UNIVERSITY OF DELHI

SCHEME OF EXAMINATION
AND
COURSES OF READING
FOR
B.Sc. (HONOURS) IN PHYSICS EXAMINATION

Part I Examination 1994
Part II Examination 1995
Part III Examination 1996

Syllabi applicable for students seeking admission to the B.Sc. (Hons.) in Physics Course in the academic year, 1993 94

Price : Rs 4-00

THE COURSE OF STUDY FOR B.Sc. (HONS.) PHYSICS EFFECTIVE FROM THE SESSION 1992-93

The integrated B.Sc. (H) Physics programme will be of three years duration. The theory and practical examinations will be held at the end of each year in April/May. There will be six theory papers and two practical laboratory courses each year. In addition, there will be a qualifying English paper in the first year. The final division/rank of a student will be determined by taking into consideration the marks of both the theory and the laboratory papers in all the three years. The marks in qualifying english will not be taken towards determining the division/rank of the student.

Two third papers (12) and lab. papers (4) are from the main discipline, viz. physics and one-third papers (6) and lab. papers (2) are from other disciplines; there is one paper of qualifying English.

The *course of study and examination scheme* for B.Sc. (H) Physics would be as follows.

Paper No.	*Title*	*Duration (Hour.)*	*Maximum Marks*
Ist Years (Part I)			
I	Mathematical Physics	3	50
II	Mechanics	3	50
III	Electricity & Magnetism	3	50
IV	Mathematics I	3	50
V	Chemistry	3	50
VI	Linear & Digital Integrated Circuits & Instruments	3	50
VII	Physics Lab. I	5	75
VIII	Chemistry Lab.	6	75
Q 1	English (qualifying)	3	50*
		Total Marks	450

II Year (Part II)

IX	Mathematical Physics II	3	50
X	Thermal Physics	3	50
XI	Vibrations & Wave Optics	3	50
XII	Quantum Mechanics and Nuclear Physics	3	50
XIII	Mathematics II	3	50
XIV	Computer Fundamental and Programming	3	50
XV	Physics Lab. II	5	75
XVI	'Digital,' Microprocessor & Computer Lab.	5	75
		Total Marks	450

III Year (Part III)

XVII	Mathematical Physics III	3	50
XVIII	Electromagnetic Theory	3	50
XIX	Statistical Physics	3	50
XX	Physics of materials	3	50
XXI	Electronic Devices : Physics and Applications	3	50
XXII	Any one of the following		
	(i) Modern Chemistry	3	50
	(ii) Bio Physics	3	50
	(iii) Economics	3	50
XXIII & XXIV	Physics Lab. III & IV Including Project	5+5	150
		Total Marks	450

Grand Total of I, II and III Year marks 1350

* Marks obtained in qualifying paper shall not be counted for determining the division of the result.

Option to Students

A student has the option to offer any one of the papers listed under paper no. XXII. No paper would be offered unless the numbers of students opting for that particular paper equals or exceeds five. Every college would offer Modern Chemistry and one more option out of Biophysics and Economics.

Remarks on Examinations

1. The examination of each paper in theory and laboratory will be held at the end of the academic year.

2. Students in each theory paper will be required to answer five questions out of which one question will be compulsory with different parts covering the entire course and designed to test application and understanding. There will be some internal choice in compulsory and other questions. The other questions will be distributed over the entire syllabus.

3. In each laboratory paper the students will be required to do one experiment at the time of examination and appear in a written test. Different experiments can be merged or some parts of long experiments deleted to make the experiments roughly of the same difficulty level at the time of examination.

4. In first and second year laboratory papers VII, VIII, XV and XVI, students will be required to do at least ten experiments out of the suggested list distributed over different units.

Third year laboratory papers XXIII and XXIV will run together. The students will be required to perform sixteen experiments (eight in each paper distributed over different units) alongwith a compulsory project.

5. There will be a written test (objective/short answer) based on laboratory experiments and general experimental techniques. This paper will be simultaneously held in all colleges separately for I, II and III years, just one day before the commencement of the practical examinations.

The answer books will be separately evaluated in each college by the group of examiners appointed to conduct the practical examination in that college.

The question papers will be set by a board of examiners appointed by the committee of courses, which will set four to six papers, that may be randomly sent to the various colleges.

The students who fail to appear in the written test will not be given another chance to reappear.

6. Distribution of marks in laboratory papers VII, VIII, XV and XVI will be as follows :

Written test (45 minutes duration)	15
Internal assessment including laboratory report	20
Experiment and viva (35+5)	40
Total (each paper)	75

Distribution of marks in third year laboratory papers XXIII and XXIV (taken together) will be as follows :

Written test (One hour duration)	20
Internal assessment including laboratory report	30
Experiment and viva (30 +5) (Paper XXIII)	35
Experiment and viva (30 + 5) (Paper XXIV)	35
Project including 10 marks for viva	30
Total Marks	150

7. Scheme of Examination for English qualifying paper :

Total marks	50 (duration 3 hours)
Comprehension*	15
Grammar	3
Vocabulary	8
Short composition	7
Reporting experiments/ precis writing	7
Letter writing	5

*Passages set for comprehension need not necessarily be from the prescribed text book.

In order to qualify in english, a student will be required to score a minimum of 40% marks.

Promotion Scheme and Final Result

The present scheme of promotion and facility for repetition of theory papers will continue in regard to two papers (instead of one as at present) which can be carried to the next higher class. The final division will be at the end of Third year taking into consideration all theory and laboratory papers in three years except qualifying english.

Schedule of Teaching

(a) *Theory :* Three periods for each theory course per week.

(b) *Practicals :* Three periods twice a week for each laboratory course.

(c) *Qualifying English* : Two periods per week only in the first year.

DETAILED COURSES OF STUDY FOR B.SC. (HONS.) PHYSICS

The following is the detailed syllabus for each course in first, second and third year of B.Sc. (H) Physics programme.

B.Sc. (H) Part I (First Year)

Paper I : Mathematical Physics I

Vector Algebra and Analysis :

Scalar and vector Products: Space reflection of vectors and scalars, polar and axial vectors and their examples from Physics. Triple and quadruple products. Vector equation of a straight line plane and sphere.

Scalar and vector fields. Differentiation of a vector with respect to scalars. Directional derivatives, gradient, divergence, Curl and Δ^2 operations and their meaning. Idea of line, surface and volume integrals. Gauss, Stokes, and Green's Theorems.

Orthogonal Curvilinear Coordinates and Multiple Integrals :

Orthogonal curvilinear coordinates. Derivation of gradient, divergence, curl and Δ^2 in cartesian spherical and cylindrical coordinates. Change in variables and Jacobian. Evaluation of line, surface and volume integrals.

Differential Equations :

Classification of differential equation : linear and nonlinear, homogeneous and non-homogeneous, and partial differential equations.

