of H can be chosen pure real in the coordinate basis (Statement only). The single-step potential: a problem in scattering, One-dimensional barrier problem: The rectangular barrier and tunneling, scattering from a rectangular potential well, kinetic properties of a wave-packet scattered from a potential barrier. **(10)**

6. The Harmonic Oscillator: Review of the classical oscillator, Symmetric potential and its effect on eigen-function, [H,P]=0, Solve the L.H.O equation by operator method due to Dirac, Matrix realization of position and momentum operators; creation and annihilation operators; number operators in energy basis, passage from the energy basis to the position basis, quantization of the oscillator in position basis, minimum uncertainty state, correspondence between linear harmonic oscillator and quantized electromagnetic field (in simple cases). **(5)**

Text: Principles of Quantum Mechanics (2^{nd} ed.) R. Shankar
Modern Quantum Mechanics (2^{nd} Ed.) by J J Sakurai, Jim J Napolitano.
Ref: Introductory Quantum Mechanics (4^{th} ed.) R. L. Liboff

Paper VIB

Lab – S3 (Practical)   (25 Marks)

1. To estimate the temperature of a torch bulb filament from resistance measurement and to verify Stefan's law.

2. Determination of thermal conductivity of a bad conductor of heat by Lee's and Chorlton's method.

3. Measurement of current by potentiometer**.**

4. To measure the voltage across the inductance (L), capacitance (C) and resistance(R) of a series LCR circuit for different frequencies of the input voltage with the help of an A.C milli-voltmeter. Hence (i) to study the variation of impedance of L and C with frequency of the impressed voltage, (ii) to draw the resonance curve of the series LCR circuit and to determine the Q-factor of the circuit.

5. To study the variation of mutual inductance of a given pair of co-axial coils by using a ballistic galvanometer.

6. Determination of Planck's constant.

4^{th} SEMESTER

Paper VII

Unit-I: Classical Mechanics - II (25 Marks) Lecture: 30 + Tutorial: 5

1. Some Methods in the Calculus of Variations: Determine the path that gives extremum solutions, Euler equation, Use of Calculus of variation to solve simple problems: a) shortest distance between two points in a plane b) Area of the surface of revolution is a minimum-Catenary c) soap film problem-minimize the surface area of revolution d) The brachistochrone problem, The second form of the Euler equation, Functions with several dependent variables, Euler's equations when Auxiliary conditions are imposed: Equations of Constraint; Lagrange undetermined Multiplier, The notation. **(5)**

2.(a) Hamilton's Principle – Lagrangian Dynamics: Hamilton's Principle - Lagrange's equations of motion, Generalized coordinates; Generalized velocities; Configuration space, Lagrange's equation of motion in Generalized Coordinates- Holonomic, fixed or scleronomic, rheonomic constraints; several examples using Lagrange's equations, Lagrange's equations with Undetermined Multipliers-Close relations between the Undetermined Multipliers and the forces of Constraint, Equivalence of Lagrange's and Newton's Equations-Virtual displacements and virtual work-Generalized forces, Kinetic energy as a function of the Generalized Coordinates and velocities, Euler's theorem concerning the kinetic energy. **(6)**

(b) Hamiltonian Dynamics: Legendre transformation–Hamilton's equations of motion, Liouville's Theorem, Momentum Space, Hamiltonian dynamics in accelerated systems, Charge particle moving in a magnetic field: Larmor's Theorem, Linearly Accelerated systems. **(5)**

(c) Canonical Transformations: Canonical Transformations, Test a transformation is canonical, Generating function and three new forms of Generating Functions, Poisson Brackets-invariance of Poisson bracket. **(3)**

3. The Two-body Central Force Motion: Reduction to the equivalent one-body problem, The equation of motion and first integrals, The equivalent one-dimensional problems and classification of orbits, The The differential equation for the orbit and integrable power-law potentials, Conditions for closed orbits (Bertrand's theorem),The Kepler problem: Inverse square law of force, The motion in time in the Kepler problem. **(6)**

