VIDYASAGAR UNIVERSITY

PHYSICS

(Honours & General)

Under Graduate Syllabus

(3 Tier Examination Pattern)

w.e.f. 2014-2015

REVISED

Vidyasagar University

Midnapore 721 102

West Bengal

PHYSICS
(HONOURS)

Honours Course:

The entire course is divided into eight Papers with total 800 marks to be studied in three years. At the end of 1st year there will be Part - I examination of two theoretical papers (Paper I, II), at the end of 2nd year two theoretical papers and one practical paper in Part II examination. At the end of 3rd year there will be one theoretical paper and two practical papers in Part III examination. Final result will be determined on the basis of Part – I, Part – II and Part – III examination taken together.

The number of total lectures allotted for each theory paper is 180 including tutorial classes which have been allotted for each course for group discussion, problem session and demonstration experiments or general guide line on different aspects.

Examination Pattern for Theory & Practical Papers:
For each theory paper: University Written Exam 90 marks – 4 hours
Internal Assessment – 10 marks
Practical Papers: Paper V – VA 50 marks – 6 hrs
VB 50 marks – 6 hrs
Paper VII – 100 marks – 6 hrs
Paper VIII A & B – 70 marks – 6 hrs

Honours Course Structure in Physics

Year	Paper	Topic	No. of Lectures + Tutorial Classes / Practical Classes	Weight of Marks allotted for University written Examination	Marks allotted for Internal Assess-ment	Total marks
Part-I	I	Mathematical methods I	36 + 4	20	10	100
		General Properties of Matter	18 + 2	10		
		Vibration & Waves	27 + 3	15		
		Geometrical & Physical Optics	54 + 6	30		
		Electronics I	27 + 3	15		
	II	Mechanics I	45 + 5	25	10	100
		Heat	36 + 4	20		
		Thermodynamics	36 + 4	20		
		Electrostatics	27 + 3	15		
		Current Electricity and Magnetism I	18+2	10		

Year	Paper	Topic	No. of Lectures + Tutorial Classes / Practical Classes	Weight of Marks allotted for University written Examination	Marks allotted for Internal Assess-ment	Total marks
Part-II	III	Mathematical Methods II	45 + 5	25	10	100
		Relativity	18 + 2	10		
		Current Electricity and Magnetism II	36+4	20		

		Electromagnetic Theory	36 + 4	20		
		Quantum Mechanics I	27 + 3	15		
	IV	Mechanics II	45 + 5	25	10	100
		Atomic, Molecular Phys with LASER	36 + 4	20		
		Electronics II	45 + 5	25		
		Nuclear Physics I	36 + 4	20		
	V	VA. Non-electrical Practical (Throughout 1st and 2nd year)	2(X 3 classes) per week – 1st year 4(X 3 classes) per week - 2nd year	----------		100
		VB. Electrical & Electronics Practical (Throughout 1st and 2nd year)				
Part-III	VI	Quantum Mechanics II	45 + 5	25	10	100
		Nuclear Physics II	36 + 4	20		
		Statistical Mechanics	36 + 4	20		
		Solid State Physics	45 + 5	25		
	VII	VIIA. Practical: Analog electronics experiments	4(X 3 classes) per week	----------		50
		VIIB. Practical: Digital electronics experiments		----------		50
	VIII	VIIIA. Practical: Non Electronic experiments		----------		50
		VIIIB. Computer Practical	2(X 2 classes) per week	----------		20
		VIIIC. Project Work	8-10 hours of contact per student	----------		30

Practical Papers (Honours Course)

Marks Distribution:

Part II	Paper VA	Full marks- 50 (Expt. – 40, LNB – 5, Viva - 5)
	Paper VB	Full marks- 50 (Expt. – 40, LNB – 5, Viva - 5)
Part III	Paper VIIA	Full marks – 50 } (Expt. - 80, LNB
	Paper VIIB	Full marks – 50 } 10, Viva - 10)
	Paper VIIIA	Full marks- 50 (Expt. - 40, LNB - 5, Viva - 5)
	Paper VIIIB (Computer)	Full marks- 20 (Program writing with algorithm and showing result – 16, LNB – 4)
	Paper VIIIC (Project)	Full marks- 30 (Nature of work – 10, Presentation – 10 and Viva – 10)

Laboratory Teaching Classes

One laboratory class (of 3-period duration) per week should be devoted to teach the following topics during the first two months of the first year. These lectures should be taken in laboratory and should be of interactive type so that students also participate in the learning process.