Linear Ordinary Differential Equations :

First order : Separable and exact equations. Integrating factor. Physical applications. Coupled equations.

Second order : Homogeneous equations with constant coefficients. Wronskian and general solution. Statement of Existence and Uniqueness theorem for initial value problems. Solution of non-homogeneous equations. Particular integral. Method of undetermined coefficients and variation of parameters.

Equations reducible to equations with constant coefficients. Bernoulli's, Ricati and Euler equations.

The phase plane, critical points, stability and phase portraits of linear differential equations.

Fourier Series :

Fourier series, Dirichlet conditions (statement only) Orthogonality of sine and cosine functions. Sine and Cosine, series. Distinctive features of Fourier expansions. Half range expansions.

Applications : Square wave, triangular wave, output of full wave rectifier and other simple functions. Summing of infinite series, Gibbs phenomenon, Solution of ordinary linear differential equations for periodic excitations.

Theory of Errors :

Systematic and Random errors. Propagation of errors, Normal law of errors, Standard and Probable error. Least square fitting of data (linear case).

Calculus of Variations :

Constrained maxima and minima Method of Lagrange undetermined multipliers and its application to problems in physics.

Variational principle. Euler-Lagrange equation and its Application to simple problems.

Paper II : Mechanics

Fundamentals of Dynamics :

Reviews of Newton Laws. Motion of charged particle in electric and magnetic fields.

Dynamics of a system of particles. Centre of mass. Conservation of momentum. Idea of conservation of momentum from Netwton's third law. Impulse. Momentum of variable mass system; motion of rocket. Work—energy theorem. Potential energy. Energy diagrams. Stable and unstable equilibrium. Conservative and non-conservative forces. Force as gradient of potential energy. Particle collision. Centre of mass and laboratory frame.

Rotational Dynamics :

Angular Momentum of a particle and system of particles. Torque. Conservation of angular momentum. Rotation about a fixed axis. Moment of inertia and its calculation for rectangular, cylindrical and spherical bodies. Theorems of parallel and perpendicular axes. Kinetic energy of rotation. Motion involving both translation and rotation.

Oscillatory Motion :

Motion of a simple and compound pendulums. Loaded spring and LC circuit as its electric analog. Energy consideration. Time average of energy. Damped harmonic oscillator. Resonance in a lightly damped system.

Gravitation and Central Force Motion :

Law of gravitation. Inertial and Gravitational mass. Expt. status of equivalence of gravitational and inertial mass Potential energy and field due to spherical shell and solid sphere.

Self energy. Motion of a particle under central force field. Angular momentum conservation, one body problem, two body problem and its reduction to one body problem and its solution. The energy equation and energy diagram. Kapler's laws. Satellites.

Non-Interial Systems :

Intertial frames and Galilean transformation. Non-inertial frames and fictitious forces. Uniformly accelerating system. Physics in rotating coordinate systems. Centrifugal and Coriolis forces.

Special Theory of Relativity :

Michelson Morley experiment and its outcome. Postulates of special theory of relativity. Lorentz transformations. Simultaneity and order of events. Lorentz contraction and time dilation. Relativistic transformation of velocity, frequency and wave number. Velocity dependence of mass and equivalence of mass and energy. Relativistic Doppler effect. Relativistic Kinematics. Transformation of energy and momentum. Twin paradox.

Paper III : Electricity and Magnetism

Electric Circuits :

Kirchhoff's laws for alternating currents. Thevenin's theorem and Norton's theorem.

Electric Field :

Electric charge; conservation and quantization. Coulomb's law and superposition principle. Electric field and electric lines. Gauss's law. Field of spherical, linear and plane charge distributions. Line integral of electric field. Electric potential. Potential and electric field of a dipole, a charged wire and a charged disc. Multipole expansion of potential due to arbitrary charge distribution. Force and Torque on a dipole. Laplace's equations : Uniqueness theorem. Conductors in a electrostatic field. Description of a system of charged conductors. An isolated conductor and capacitance. Method of images and its application to simple electrostatic problems (Plane infinite conducting sheet and sphere).

Electrostatic Energy :

System of point charges, a uniform sphere, a condenser, an ionic crystal, nucler, electric field, point charge.

Magnetic Field :

Magnetic force between current elements and definition of B, Properties. of B : Vector potential, Ampere circuital law, curl and div. of B. Magnetic flux. Calculation of B for circular and solenoidal currents. Torque on a current loop in a uniform magnetic field. Magnetic dipole. Magnetic shell equivalent. Forces on an isolated moving charge.

Electromagnetic Induction :

A conducting rod moving through a uniform magnetic field. A loop through a non-uniform magnetic field. A stationary loop with field source moving. Faradys's law of induction. Curl E= dB/dt. Mutual induction—Reciprocity Theorem ($M_{12}=M_{21}$). Self Induction, Energy Stored in Magnetic field.

Dielectric Properties of Matter :

Dielectric polarization and polarization charges. Gauss's law in dielectric. Field vectors D and E and their boundary conditions. Capacitors filled with dielectrics.

Magnetic Contribution of matter :

B, H and their relation Magnetic susceptibility and its measurement for paramagnetic liquids. Stored magnetic energy in matter. Magnetic circuit. B—H curve and energy loss in Hysterisis.

Paper IV : Mathematics I

Sequences of real numbers, convergent, Cauchy, monotonic and bounded sequences, subsequences, limit superior and limit inferior of a sequence. Infinite series and their convergence. Comparison test, Cauchy's root test, D 'Alembert's ratio test, Raabe's test, Cauchy's integral test. Alternating series and Leibnitz test. Absolute and conditional convergence.

Functions of a real variable limits, continuity and differentiability of functions, Uniform continuity, Continuity on (a, b) implying

uniform continuity and boundedness. Intermediate value theorems and Taylor's theorem analytic functions. Taylor's and Maclaurin's series of elementary analytic functions.

Functions of two and three real variables, their continuity and differentiability. Schwarz and Young's theorem, Implicit function theorem, Taylor's theorem. Maxima and minima.

Definition and examples of Riemann integral of a bounded function. Riemann integrability of continuous and monotonic functions. Riemann integral as the limit of a sum. The fundamental theorem of integral calculus. Mean—value theorems.

Integration of rational and irrational functions. Integration by partial functions. Properties of definite integrals. Reduction formulae.

Paper V : Chemistry

SECTION A

Bonding : Qualitative approach to Valence Bond Theory and its limitations. Hybridisation equivalent and non-equivalent hybrid orbitals, Bents rule and applications.

Molecular orbital theory, symmetry, and overlap. Molecular orbital diagrams of diatomic and simple polyatomic systems (O_2, C_2, B_2, CO, NO and their ions; HCl, BeF_2, CH_4 BCl_3) (Idea of s—p, mixing and orbital interaction to be given).