4. Small Oscillations in Lagrangian Formulation: Formulation of Problem, The eigenvalue equation and the Principal axis transformation, Frequencies of free vibration, and normal coordinates, Free vibration of a linear triatomic molecule. **(5)**

TEXT: Classical Dynamics of particles and systems (5^{th} Ed.) by S.T. Thornton and J. B. Marion (See Chapter 6 for Sec 1, Chapter 7 for Sec 2A), Analytical Mechanics by Louis N Hand and janet D Finch (See Chapter 5 for Sec 2B, Chapter 6 for 2C), Classical Mechanics (2^{nd} Ed.)by Herbert Goldstein (see chapter 3 , 6 for Sec 3 , 4 respectively).
REF: Mechanics (3^{rd} Ed.) Course of theoretical Physics Vol.1 by L. D. Landau and E M Lifshitz.

Unit-II: Quantum Mechanics - II (25 Marks) **Lecture: 30 + Tutorial: 5**

1. Symmetries and their consequences: Translational invariance in quantum theory, time translational invariance, parity invariance. **(3)**

2. Angular Momentum: Angular momentum operators and their commutation relations, orbital versus spin angular momentum, General theory of angular momentum: the ladder operators, the spectrum of J^2 and J_z, the raising and lowering process must terminate, the action of J_+ and J_- on the general eigen-ket $|j,m\rangle$, matrix realization of J_x, J_y, J_z and J^2 for j=0,1/2,1. Pauli spin matrices. Eigenstates of spin ½, Representation of $|l,m\rangle$ states in spherical coordinates, Addition of angular momentum. **(12)**

3. The Hydrogen atom problem: Reduction of effective 1D problem, Stationary state wave-functions as simultaneous eigen-functions of H, L^2 and L_z, Radial Schrodinger equation and energy spectrum, degeneracy of the spectrum , solution of radial equation by operator method. **(9)**

4. Problems in two and three dimensions: Particle in a box, free particle and harmonic oscillator, notion of accidental degeneracy, Particle in an infinite spherical well. **(6)**

TEXT: Principles of Quantum Mechanics (2^{nd} ed) R. Shankar
Modern Quantum Mechanics (2^{nd} Ed.) by J. J. Sakurai, Jim J Napolitano.
REF: Introductory Quantum Mechanics (4^{th} ed) R.L. Liboff
Quantum Physics by Stephen Gasiorowicz.

Paper VIIIA

Electromagnetic Theory (25 Marks) **Lecture: 30 + Tutorial: 5**

1. **Maxwell's Equations:** Displacement Current, Maxwell's Field Equations, Wave equation for electromagnetic (EM) field and its solution – plane wave and spherical wave solutions, transverse nature of field, relation between **E** and **B**; energy density of field, Poynting vector and Poynting's theorem, boundary conditions. **(7)**

2. **EM Waves in an isotropic dielectric:** Wave equation, polarization of EM waves, reflection and refraction at plane boundary, reflection and transmission coefficients, Fresnel's formula, change of phase on reflection, polarization on reflection and Brewster's law, total internal reflection. **(5)**

3**. EM waves in conducting medium:** Wave equation in conducting medium, reflection and transmission at metallic surface – skin effect and skin depth, propagation of E-M waves between parallel and conducting plates – wave guides (rectangular only). **(5)**

4. **Potential and Fields:** Scalar and Vector potentials, Coulomb and Lorentz Gauge, Retarded potentials, Lienard-Wiechert potentials. (**6**)

5. Dispersion: Equation of motion of an electron in a radiation field: Lorentz theory of dispersion – normal and anomalous; Sellmeier's and Cauchy's formulae, absorptive and dispersive mode, half power frequency, band width. **(3)**

6. Scattering: Rayleigh's scattering (qualitative ideas), blue colour of the sky, absorption, Electric dipole radiation. **(4)**

TEXT: Introduction to Electrodynamics by D. J. Griffiths.
REF: The Feynman Lectures on Physics (Vol. II)

Paper VIIIB

Lab – S4 (Practical) (25 Marks)

1. To calibrate a thermocouple with the help of potentiometer and hence (i) to measure the thermoelectric power at a particular temperature (ii) to measure an unknown temperature.