As the course on computer will be taught in the third year, students should get one theory class (of 3-period duration) on Computer per week during the first three months of the third year. After that period each student has to write a number of computer programmes and execute them on a computer. The programmes and the results should be collected in the form of a note book and that is to be submitted at the time of practical

examination in Part III. This Computer Note Book [CNB] must be signed by the class teacher. During the practical examination, the examiners will check the CNB and ask questions on the report presented by the students in their CNB. The students also will have to solve one problem during the examination.

Laboratory Teaching

1. Demonstration lectures on use of vernier, micrometer, spherometer, barometer, common balance, etc.; graph plotting -2 Lab-class

2. (i) Basic ideas of Probability & Statistics
   (ii) Error analysis, significant figures, limits of accuracy of an Experiment-associated choice of equipments. -3 Lab-class

3. Measuring instruments (e.g. Galvanometer, Multimeter & CRO) to be used in the laboratory -3 Lab-class

Total = 8 Lab-class

In practical classes all data should be recorded directly in the Laboratory Note Book and should be signed regularly by the attending teachers. This Note Book should be submitted at the time of final practical examination. Separate fair L.N.B. needs not to be maintained. The evaluation of the L.N.B. will be done by the external examiner.

Paper-I

Year	Paper	Topic	No. of Lectures + Tutorial Classes / Practical Classes	Weight of marks for University written Examination	Marks allotted for Class Test	Total marks
Part I	I	Mathematical methods I	36 + 4	20	10	100
		General Properties of Matter	18 + 2	10		
		Vibration & Waves	27 + 3	15		
		Geometrical & Physical Optics	54 + 6	30		
		Electronics I	27 + 3	15		

Mathematical Physics- I (20 marks, 40 Lectures)

1. Vector Analysis (5L): Definition of vector by rotational transformation of cartesian axes. Definition of scalar, pseudoscalar, polar and axial vector, Fundamentals of vector algebra. Vector identities. Gradient of a scalar field, divergence and curl of a vector field and their physical significance, solenoidal and irrotational vector, conservative vector field and scalar potential, identities involving gradient, divergence & curl.

2. Vector Integration (6L): Line integral, path independence, exact differential, surface integral, flux, volume integral, Gauss divergence theorem, continuity equation, Stoke's theorem, Green's theorem for simply connected region, verification of integral theorems in simple cases (Proofs are not required). Change of variables and the Jacobian & its use in the evaluation of surface and volume integrals.

3. Orthogonal Curvilinear Coordinates (4L): Covariant and contravariant components, unit vectors & unitary base vectors. Length, area and volume element, general expression of gradient, divergence, Laplacian and curl, their expressions in spherical and cylindrical polar coordinates.

4. Analytic functions (2L): Analytic functions and Taylor's (Maclaurin's) series for functions of one & two variables, illustrations with simple problems.

5. Differential Equation (6L): (a) Second order ODEs with constant coefficients (homogeneous and non-homogeneous) (b) Second order ODEs with variable coefficients: Linearly independent solutions, Wronskian, ordinary point, regular & irregular singular points. Power series solution about an ordinary point (x=0) by substituting $y = \sum_{\lambda=0}^{\infty} a_\lambda x^\lambda$ and a regular singular point (x=0) by Frobenius series $y = \sum_{\lambda=0}^{\infty} a_\lambda x^{\lambda+k}$ for (i) distinct roots not differing by an integer, (ii) repeated root, (iii) distinct roots differing by an integer. Obtaining a second independent solution (only Wronskian method) for cases (ii) and (iii).