Organisation of Solids :

(i) Packing of ions in crystals, close packed structures. Spinel, Ilmenite and Perovskite structures of mixed metal oxides. Size effects radius ratio rules and their limitations. Lattice energy—Born equation (calculations of energy in ion pair and ion pairs square formation), Madelung constant Kapustinskii equation and its applications. Born-Haber cycle and its applications.

(ii) Solvation energy. Packing of atoms in metals, qualitative idea of valence bond and band theories. Semiconductors and insulators. Defects in solids.

Conductance in ionic solids. Introduction to superconductors.

(iii) Weak Chemical forces : van der Waals forces, Hydrogen bonding. Effects of chemical forces on m.p., b.p. and solubility. Energetics of dissolution process.

Coordination Compounds and Inorganic Reaction Mechanisms :

Crystal field theory—measurement of 10 Dq. CFSE in weak and strong fields. Pairing energies, Factors affecting the magnitude of 10 Dq. Octahedral vs. Tetrahedral coordination, tetragonal distortions from octahedral symmetry. The Jahn-Teller theorem, square-planar coordination. Ligand field and molecular orbital theories.

The trans effect, mechanism of the trans effect, kinetics of square planar substitution reactions. Thermodynamic and kinetic stability. Zabile and inert complexes.

Kinetics of octatedral substituion, reactions mechanism of substitution in octahedral complexes. Mechanism of electron transfer reactions (inner & outer spherc mechanism).

SECTION B

General Organic Chemistry :

Bonding in organic molecules and its effects on shape, chirality and RS nomenclature as applied to chiral centers. Treatment of chairality upto threc chiral centres, conformation of acyclic and cyiic systems, conformational analysis of disubstituted cyclohexanes, Geometrieal isomerism and E-2 nomenclature.

Electronic displacements in organic molecules. Aromaticity, Reactivity of organic molecules. Heterolytic and homolytic fission, Nucleophiles, electrophiles, acids and bases and their relative strength (including carbon acids) Addition, elimination and substitution reactions (including electrophilic, nucleophilic and aromatic types).

Arynes and carbenes as reaction intermediates.

Functional Group Chemistry :

Rationalisation of functional group reactivity on mechanistic basis of the following groups : hydroxyl, carbonyl, caoboxyl and its derivatives such as ester and amide, cyano, nitro and amino. Orientation effect in aromatic substitution, polymerisation and overview of polymers. Organic reactions as synthetic tools : Claissen, Cannizzaro, Grignard, Michael, Mannich, Darzen, Aldol, Diekmann, Perkin, etc.

Paper VI : Linear and Digital Integrated Circuits and Instruments

Basic Concept of Integrated Circuits :

Active and passivc components, discrcte component circuits, wafer, chip, advantages of integrated circuits, MSI, LSI and VLSI (Basic indea and definitions only).

Operational Amplifiers (OP-AMP) :

Basic characteristics without detailed internal circuit of IC : Requirement of ideal volttage amplifier, characteristics of ideal operational amplifier, feedack in amplifier (black box approach), open loop and close loop gain, inverting and non-inverting amplifier, zero crossing detector.

Applications of op-amps : Mathematical operations, addition, multiplication, integration and differentiation. Electronic Circuits : Oscillator (Weins Bridge), rectangular and triangular wave generators, (all circuit analysis based ou Kirchhoff's Laws).

Digital Circuits :

Difference between analog and digital circuits, binary numbers, binary to decimal conversion, AND, OR and NOT gates (realization using diodes and transistor), Boolean algebra, Boolean equations of logic circuits, DeMorgan theorem, NOR and NAND gates.

Combinational Logic : Boolean laws and theorem, sum of product methods of realizing a circuit for given truth table, truth table to Karanaugh map and simplification (elementary idea).

Data Processing Circuits : Multiplexers, demultiplexers decoders, encoders, Exclusive OR gate, Parity Checker, Read only Memories (ROM), PROM, EPROM.

Arithmetic Circuits : Binary addition and subtraction (only 2's compliment method), half adders and full adders and subtractors (only upto eight bits).

Sequential Circuits : Flip-flops-RS, JK, D, clocked, preset and clear operations, race around conditions in JK flip-flop, master-slave JK flip-flop as building block of sequential circuits.

Shift Registers : Serial-in-serial out, serial in parallel out, Parallel in Parallel out, Parallel in paralleled out (only upto 4 bits).

Counters : Asynchronous counters, synchronous counters, decade counter.

D/A and A/D Conversion : D/A Converter : Resistive network and binary ladders, accuracy and resolution. A/D converter : (Only counter method) accuracy and resolution. Digital voltmeter,

Simple applications of 555 Timer Circuits.

Electronic Instruments :

Simple concept of active and passive transducers and their importance in using electronic instruments for various applications. Function generator (already done with op-amp).

Power Supply : Requirement of ideal voltage and current source, voltage source, half wave and full wave rectifier, bridge rectifier, L and C filters, some idea of ripple.

Oscilloscope : Input attenuators, dc, ac and ground, horizontal and vertical deflecting system, time base generation and synchronization, measurement of positive, positive-negative wave shape, rise time and fall time, frequency and amplitude and phase of sinusoidal waves.

Paper VII : Physics Laboratory I

Unit I : Methodology

1. Measurement of length using
   - crude estimation, ungraduated and graduated scales
   - triangulation method

- vernier calipers, screw gauge, traveling microscope
- indirect methods e.g. for estimation of atomic size

2. To study the random errors in observations.

3. Experiments for generation and analysis of linear and nonlinear data e.g. flow of liquid through a capillary tube

Unit II : Familiarisation with Devices and Test Equipment

1. Familiarization with basic electronic components.

2. Familiarization with operation of basic measuring and test equipment (power supplies, analog and digital multimeters, function generator and CRO).

3. To test a diode and transistor using multimeter and CRO.

4. Determination of speed of sound by the time of flight method.

Unit III : Electronics for Instrumentation

1. To study an amplifier of given gain using op-amp 741 in inverting and non-inverting configurations.

2. To design a precision differential amplifier of given I/O specifications using 741.

3. To design an astable oscillator of given specifications using timer 555.

4. To design a monostable oscillator of given specifications using timer 555.

Unit IV : Measurement of Resistance and Voltage

1. Precise measurement of a low resistance.

2. To calibrate a Resistance Temperature Device (RTD) to measure temperature in a specified range using.

(a) null method

(b) off-balance bridge with galvanometer based measurement

3. To calibrate a thermo-couple to measure temperature in a specified range using.

(a) null method.

(b) direct measurement using an op-amp difference amplifier.

(In experiments 2 and 3, the measurements suggested are the determination of melting point of a chemical substance like naptha or phenyl acetic acid from its cooling curve, or the study of eutectic mixtures).