2. To draw the B-H loop for the material of an anchor ring by ballistic galvanometer and to estimate the energy loss per cycle of magnetization.

3. (a) To measure the self inductance of two coils by Anderson bridge. To find the total inductance of the above two coils connected in series and hence estimate the coefficient of coupling between the coils. (b)To study the variation of inductance of two coils in series with angle between their planes by Anderson bridge.

4. To determine Fourier spectrum of (i) square, (ii) triangular and (iii) half sinusoidal waveform by CRO.

5. To find band gap energy of a semiconductor using Four-probe method.

6. Verification of Fresnel's equation of reflection of electromagnetic waves with the help of prism and two polaroids.

7. To determine the boiling point of a liquid using a platinum resistance thermometer.

5th SEMESTER

Paper IX

Unit-I: Waves and optics-II (25 Marks) **Lecture: 30 + Tutorial: 5**

1. Interference of light waves: Young's experiment; spatial and temporal coherence; intensity distribution; Fresnel's biprism, interference in thin films; fringes of equal inclination and equal thickness; Newton's ring. Michelson's interferometer. Multiple beam interference-reflected and transmitted pattern. Fabry –Perot interferometer. Mach-Zender Interferometer. **(9)**

2. Diffraction of light waves: Fresnel and Fraunhofer class, Fresnel's half period zones; explanation of rectilinear propagation of light; Zone plate. Fraunhofer diffraction due to a single slit, double slit and circular aperture. Plane diffraction grating (transmission). Rayleigh criterion of resolution; resolving power of prism, telescope, microscope and transmission grating. **(9)**

3. Polarization: Different states of polarization; double refraction, Huygen's construction for uniaxial crystals; Polaroids and their uses. Production and analysis of plane, circularly and elliptically polarized light by retardation plates. Optical activity; Modern explanation of optical activity; Biquartz and half shade polarimeter. **(7)**

4. Polarization properties of quasi-monochromatic light: The coherency matrix of quasi-monochromatic plane wave a) Completely unpolarized light (natural light) b) Complete polarized light. Some equivalent representations. The degree of polarization of light wave. The Stokes parameters of a quasi-monochromatic plane wave. **(5)**

TEXT: Optics by E. Hecht and A. R. Ganesan
Principles of Optics by M. Born and E. Wolf
REF: Optics by **A.** Ghatak

Unit-II: Atomic and Molecular Physics (25 Marks) Lecture: 30 + Tutorial: 5

1. Basic ideas: Transition rate, density of states, selection of rules. **(2)**

2. Laser Physics: Absorption, stimulated emission, spontaneous emission, Generation of Population inversion, calculation of population inversion for three level system, He-Ne laser. **(3)**

3. Vector atom model: Magnetic moment of the electron, Lande g factor, Vector model-space quantization, L-S coupling, Zeeman effect, Explanation from vector atom model. Fine structure of H-like atom and different terms in fine structure. **(6)**

4. Many electron atom: Shell structure. Hund's rule, spectroscopic terms of many Electron atoms in the ground state. The central field approximation-spin, Pauli exclusion principle and Slater determinants, electron states in a central field. Comparison of L-S coupling and j-j coupling in the light of central field approximation. **(8)**

5. The spectra of the Alkalis: Absorption spectra, Emission spectra, Fine structure. **(2)**

6. Molecular structure: General nature of molecular structure, Born-Oppenheimer separation for diatomic molecules, rotation and vibration of diatomic molecules. **(5)**

7. Molecular Spectra: Rotational energy levels of diatomic molecules, rotational spectra, vibrational-rotational spectra of diatomic molecules; Raman scattering (Classical calculation). **(4)**

TEXT: Atomic and Nuclear Physics by S. K. Sharma
Laser Principles and Applications by A. K. Ghatak and K. Tyagrajan
REF: Physics of Atoms and Molecules by B. H. Bransden and C. J. Joachain