6. Legendre Polynomial (4L): Introduction from (i) the solution of Legendre differential equation about origin by Power series $y = \sum_{\lambda=0}^{\infty} a_\lambda x^\lambda$. Legendre functions of second kind (mention only). Mention the descending series and the interval of 'x' for which the series will be convergent (no derivation required), (ii) Generating function – its physical basis – recurrence relation – orthonormality. (iii) Rodrigue's formula – its justification using Leibnitz theorem. Associated Legendre Polynomial (only formula).

7. Partial Differential Equation (5L): Laplace's equation- 3D and 2D (Elliptic equation), its solution by the method of separation of variables in

Cartesian, spherical coordinates, plane polar coordinates (for 2D), initial and boundary value problems.

8. Fourier Series (4L): Fourier's theorem, Dirichlet conditions, Euler's formulae for Fourier coefficients, Symmetry and Fourier coefficients, Euler's formulae for functions having arbitrary period,

9. Tutorial : (4 L)

General Properties of Matter (10 marks, 20 Lectures)

1. Elasticity (8L):

Hooks law. Young's modulus, bulk modulus, rigidity modulus, Poisson's ratio and their interrelations.
Torsion in a cylinder: Expression for torque per unit twist, derivation of working formula of determination of rigidity modulus by static and dynamic method.
Elastic potential energy: Strain energy expression for longitudinal, volume and shearing strain and due to twist.
Bending of beam: Neutral layer, geometrical moment of inertia, bending moment and shearing force.
Cantilever: Expression for depression of light cantilever due to load at the free end. Reciprocity theorem statement and proof (*for light cantilever*). Depression at the midpoint of a light beam supported at both the ends. Derivation of working formula of determination of Young's modulus by flexure method.

2. Surface tension (6L):

Molecular interpretation of surface tension. Surface tension and surface energy: Work done due to spraying, relation between surface tension and total surface energy (thermodynamic treatment).
Excess pressure on a curved liquid surface. Curvature of contact surface of two soap bubbles. Liquid in a vessel with small hole at the bottom.

Angle of contact. Expression of capillary rise (or fall). Jurin's law. Capillary rise in a short capillary tube. Energy changes in capillary rise. Height of liquid in a U tube with vertical arms of different radii.

3. Viscosity (4L):

Streamline and turbulent flow. Viscosity, coefficient of viscosity. Newtonian and non-Newtonian liquid. Critical velocity, Reynolds' number, Stokes' law.
Flow of liquid in a narrow horizontal tube under constant pressure difference. Poiseuille's equation. Correction for kinetic energy.

4. Tutorial: (2L)

Vibration and Waves (15 marks, 30 Lectures)

1. Linear Harmonic Oscillation (3L):

Energy of linear harmonic oscillation; superposition of simple harmonic oscillations, Lissajous figures.

2. Damped and Forced oscillation (6L):

Damped oscillation, analytical treatment, critical damping, energy relations; forced vibration, analytical treatment, transient beats, mechanical and electrical analogue, amplitude and velocity resonance, power relations, sharpness of resonance, band width, Q factor, low and high frequency responses.

2. Waves (9 L):

Mathematical representation of plane progressive wave, differential wave equation in one dimension; velocity of plane progressive longitudinal wave in elastic fluids (gases, liquids and solid bars); solution of plane progressive differential wave equation, particle displacement, particle velocity, acoustic pressure, dilatation, condensation; energy density,

intensity, sound pressure level, bel, decibel and phon; group velocity, phase velocity; stationary waves: equation of stationary waves, energy density of stationary waves; Doppler effect; definition and properties of shock waves (detailed mathematical treatment not required); ultrasonic waves: definition, magnetostrictive and piezoelectric generation.

3. Vibration of Strings (6L):

Differential wave equation of transverse vibration of a stretched string, velocity of transverse wave in stretched string, solution of wave equation (Hyperbolic Equation), stretched string rigidly fixed at both ends, eigen frequencies and eigen functions, modes of transverse vibration, energy of a vibrating string, solutions of wave equation for plucked & struck string, Young-Helmholtz law.

4. Acoustics (3L):

Reverberation, acoustics of halls, Sabine's formula, live and dead rooms.