Unit V Mechanics

1. To determine the acceleration due to gravity using compound pendulum.

2 To determine the acceleration due to gravity using Kater's compound pendulum.

3. To determine the acceleration due to gravity for a freely falling body, using digital timing techniques.

4. To determine the velocity of an object using digital timing techniques.

Unit VI : Oscillators

1. To investigate the motion of a simple or physical pendulum with (a) variation of moment of inertia. (b) viscous, frictional and electro-magnetic damping.

2. To investigate the motion of coupled oscillators.

3. To investigate the forced oscillations of an LCR circuit in series and parallel configurations.

Paper VIII : Chemistry Laboratory

1. Separation of cations and anions by Paper Chromatography.

2. Preparation of

(i) Manganese (III) Phosphate. Estimation of Mn content in the above Complex colorimetrically (periodate oxidation). Estimation of oxidising equivalents in the above complex titrimetrically (titration of liberated iodine).

(ii) Tetramine Copper (II) sulphate and estimation of Copper as CuCNS gravimetrically in the above complex.

3. Preparation of

(i) Aspirin, (ii) Hippuric acid (Benzol glycine), (iii) Methyl orange or Phenolphthalein. Characterisation by mp, mmp, and TLC.

4. Two steps preparations :

(i) Nitrobenzene, from benzere purification of nitrobenzene and characterisation by refractive index, further nitration.

(ii) P-bromoacetanilide from aniline.

5. Preparation of Lactose and casein from milk or isolation of caffeine from tea leaves (mp, colour tests).

6. Estimation of glucose, Saponification value or Iodine value of a fat or oil.

7. Potentiometric titration of Mohrs' salt with $K_2Cr_2O_7$ or $KMnO_4$ using a digital multimeter or low cost potentiometer.

8. Conductometric titration of a solution of HCl or CH_3COOH with NaOH a direct reading conductometer.

9. Determination of molecular mass of a polymer by measurement of viscosity.

10. The effect of detergent on the surface tension of water. (Variation of surface tension with concentration to be studied).

11. Determination of the rate law for one of the following reactions. All solutions needed to be provided.

(i) Persulphate-Iodide-reaction.

(ii) Iodination of acetone.

12. To study the kinetics of Inversion of cane sugar (Polarimetrically).

Paper Q. 1 : Qualifying English Course A

A textbook-cum-workbook consisting of a selection of essays and poems of special interest to students of science and a workbook

with exercises on vocabulary (word roots, prefixes, infixes and suffixes, antonyms etc.). Comprehension (inference drawing. wherence etc.) and composition exercises.

B. Sc. (H) Part II (Second Year)

Paper IX Mathematical Physics II

Complex Variables :

Importance of complex numbers and their graphical representation. De Moiver's theoren. Roots of complex numbers. Euler's formula. Functions of complex variables. Examples. Cauchy-Reimann conditions. Analytic functions. Singularities. Differentiation and integration of a function of a complex variable. Cauchy's theorem. Cauchy's integral formula, Morera's theorem. Cauchy's inequality. Liouville's theorem. Fundamental theorem of algebra. The Argument Theorem.

Power series of a complex variable; absolute and uniform convergence test. Taylor and Laurent series. Residue and Residue Theorem. Contour integration and its application to evaluation of integrals and series. Multiple valued functions. Branch points and Riemann surfaces.

Series Solution of Lrneur Second Order Ordinary Differential Equation :

Singular points of second order differential equations and their importance, Series methods (Frobenius), Simple examples. Legendre, Bessel, Hermite and Laguerre differential equations.

Special Functions :

Gamma and Beta functions.

Legendra Hermite and Laguerre polynomials : Rodrigue's formulae, generating functions, recurrence relations, orthogonality. Associated Legendre functions. Spherical harmonics.

Bessel functions : First and second kind, generating function, recurrence formulas, zeros of Bessel functions, Orthogonality and Asymptotic formulas. Fraunhoffer diffraction integral.

Series expansion of a function in terms of a complete set of orthogonal functions.

Partial Differential Equations :

General solution of wave equation in 1-dimension. Transverse vibration of stretched string. Oscillation of hanging chain. Wave equation in 2-and 3-dimensions. Vibrations of rectangular and circular membrane.

Derivation of the equation of heat conduction. Linear flow. Two and three dimensional heat conduction. Temperature inside circular plate.

Laplace equation in Cartesian, cylindrical and spherical coordinate system. Problems of steady flow of heat in rectangular and circular plate. Gravitational potential of a ring.

Paper X : Thermal Physics

Kinetic Theory of Gases :

Derivation of Maxwell's law of distribution of velocities and its experimental verification. Mean freepath. Transport phenomena, viscosity, conduction and diffusion. Brownian motion. Langevin and Einstein's theories and experimental determination of Avogadro's number. Examples of Brownian motion in physics (galvanometer mirror, sedimentation. Johnson's noise).

Ideal gases : Equation of state, internal energy, specific heats, entropy. Isothermal and adiabatic processes. Compressibility and expansion coefficient, Adiabatic lapse rate.

Real gases : Deviations from the ideal gas equation. The virial equation Andrew's experiments on CO_2 gas, continuity of liquid and gaseous state. Van der wall's equation. Critical constants and law of corresponding states. Free expansion. Joule-Thompson effect,

Thermodynamics

Zeroth and First law of thermodynamics. Reversible and irreversible processes. Conversion of heat into work, Carnot theorem. Second law of thermodynamics. Thermodynamic temperature. Clausius inequality. Entropy. Entropy changes in reversible and irreversible processes. Temperature-Entropy diagrams. The principle of increase of entropy: applications.

Thermodynamic Potentials : Enthalpy, Gibb's Helmholtz functions. Maxwell relations and their applications. Magnetic work. Magnetic cooling by adiabatic demagnetization, approach to absolute zero. Change of phase, equilibrium between a liquid and its vapour. Clausius-Clapeyron equation. The triple point with examples from Physics, second order phase transitions.

Paper XI : Vibrations and Wave Optics

Vibrations :

Free oscillations of systems with one degree of freedom, Linearity and superposition principle. Superposition of (i) two, and (ii) N collinear harmonic oscillations ; beats. System with two degrees of freedom (coupled oscillators). Normal coordinates and normal modes. Energy relation and energy transfer. Normal modes of N coupled oscillators. Normal modes of stretched string. Energy of vibrating string. Plucked and struck strings.

Waves :

Wave equation. Traveling waves. Plane and spherical waves. Superposition of two harmonic waves. Standing waves on a string. Superposition of N harmonic waves. Pulses and wave packets.

Acoustics :

Reflection, refraction and diffraction of sound, acoustic impedance of a medium, production of ultrasonic waves, measurement of frequency and velocity of ultrasonic waves, principle of Sonar system. Acoustic of halls.