Paper X

Unit-I: Special Theory of Relativity (25 Marks) Lecture: 30 + Tutorial: 5

1. Galilean Relativity: Inertial frames of reference; Galilean Relativity Principle; invariance of length in 3 dimensional Euclidean space; Absolute nature of time; invariance of Newton's laws of mechanics and gravitation and Coulomb's law of electrostatics; problem with electromagnetism. **(2)**

2. Velocity of Electromagnetic Waves: Plane wave solutions of Maxwell's equations; invariance of parameters under transformation between inertial frames; interpretation of c as phase velocity of plane waves and its consequent absolute nature; relativity of time; space-time and the invariant light-like interval; time-like and space-like intervals; postulates of special relativity; non-Euclidean geometry of space-time. **(8)**

3. Space-time diagrams in special relativity: World lines of electromagnetic waves and material objects; events in different inertial frames as invariant hyperboloids in spacetime; time dilation; derivation of Lorentz transformation formulae along coordinate axes and in general directions; length contraction; faster than light particles; relative velocity; relativistic Doppler efect; clock paradox and length contraction paradox and their resolution. **(8)**

4. Four vectors and tensors in spacetime: 4-vectors and co-vectors; invariant squared interval and the metric of spacetime; signature of spactime metric : Euclidean vs Lorentizian; invariant scalar product and norms; timelike, spacelike and lightlike (null) vectors; orthogonality of 4-vectors; position and momentum 4-vectors; 4-tensors: electromagnetic fields. **(8)**

5**. Relativistic kinematics**: invariant hyperboloids in 4-momentum space; energy-momentum relation and its consequences: $E = mc^2$; massless particles; 4-momentum conservation; relativistic collision problems. **(4)**

TEXT: Introduction to special Relativity by Robert Resnik
Introduction to special Relativity by Wolfgang Rindler
REF: Spacetime Physics by Edwin F Taylor & J A Wheeler

Unit-II: Thermal & Statistical Physics-II (25 Marks) Lecture: 30 + Tutorial: 5

1. Introduction to Statistical Physics & Micro-canonical Ensemble: Interaction between two systems-thermal, mechanical and diffusive. Statistical definition of temperature, pressure, entropy and chemical potential. Partition function of a system in thermal equilibrium with a heat bath. Hypothesis of equal a priori probability for microstates of an isolated system in equilibrium. Counting of microstates in phase space, entropy of ideal gas. **(6)**

2. Canonical Ensemble: System in contact with a heat reservoir. Expression of entropy. Canonical partition function, Helmholtz free energy. **(3)**

3. Classical Statistical Mechanics & Motivation for Quantum Mechanics: Maxwell-Boltzmann distribution law. Calculation of thermodynamic quantities for ideal mono-atomic gases. Gibb's paradox and Sackur Tetrode equation. Identical particle and symmetry requirement. Derivation of MB, FD and BE statistics as the most probable distributions (micro-canonical ensemble). Classical limit of Quantum statistics. **(8)**

4. Quantum Statistical Mechanics-FD Statistics: Fermi distribution at zero and non-zero temperatures. Fermi energy and its expression in terms of particle density. Degenerate and non-degenerate Fermi Gas. **(5)**

5. Quantum Statistical Mechanics-BE statistics: Application to radiation-Planck's law. Rayleigh Jeans and Wien laws as limiting cases, Stefan's law. **(4)**

6. Application to Astrophysics: Saha equation for thermal ionization and its application in stellar classification; in the accretion disk, Relativistic ideal gas and review of MB distribution, white dwarf. **(4)**

TEXT: Fundamentals of Statistical and Thermal Physics by F. Reif
Statistical Physics by F. Mandle
REF: Statistical Mechanics: Avijit Lahiri

Paper XI

Unit-I: Solid state Physics-I (25 Marks) Lecture: 30 + Tutorial: 5

1. Crystal Structure: Crystalline and amorphous solids, translational symmetry. Elementary ideas about crystal structure, lattice and bases, unit cell, reciprocal lattice, fundamental types of lattices, Miller indices, lattice planes, simple cubic, f.c.c. and b.c.c. lattices. Laue and Bragg equations. Determination of crystal structure with X-rays. **(9)**