Wave Optics :

Light Waves, Electromagnetic nature of light waves.

Conference and Interference :

Interaction of independent sources of light. Demonstration of interference by Lloyd's mirror and Fresnel's Biprism. Classification in terms of division of amplitude and division of wave front, Michelson's interferometer.

Theory of Partial Coherence. Visibility of fringes. Coherence time and coherence length. Spatial coherence.

Interference in thin films : Parallel and wedge shaped films. Fabry-Perot interferometer.

Diffraction ;

Kirchhoff's integral theorem and Fresnel-Kirchhoff's integral formula. Fraunhofer and Fresnel diffraction. Fraunhofer diffraction patterns of a single slit, rectangular and circular aperture. Multiple slit. Plane diffraction grating. Resolving power and dispersive power of a plane diffraction grating.

Fresnel's integrals. Cornu's spiral. Fresnel diffraction pattern at a straight edge, a slit and a wire.

Holography : Principle of holography, interference between two plane waves. Point source holograms.

Paper XII : Quantum Mechanics and Nuclear Physics

Particle and Waves :

Photoelectric effect. Compton effect. Franck-Hertz experiment. Reduced mass correction. de Broglie hypothesis. Wave particle duality. Davission-Germer experiment. Wave packets. Two slit experiment with electrons. Probability. Wave amplitude and wave functions. Uncertainty prenciple.

Quantum Mechanics :

Basic Postulates and formalism : Schrodinger equation, wave function, eigen values, probabilistic interpretation, conditions for physical acceptance of wave functions. Free particle. Time independent Schrodinger equation, stationary states, Particle in one dimensional box, quantization of energy.

Scattering problem in one-dimension : Reflection and transmission by a finite potential step. Stationary solutions, probability current. Attractive and repulsive potential barriers. Quantum phenomena of tunneling. Spectra for a square well.

Bound state problems : General features of a bound particle system. One dimensional simple harmonic oscillator. Particle in a spherically symmetric potential. Orbital angular momentum and azimuthal quantum numbers and space quantization. Physical

significance. Radial solutions and principle quantum number. Hydrogen atom.

Atoms in electric and magnetic field : Electron spin. Stern-Gerlach experiment. Orbital angular momentum, magnetic dipole moment and energy in magnetic field from classical viewpoint. Zeeman effect. Spin-orbit coupling. Fine structure. Total angular momentum.

Many electron atoms : Pauli exclusion principle. Many particles in one dimensional box. Symmetric and anti-symmetric wave functions. Atomic shell model and periodic table. Spectral notations for atomic states. Vector model. LS and JJ coupling. Doublet structure of alkali spectra. Empirical evidence of multiplets. Selection rules.

Nucleus :

Properties : Mass, size, angular momentum, constituents, binding energy, stability

Models : Liquid drop model. Mass formula. Shell Model. Nuclear forces.

Radioactivity : Law of radioactive decay. Theory of successive radioactive transformations. Radioactive series. Theory of alpha decay. Beta-decay and Neutrino hypothesis. Gamma-decay.

Paper XIII : Mathematics

Sequences and series of functions of a real variable. Pointwise and uniform convergence. Weirstrass M-test. Uniform convergence and continuity. Uniform convergence and differentiation. Uniform convergence and integration. Weirstrass approximation Theorem. Power series and their convergence and uniform convergence. Definition of exponential, logarithmic and trigonometric functions by means of power series.

Improper integrals and their convergence. Comparison, Abel's and Dirichlets tests. Beta and Gamma functions and their properties. Differentiation under the sign of integration.

Statistics :

Probability : Classical, relative frequency and axiomatic approaches to probability. Theorems of total and compound probability. Conditional probability, independent events. Bayes theorem. Random variables. Discrete and continuous random variables distribution function. Expectation of a random variable. Moments, moment generating function and probability generating function.

Discrete and continuous distribution: Binomial, Poisson, Geometric, Normal and Exponential distributions, Bivariate distribution, conditional distribution and marginal distribution. Correlation and regression for two variables only. Weak law of large numbers. Central limit theorem for independent and identically distributed random variables.

Statistical inference: Definitions of random sample, Parameter and statistic. Concept of sampling distribution and standard error. Sampling distribution of mean variance of random sample from a normal population. Tests of significance based on t, F and chi-square distributions.

Paper XIV-Computer Fundamental and Programming

(a) Basic components of a computer system; their function and inter-relation; types of computer systems; number systems (binary, octal and hexadecimal) and arithmetic; internal data representation; integer floating point numbers.

Data storage; semiconductor main memory; cache memory; magnetic tapes/disks; data organization methods; Read/Write operations; floppy disk; optical disk and CD-ROM.

Input/output devices: tape/disk/diskettes; VDU; lightpen; mouse & joysticks; MICR, OMC, OCR; serial, line and page printers.

Microprocessor Architecture: processor organization; registers; instruction cycle; instruction sets; instruction types; ALU and Control Unit Characteristics and functions (Inte/ 18085/8086 microprocessor may be used for illustration).

(b) Problem solving and Pascal Programming: Algorithms & flowcharts; program definition and development concepts; structure programming; data types; constants and variables; expression and statements; input/output commands; control and interative structures; data structures-arrays, records, sets, files; sub-programms; recursion.

(c) *Numerical Computation*

Truncation and roundoff errors; floating point computations; overflow and underflow; single & double precision arithmetic; error analysis and stability considerations.

Numerical differentiations and integration; numerical differentiation of data and functions; quadrature rules trapezoidal, Simpson's and Gauss-Jacobi; choosing quadrature formula.

Solution of O.D.E. : Predictor-Corrector method; error estimation & stability; Runge-Kutta second order method; practical error estimation; step-size strategy; comparison of Runge-Kutta & Predictor-Corrector methods. Solution of linear, nonlinear equations : Simultaneous linear equations; Computation of eigen values & eigrn vectors of matrices; error considerations and convergence.

Paper XV : Physics Laboratory II

Unit I : Familiarisation with Devices

1. Measurement of focal length of lenses, combination of lenses. Familiarization with eye-pieces.

2. Familiarization with spectrometer. Schuster's focusing.

3. Familiarization with ballistic galvanometer.

4. Investigation of factors which affect induced voltages in a coil using a CRO.

5. Investigation of factors which determine secondary emf and current in coupled coils.

UNIT II : Measurements in Waves and Optics.

1. Determination of resolving and dispersive power of dispersing devices ((i) prism and (ii) diffraction grating)

2. Measurement of intensity using photo-sensor and laser in diffraction patterns of single and double slits.

3. Measurement of a small thickness using interference.

4. Measurement of refractive index of transparent and opaque liquids using total internal reflection.

5. Determination of Cauchy's constants.

6. Determination of an unknown wavelength using (i) prism and (ii) diffraction grating.

UNIT III : Measurement of High Resistance and Charge

1. Determination of dielectric constant of a dielectric placed inside a parallel plate capacitor using Ballistic galvanometer.

2. Mesurement of charge by determination of time of impact.

3. Measurement of resistance by methods of leakage.

UNIT IV : Measuremeot of Self Inductance and Mutual Inductances

1. Using Absolute method

2, Using A.C. Bridge.

UNIT V : Measurement of Temperature

1. Determination of heat conductivity of a good conductor by Angstroms methods.

2. Determination of heat conductivity of a bad conductor (Lees method. Use of heating clements in preference to steam recommended).

Paper XVI : Digital Electronics, Microprocessors and Computers Liboratory

Unit I Combinational Logic

1. Verification and design of AND, OR, NOT and XOR gates using NAND gates.

2. To design a combinational logic system for a specified truth table.

3. To convert a Boolean expression into a logic gate circuit and assemble it using logic gate ICs.

4. To minimize a given logic circuit

5. To study TTL ICs (Binary decoder, 7-segment decoder, Schmitt trigger).

6. To design a seven segment display driver.

Unit II : Arithmetic and Logic Units (ALU)

(Building of basic ingredients of ALU)

1. Half adder, Full adder, 4 bit binary adder.

2. Half subtractor, full subtractor, adder-subtractor using full adder IC.

Unit III : Flip-Flops, Counters and Shift Registers :

1. To build Flip-flop circuits using elementary gates (RS, Clocked RS, D-type, JK flip-flop).

2. To build a 4-bit counter using D-type flip-flop.

3. To make a shift register from D-type flip flop.

4. Serial and parallel shifting of data.

Unit IV : Analog/Digital Conversion

1. To design an analog to digital conveter of given specifications.

2. To design a digital to analog converter of given specifications.

Unit V : Familiarisation with the Microprocessor Kit

1. Use of hardware.

2. Use of registers.

Unit VI ; Elements of Machine Language and Pascal Programming

1. Addition and subtraction of numbers using direct and indirect addressing modes.

2. Multiplication by repeated addition.
3. Division by repeated subtraction-
4. Other algorithms multiplication and division.
5. Handling of 16-bit numbers.
6. Use of CALL and RETURN instructions.
7. Block data handling.
8. Other exercises (e.g. parity check etc.)
9. Programming exercise based on computer course. (a)
10. Programming exercise based on computer course. (b)
11. Programming exercise based on computer course. (c)

B.Sc. (H) Part III (Third Year)

Paper XVII : Mathematical Physics III

Linear Vector Spaces and Matrices :

Introduction to groups, rings and fields.

Vector spaces and subspaces. Linear independence-basis and dimensions. Linear transformations. Algebra of linear transformations. Non singular transformations. Isomorphism. Representation of linear transformation by matrices. Transpose of linear transformations.

Special matrices: Hermitian and Skew-Hermitian, symmetric and anti-symmetric, orthogonal and unitary matrices. Similarity transformations and Biquadratic forms. Trace of a matrix. Caley - Hamilton theorem. Function of a matrix.

Metric spaces. Inner product and metric concept. Dual vector spaces.

Sturm-Liouville's theorem.

Cartesian Tensors :

Transformation of coordinates. Tensorial character of the physical quantities. Symmetric and anti-symmetric tensors. Contraction and differentiation. Pseudotensors. Kronecker and

alternating tensors. Determinants using higher order alternating tensors. Stress and strain tensor. Elasticity tensor.

Integral Transform :

Fourier transform : Fourier integral theorem. Sine and Cosine Transforms. Convolution theorem. Solution of one dimensional diffusion and wave equation. Heat flow in an infinite and semi-infinite rod.

Step function and Dirac delta function.

Laplace transform : Transform of elementary functions, derivatives and integrals. Unit step function. Periodic functions. Translation, substitution and convolution theorem. Inverse transform (Bromwich integral). Solution of first and second order ordinary differential equations with constant coefficients and simultaneous first order ordinary differential equations. Solution of partial differential equations.

Evaluation of integrals using transform.

Matrix Algebra : Addition and multiplication. Null and unit matrices. Singular and non-singular matrices. Inverse of a matrix. Eigen values and eigen vectors Diogonalization. Solution of coupled linear ordinary differential.

Paper XVIII : Electromagnetic Theory

Maxwell equations. Displacement current. Vector and scalar potentials. Gauge transformations : Lorentz and Coulomb gauge. Boundary conditions at interfaces between different media. Wave equations plane waves in dielectric media.

Poynting theorem and Poynting vector. Energy momentum tensor. Angular momentum. Magnetic monopole (Quantisation of charge).

Polarization of e.m. wave. Description of linear, circular and elliptic polarizatian.

Reflection and refraction of a plane wave at a plane interface between dielectrics. Fresnel formulae. Total internal reflection. Brewster's angle.

Waves in conducting media. Metaleic reflection (normal incidence) Skin depth.

Wave guides. Coaxial transmission line. Modes in a rectangular wave guide. Energy flow and attenuation in wave guides. Resonant cavities.

Planar optical wave guides. Planar dielectric wave guide condition of continuity at the interfaces, phase shift on total refection, eigen value equations, phase and group velocity. field energy and power transmission. Optical fibre—Numerical aperture, step index and graded index single mode and multiple mode fibres.

Propagation of e.m. waves in anisotropic media. Symmetrie nature of dielectric tensor. Fresnel's formula. Light propagation in uniaxial crystal. Double refraction. Nicol prism. Production of circularly and elliptically polarized light. Babinet compensator. Analysis of polarized light.

Maxwell's equations in Microscopic media (plasma). Characteristic plasma frequency. Refractive index. Canductivity of an ionised gas. Propagation of electromagnetic waves in ionosphere.

Paper XIX : Statistical Physics

Classical Theory of Radiation : Kirchhoff's law, Stefan's Law, Wien's Displacement Law, Planck's Law.

Classical statistics : Entropy and thermodynamic probability, Maxwell Boltzman distribution, Partition function, Thermodynamic functions of finite number of energy levels, Negative temperature, Thermodynamic functions of an ideal gas, Classical entropy expression, Gibb's paradox, Law of equipartition of energy and its application to specific heats, specific heat of hydrogen. Ortho and para hydrogen.

Quantum Statistics : Bose-Einstein and Fermi-Dirac distribution laws, Calculation of the thermodynamic functions of an ideal weakly deganerate gas, strong degeneration, Calculation of the thermodynamic functions of an ideal Bose gas, Bose-Einstein condensation, Properties of liquid He (qualitative description), Radiation

as a gas of photons and Bose's derivation of Planck's Law, Flux of radiation energy, radiation pressure.

Laser : Working principle, Thermal equilibrium of radiation, Principle of detailed balance, Einstein A and B coefficients, Population inversion, optical pumping, Two level and three level system.