2. Bonding in Solids: Different types of bonding- ionic, covalent, metallic, van der Waals and hydrogen. **(2)**

3. Dielectric properties of materials: Electronic, ionic and dipolar polarizability, local fields, induced and oriented polarization – molecular field in a dielectric; Clausius-Mosotti relation. Complex dielectrics: Complex dielectric constant and dielectric losses, relaxation time. Classical theory of electronic and ionic polarization-optical absorption. **(9)**

4. Magnetic properties of materials: Dia, para and ferro-magnetic properties of solids. Langevin’s theory of diamagnetism and paramagnetism. Quantum theory of paramagnetism, Pauli Paramagnetism, Curie’s law. Ferromagnetism : spontaneous magnetization and domain structure; temperature dependence of spontaneous magnetisation; Curie Weiss law, explanation of hysteresis. Ferri and Antiferri magnetization, Neel temperature. **(10)**

TEXT: Introduction to Solid State Physics by C. Kittel
Solid State Physics by A. J. Dekker, Solid state Physics by S. O. Pillai
REF: Solid state Physics by D. W. Snoke

Unit-II: Nuclear & Particle Physics-I (25 Marks) Lecture: 30 + Tutorial: 5

1. Basic Nuclear Parameters; classical treatment of Rutherford scattering, Experimental verification, Implication of Rutherford Scattering in determination of Nuclear Structure. **(5)**

2. Properties of Nuclei: Labeling of Nuclei, Masses of Nuclei, Sizes of Nuclei, Nuclear spins and dipole moments, Stability of Nuclei, Nature of Nuclear forces. **(3)**

3. Nuclear Models: Liquid drop model, The Fermi Gas Model, Ground state properties of Nuclei: the Shell Model- a) Infinite square well b)Harmonic oscillator c) Spin-orbit potential :Energy shell and Angular Momentum, Magic Numbers. The magnetic dipole moment of the nucleus, Calculation of the magnetic dipole moment, the electric quadruple moment of nucleus. **(9)**

4. Nuclear Reactions: Conservation principles in nuclear reactions. Q-values and thresholds, nuclear reaction cross-sections, examples of different types of reactions and their characteristics. Bohr's postulate of compound nuclear reaction, Ghoshal's experiment. **(4)**

5. Nuclear Radiation: Alpha Decay and spontaneous emission- Alpha particle spectra- velocity and energy of alpha particles, Barrier penetration, Geiger-Nuttal law, spontaneous fission. Beta Decay- nature of beta ray spectra, neutrino hypothesis, energy levels and decay schemes, positron emission and electron capture, selection rules, beta absorption and range of beta particles, Kurie plot. Gamma Decay-Gamma ray spectra and nuclear energy levels, isomeric states. Interaction of photons with matter: Pair production. **(5)**

6. Particle Detection and accelerators: G.M Counters, semiconductor detector, Cerenkov counter, Cyclotron, Linear accelerator, Synchronous accelerator, Phase stability, strong focusing, colliding beams. **(4)**

TEXT: Introduction to Nuclear and Particle Physics (2^{nd} Ed.) by A. Das and T. Ferbel
Concepts of Nuclear Physics by R. Cohen, S. N. Ghoshal

REF: An Introduction to Nuclear Physics (2^{nd} Ed.) by W. N. Cottingham, D. A. Greenwood.

Paper XII

Lab – S5 (Practical)   (50 Marks)

1. To study the variation of refractive index (μ) of the material of a prism with wave length and to verify Cauchy's dispersion formula and to find the dispersive power of the material of the prism by spectrometer.

2. Measurement of the slit width and the separation between the slits of a double slit by observing the diffraction and interference fringes.

3. To determine the wavelength of a monochromatic light by Fresnel's biprism.

4. To find the number of lines per centimeter of the transmission grating and hence to measure the wavelength of an unknown spectral line and to measure the wavelength difference between D1 and D2 lines of sodium using a slit of adjustable width.