Fermi energy : Thermodynamic functions of an ideal fermi electron gas, Free electron model for metal, specific heats of metals, Richardson's equation of thermal ionisation. Relativistic fermi gas, white dwarf stars, Chandrasekhar mass limit.

Third law of thermodynamics : Absolute definition of entrophy, consequences of the third law, unattainability of absolute zero.

Paper XX : Physics of Materials

Crystal Structure :

Amorphous and crystalline materials.

Lattice translation vectors. Lattice with a basis central and non-cental elements. Unit Cell, reciprocal lattice. Types of lattices. Crystal Diffraction : Bragg's law Diffraction of X—rays. Defects in crystals.

X-ray Diffractometer—Measurement of lattice constants.

Elementary Lattice Dynamics :

Lattice vibrations. Linear monoatomic and diatomic chains. Acoustical and optical phonons. Qualitative description of the phonon spectrum in solid. Brillouin zones. Einstein and Debye theories of specific heat of solids. T^3 law.

Dielectric Properties of Materials :

Polarization. Local electric field at an atom. Depolarization field. Lorentz fields of dipoles inside a cavity.

Dielectric constant and polarizability : Electric susceptibility, polarizability, Clausius-Mossoti equation. Classical Theory of electronic polarizability. Normal and anomalous dispersion. Cauchy, Sellmier's relations. Orientational polarizability and Langevin—

Debye equation Complex dielectric constant, dielectric constant and loss. Conducting and dielectric sphere in a Uniform field. Qualitative discussion of pyroelectric, piezo-electric and ferro-electric properties of materials.

Measurement of dielectric constant and loss, and P-E hysteresis loop in ferroelectricity.

Magnetic Properties of Matter :

Response of substances to magnetic field. Dia, para and ferri and ferromagnetic materials. Langevin's theory of dia-and para-magnetic domains. Ferri magnets and Ferrites. Measurement of magnetic permeability and B—H hysteresis.

Elementary Band Theory :

Kronig Penny model. Band gaps. Conductors. Semicor-ductors and Insulators. P and N type semiconductors. Con-ductivity of semiconductors, mobility, Hall effect. Measurement of conductivity (Four probe method) and Hall coefficient.

Superconductivity :

Experimental properties; Meissner effect. Type I and type II superconductors. London Equations. Penetration depth. Flux quantization.

Paper XXI : Electronic Devices—Physics and Applications

Electronic Devices : Historical background, vacuum tube diodes and triode. Construction and characteristics. μ, r_p, and g_m of vacuum tube triode.

Basic Semiconductor Physics, p and n type semiconductors energy level diagram, conductivity and mobility (Only basic equations, detailed physics in paper XVI.), pn junction Fabrication (simple idea), Barrier formation in pn junction diode, current flow mechanism in forward and reverse biased diode (recombination drift and saturation of drift velocity). Derivation of mathematical equations for barrier potential, barrier width and current.

Single pn junction devices (physical explanation, current voltage characteristics and one or two application) ; (two terminal

devices) rectifier diode, zener diode, photodiode, LED, solar cell and varactor diode. (Three terminal devices) junction field effect transistor (FET), definitions of μ, r_p and g_m)Unijunction transistor (UJT).

Two junction devices : p-n-p and n-p-n transistor, physical mechanism of current flow, active, cutoff and saturation regions, transistor in active regions and equivalent circuit. T and π equivalent of a black box circuit, Thevenin and Norton theorem, Maximum power transfer theorem, z, y and h parameters, equivalent circuit of a triode valve, FET and BJT in active linear region,

Amplifiers : Only bipolar junction transistor. CB, CE and CC Configurations, biasing and stabilisation circuits, Q-point, equivalent circuit, input impedance, output impedance, voltage and current gains. Class A, B and C amplifiers definitions. RC coupled amplifiers (frequency response, Bode plot, amplitude and phase). Tuned amplifiers, power amplifier (push-pull circuits).

Feedback in amplifiers : Voltage and current feedback, effect of negative and positive feedback on input impedance, output impedance and gain, stability, distortion and noise.

Oscillators : Barkhausen criteria, Hartley, Colpitts, RC and crystal oscillators.

Multivibrator and Sweep circuits : Basic circuits of astable, bistable and monostable multivibrators, details of astable multivibrators (Deviation of time period). Simple idea of a sweep circuit using transistor as a switch and UJT.

Modulation and detection : Basic concepts of amplitude, frequency and phase modulations, and pulse code modulation and demodulation. Detailed circuit of amplitude modulation and balanced detector, modulation and demodulation of optical waves (elementary idea of optical communication).

Paper XXII (Option—1) : Modern Chemistry

Quantum Chemistry :

A review of Schrodinger equation, quantum mechanical operators (eg. Hamiltonian operator). Solution of Schrodinger equa-

tion for single particle systems. Electron spin. Pauli exclusion principle.

Quantum mechanics of polyelectronic systems (atoms and molecules). The Helium atom. Self-consistent field method (qualitative account). The variation theorem-its statement and use. Chemical bonding. Valence Bond and Molecular Oribital approaches. Thc L.C.A.O. treatment of H_2^+ and H_2 molecules. Valence Bond treatment of H_2.

Bonding in heteroatomic diatomic molecules (eg. HF.), triatomic molecules (BeH_2, H_2O), polyatomics (NH_3) II-electron theory (Huckel theory) for conjugated systems (eg. Butadien).

Molecular Spectra :

Electromagnetic radiation, the quantization of different forms of energies in molecules (translational, rotational, vibrational and electronic). Interaction of electromagnetic radiation with molecules; various types of spectra, Born-Oppenheimer approximation.

Rotational Spectra :

Rigid rotator model, rotational spectra, Intensity of spectral lines and determination of bond distance of diatomic molecules. Isotopic substitution.

Vibrational Spectra :

Vibrational energies of diatomic molecules, zero-point energy. evaluation of force constant and stiffness of the bond. Amplitude of diatomic molecular vibrations, Anharmonicity, Morse potential. Dissociation energies. Concept of group frequencies.

Raman Spectra :

(Qualitative Treatment). Raman effect, rotational Raman spectra, Vibrational Raman spectra, Stokes and antistokes lines and their intensity difference. Rule of mutual exclusion.

Electronic Spectra :

Frank-Condon Principle, electronic transitions. Single and triplet states. Flourescence and phosphorescene. Dissociation and

predissociation. Calculation of electronic transitions of polyenes using free electron model (particle in a box).

NMR : Principle, Larmor precession. Chemical shift and low resolution spectra, and scales. Spin-spin coupling and high resolution spectra. (Interpretation of PMR spectra of A-X type organic molecules).

ESP : Principle, hyperfine structure, ESR of simple radicals, (methyl radical, Vanadyl ion).