5. To study the diffraction pattern of a crossed grating with the help of a LASER source.

6. To calibrate a polarimeter and hence to determine the concentration of sugar solution.

6th SEMESTER

Paper XIII

Unit-I: Solid State Physics -II (25 Marks) Lecture: 30 + Tutorial: 5

1. Specific heat in Solids: Specific heat in solids at low and high temperatures. Einstein's and Debye's theories of specific heats of solids. **(3)**

2. Lattice vibrations: Elastic and atomic force constants; Dynamics of a chain of similar atoms and chain of two types of atoms; optical and acoustic modes. **(3)**

3. Free Electron Theory: free electron theory of metals, effective mass, drift current, mobility and conductivity, Wiedemann-Franz law. Hall Effect in metals: Phenomenology and implication. **(4)**

4. Band theory of solids: Periodic potential and Bloch theorem, Kronig-Penny model, energy band structure. Band structure in conductors, direct and indirect semiconductors and insulators (qualitative discussions). **(8)**

5. Physics of Semiconductor devices: Carrier Concentration in Semi-conductors, Fermi energy in intrinsic semi-conductor, temperature and doping dependence, conductivity; mobility and its temperature dependence. **(5)**

6. Superconductivity: Introduction (Kamerlingh-Onnes experiment), effect of magnetic field, Type-I and type-II superconductors, Isotope effect. Meissner effect. Heat capacity. Energy gap. Ideas about High-T_c superconductors, Flux quantization and Josephson effect, Outline of BCS theory. **(7)**

TEXT: Introduction to Solid State Physics by C. Kittel
Solid State Physics by A. J. Dekker
Solid state Physics by S. O. Pillai
Elements of Solid State Physics by J. P. Srivastava
REF: Solid state Physics by D. W. Snoke

Unit-II: Electronics-II (25 Marks) Lecture: 30 + Tutorial: 5

1. Amplifiers: Class A, B, AB and C amplifier, Voltage and current gain, response of a two stage R-C coupled amplifier, tuned amplifier, push pull amplifier, requirement of power amplifiers, Noise. (**3**)

2. Feedback: Principle of feedback, positive and negative feedback, advantages of negative feedback, regulated power supply. **(2)**

3. Oscillators: Barkhausen criterion for sustained oscillation, Sinosoidal oscillation (Concept of Hartley and Colpitt oscillator, R C couple oscillator Weinbridge and crystal oscillators,), Square oscillator (relaxation oscillators - monostable, bistable and astable multivibrators). **(7)**

4. Operational amplifier: Properties of ideal OP-AMP, differential amplifiers, CMRR, slew rate, inverting and non-inverting amplifiers, and mathematical operations analog computing, active and passive filter (1^{st} order and 2^{nd} order) **(5)**

5. Combinational logic: Digital comparator, multiplexer/demultiplexer, Encoder/decoder, Multibit adder/subtractor circuit, programmable logic device (PLD), CCD camera, Digital multimeter. **(5)**

6. Sequential logic: Master slave flip flop, Counter (asynchronous and synchronous counter), MOD counter, Up down counter, Shift register, Left right shift register, RAM **(5)**

7. Communication principles: Modulation and demodulation – elementary theory of AM, FM and PM, demodulation of AM (diode detector) and FM (slope detector) waves. **(3)**

TEXT: Electronics fundamental and application by Chattopadhyay and Rakshit
Intergtared Electronics by Millman Halkias
Digital circuit Vol 1 Combinational circuits by D Roychaudury
Digital circuit Vol 2 Sequential circuits by D Roychowdury

REF: Solid State Electronic Devices by Ben G. Streetman and Sanjay Banerjee
Electronic Circuits (Sie) 3E by Neamen
Digital Electronics by Morris Mano
Digital Systems : Principles & Applications by Ronald J Tocci.