Paper XXII (Option—2) : Bio-Physics

Intra and intermolecular interactions : Forces responsible for molecular conformation e.g. Hydrogen bonds. Ionic interaction. Van der waals interaction, Hydrophobic interaction, Interaction between structural units.

Protein structure : Amino acids, Peptide bond, primary, secondary, tertiary, quarternary structure of protein, Principles of protein folding, Enzymes.

Nucleic acid structures : Purine and Pyrimidine bases, sugar, nucleosides and nucleotides, RNA structure, DNA—the genetic material, DNA structure and conformation, polymorphism, supercoiling of DNA, linking, twisting and writhing brief ideas. The phenomenon of cooperativity, Helix coil transitions in nucleic acids and proteins.

Biological Membranes : Basic components of membrane structure, Lipids, Micelles and reverse micelles, Bilayers, Liposomes, structural determinants of bilayer formation. Phase transitions in bio-membranes. Techniques to detect phase transitions e.g. scanning colorimetry etc.

Elements of non-equilibrium thermodynamics, Membrane transport, Active and passive transport, coupling of transport processes, Membrane potential, Basic ideas of cybernetics.

Other Biological Polymers : Polysaccharides, Associations formed among different macromolecular types, protein lipid interaction. nucleoproteins.

Non-linear Dynamic Processes : Non-linear systems, critical points, stability, limit cycles, bifurcation theory. autocatalytic systems, Lotka Volterra equation and its application in ecosystem analysis, Oscillatory reactions in biology.

Prebiotic Evolution : Theories and models, Eigen's hypercycle. Kimura's ideas, nonlinearity and biological evolution.

Biological spectroscopy : Quantum physics of chemical bonding. Molecular orbitals, Absorption spectroscopy, Infrared and Raman spectroscopy, Fluorescence spectroscopy. Light scattering in Biology, X-ray crystallography in biomolecular structure determination. NMR, ESR, CD-ORD.

Neurobiophysics :

Biophysics of perception : Brain structure and Function, Neurones; Excitation and transmission of impulse, Information processing in brain. Fundamentals of sensory transduction systems in cells, mechanoreception, chemoreception, photoreception, electroreception, Geobiophysics.

Applications and Current Trends in Biophysics : e.g. Biomechanics. Medical biophysics, various kinds of instrumentations. Biosensors, drug delivery, use of isotopes.

Paper XXII (Option-3) : Economics

I. Microeconomics

1. The Theory of Consumer Behaviour :

Utility Function and Demand Function, Substitution and Income Effects. The Slutsky Equation, The Theory of Revealed Preference, Consumer's Surplus The Expenditure and the Indirect Utility function.

2. The Theory of the Firm :

The production Function, Constrained output maximization and cost minimization, Cost Function, The Short Run and the Long Run.

3. Market Structures :

Perfect Competition, Monopoly, Monopolistic Competition, Duopoly and Oligopoly.

4. General Equilibrium Theory :

The existence of Equilibrium, Stability and Uniqueness of Equilibrium.

5. Welfare Economics :

Pareto Optimality and the Efficiency of Perfect Competition, Social Welfare Functions, Utilitarianism and Equity.

II. Macroeconomics :

1. National Income Accounting :

The concepts of Gross National Product. Net National Product and other macro aggregates, Real and Nominal GNP.

2. The Simple Keynesian Model :

Equilibrium level of Income and Output. The Consumption Function, Saving and Investment, The Multiplier.

3. Money, Interest and Income :

The Product Market and the Money Market Equilibrium, The Role of Monetary and Fiscal Policy in Macroeconomic Management.

4. Macroeconomics in an open economy :

Trade and Capital Flows under Fixed and Flexible Exchange Rates, The Monetary Approach to the Balance of Payments, Devaluation.

III. Econometrics

1. Problems of Estimation and Inference in the Two Variable Linear Regression Model.

2. Multiple Regression—estimation and interpretation tests and tests of the General Linear Hypothesis.

3. Violations of the classical assumptions : multicollinearity serial correlation and heteroscedasticity.

Paper XXIII : Physics Laboratory III

Unit I : Measurement of Magnetic field and related parameters

1. Measurement of field strength B and its variation in a solenoid (determination of dB/dx).

2. Determination of the B/H curve using Ballistic galvanometer.

3. Determination of magnetic susceptibility for liquids and solids.

Unit II : Measurements of spectra

1. Determination of wavelength of H-a emission line of hydrogen atom.

2. Determination of absorption lines in the rotational spectra of iodine vapour.

Unit III : Determination of Fundamental constants

1. Determination of Boltzmann constant by studying forward characteristics of a diode.

2. Determination of e/m by method of magnetic focusing or bar magnet.

3. Determination of Stefan's constant.

Unit IV : Measurements in solid state Physics

1. Measurement of resistivity as a function of temperature for a Ge crystal using four probe method (Temp. R.T to 200 C) and determination of energy gap.

2. Determination of Hall coefficient of a given sample.

3. Measurement of PE Hysterisis of a ferro-electric crystal.

4. Measurement of magnetic susceptibility.

Unit V : Miscellaneous

1. Polarization of light by simple reflection (determination of variation of percentage reflection and degree of polarization with angle of incidence).

2. Determination of specific rotation for a (sugar) solution.
3. Study of elliptically polarized light.
4. Diffraction using ultrasonic grating.

Paper XXIV : Physics Laboratory IV

Unit I : Power supply

1. To design a semiconductor power supply of given rating using half or full wave or bridge rectifiers.
2. To investigate the effect of filters.
3. To investigate simple regulation and stabilization circuits using zener diodes and voltage regulator ICs.

Unit II : Transistor Applications

1. To study the various transistor biasing configurations.
2. To design an amplifier of a given gain.
3. To design an oscillator of given specifications.
4. To study the characteristics of FET and design a common source amplifier.

Unit III : Operational Amplifier based Experiments

1. To investigate the use of an op-amp as an integrator and a differentiator.
2. To design an analong circuit to simulate the solution of a first/second order differential equation.
3. To design an op-amp oscillator.

Unit IV : Modulation

1. To study amplitude modulation.
2. To study a crystal rectifier.
3. Pulse width/pulse, position and pulse amplitude modulation using IC's.

Unit V : Multivibrator and sweep circuits

1. To study the characteristics of UJT and design a simple relaxation oscillator.

2. To design an astable multivibrator of given time period (ms order).

3. To design a sweep of given amplitude and time.

Unit VI : Transducers

1. Determination of coupling coefficient of a piezo-electric crystal.

2. To determine the characteristics of p–n junction of solar cell.

3. To study the characteristics of a photo-diode.

Unit VII : Networks,

1. Verification of Thevenin, Norton and Maximum Power Transfer Theorems.

2. Measurement of input and output impedance of an unknown network and making equivalent T and π circuits.