Paper XIV

Unit-I: Nuclear& Particle Physics-II (25 Marks) Lecture: 30 + Tutorial: 5

1. Conservation Rules and Symmetry: Fundamental interactions**,** various quantum numbers-their conservations and violation of symmetry. **(6)**

2. **Structure of Quarks and Leptons**: Quark, charges, strangeness, magnetic moment of neutron, W boson, z-boson, Higgs boson. **(3)**

3. Discrete Transformations: Parity, Conservation of parity, Violation of parity, Time reversal, Charge conjugation, CPT theorem. **(4)**

4. Formulation of the Standard model: Quarks and Leptons, Quark content of Mesons, Quark content of Baryons, Needed for color, Quark model for mesons, valence and sea quarks in Hadrons, Weak isospin and color symmetry, Gauge bosons, dynamics of gauge particles, symmetry breaking. **(5)**

5. **The Neutrinos:** The mass of electron-neutrino, neutrino mixing and neutrino oscillations, atmospheric neutrinos. **(2)**

6. Nuclear Fusion: The Sun, Cross-section for hydrogen burning, nuclear reaction rate in a plasma, solar neutrinos, Fusion reactors, Muon-catalysed fusion. **(4)**

7. Application to Astrophysics: Cosmic Nucleosynthesis, Stellar nucleosynthesis, pp chain, CNO cycle, Nucleosynthesis in Supernovae, Nucleosynthesis of heavy elements, energy sources in star. **(6)**

TEXT: Introduction to Nuclear and Particle Physics (2nd Ed.) by A. Das and T. Ferbel
An Introduction to Nuclear Physics (2nd Ed.) by W.N. Cottingham and D. A. Greenwood (for Sec 4 to 6.)

REF: Introduction to High Energy Physics by D. H. Perkins
Introduction to Elementary Particle Physics by A. Bettinni.

Unit-II: Project work (25 Marks)

READING or EXPERIPENTAL PROJECT WITH DEMONSTRATION

Paper XV

Lab - S6 (Practical)   (50 Marks)

1. To construct and study the frequency response of a voltage amplifier using a transistor in CE mode and to find its bandwidth.

2. To design and test the following circuits using an OPAMP :
(i) Inverting and non inverting amplifier, (ii) Differential amplifier, (iii) Schmitt trigger,
(iv) Integrator, (v) Differentiator.

3. To design and fabricate a temperature controller and then to study its performance characteristics.

4. To construct Wein Bridge oscillator on a bread board using OPAMP and to study the wave form of the oscillator and calibrate it using CRO.

5. To design and verify the following digital circuits using basic gates:
(i) S-R flip-flop, (ii) J-K flip-flops, (iii) 4-input multiplexer, (v) Mod-5 and decade counters.

6. To design an astable multivibrator and to study its performance.

Paper XVI

Computer Lab (Practical) (50 Marks)

1. Language (FORTRAN or C): Constants and variables. Assignment and arithmetic expressions. Logical expressions and control statements, loops, array, input and output statements (with I, F and E formats), function subprogram, subroutine.

2. Numerical analysis: Computer arithmetic and errors in floating point representation of numbers, different numerical methods for the following problems:

Group A

(i) Sorting.
(ii) Read N numbers, find their mean, median, mode
(iii) Find whether a number is prime, factorize a number
(iv) Sum of different types of series term by term with a specified accuracy
(v) Matrix operations (addition, subtraction, multiplication, transpose).

Group B

(i) Solution of simultaneous linear equations by Gauss-Siedel method
(ii) Least square fit of given set of data to a straight line, application to exponential($y = a\ e^{bx}$) and power ($y = a\ x^{b}$) laws.
(iii) Finding zeroes of a given function by the method of bisection and Newton-Raphson
(iv) Interpolation by Lagrange's method
(v) Integration by trapezoidal and Simpson's rule.

The above basic types of programs should be explained in practical classes.

Each student will have to solve one problem each from Group A and Group B (each of 15 marks) during the examinations.

Apart from executing the programs prescribed in the syllabus, students should be encouraged to execute other problems of Physics, particularly associated with practical with the help of computer, using available software packages (e.g. graph plotting etc.)