6. Tutorial: (3L)

Optics (30 marks, 60 Lectures)

Geometrical Optics

1. Fermat's principle and its applications (3L):

Fermat's principle and its application to reflection and refraction at plane and spherical surfaces.

2. Magnification (1L): Different magnifications, Helmholtz-Lagrange Law.

3. Cardinal points of optical systems (9L):

Paraxial approximation, introduction to matrix method in paraxial optics - simple applications like the evaluation of cardinal points and lens equations, Combination of lenses and equivalent lens.

4. Aberrations (3L):

Qualitative discussions of aberrations, Dispersive power of prisms, Chromatic aberration and achromatic combination of lenses.

5. Eye pieces (2L):

Ramsdan & Huygen eyepieces.

6. Tutorials: (2L)

Physical Optics

1. Wave theory of light (3L):

Huygen's principle, deduction of law of reflection and refraction at plane and curve surfaces.

2. Interference (13L):

Two-beam interference, interference of light by division of wave front and division of amplitude, Young's experiment – interference pattern and intensity distribution; spatial and temporal coherence, Fresnel's biprism, Lloyd's mirror, Interference of thin films, fringes of equal inclination and equal thickness, Haidinger fringes, Newton's ring, Michelson's interferometer, Circular and straight fringes, localization of fringes, standardization of metre scale and applications. (9L)

Multiple beam interferometry –Multiple reflections from a plane parallel film pattern - reflectivity and transmittivity, coefficient of Finesse, Fabry-Perot etalon and its applications, Fabry-Perot interferometer, resolving power. (4L)

3. Diffraction (9L):

Fresnel's half period zones, explanation of rectilinear propagation of light, zone plate, Fresnel diffraction at straight edge and circular aperture, Fraunhofer diffraction, Diffraction at single slit and double slit (both qualitatively), and plane diffraction grating (transmission), Rayleigh criteria of resolution, resolving power of prism, telescope, microscope and transmission grating.

4. Polarisation (11L):

Different states of polarization (emphasis on 's' and 'p' polarizations), Polarisation by reflection, Brewster's law, Double refraction – ordinary and extraordinary ray, Optic axis, Principal section, Huygen's construction for uniaxial crystals, Tourmaline, Calcite, Quartz, Nicol prism, polaroids, half and quarter wave plates, production and analysis of (i) plane polarized, (ii) circularly polarized, and (iii) elliptically polarized light, Optical activity- Fresnel's explanation, Biot's law, Principles (qualitatively) of Biquartz and half shade polarimeter, Preliminary idea of Kerr and Faraday effect.

5. Tutorials: (4L)

Electronics (15 marks, 30 Lectures)

1. Semiconductor diodes (9L):

p-n junction diode, space charge and electric field distribution at junctions, forward and reverse biased junctions, depletion region; I-V characteristics (Derivation not required), Avalanche and Zener breakdown; rectifier diode, Zener diode, optoelectronic diodes: LED, photo diodes; analysis of

half and full wave rectifiers, bridge rectifier with C, L and π filter; Zener diode as voltage regulator.

2. Bipolar junction transistors (BJT) (11L):

Current flow mechanism in p-n-p and n-p-n transistors, different type of configurations (common emitter, common base and common collector); BJT characteristics, α and β of a transistor and their interrelations; different methods of transistor biasing (Fixed Bias, Collector-to-base Bias and Self Bias); Q-point and load line; limits of transistor operation; transistor hybrid model, analysis of transistor amplifier using hybrid model (Small signal mid frequency analysis only); emitter follower circuit; comparison of CE,CB and CC amplifier.

3. Digital electronics (7L):

Binary, decimal and hexadecimal systems, conversion of one system to another, 1's and 2's complement, binary number addition, subtraction and multiplication; Boolean theorem, Boolean identities; OR, AND, NOT, NAND, NOR gates, Ex-OR, Ex-NOR gates, universal gate, functional completeness, S-O-P and P-O-S representation, Karnaugh map.

4. Tutorials: (3L)

Paper II

Year	Paper	Topic	No. of Lectures + Tutorial Classes / Practical Classes	Weight of marks for University written Examination	Marks allotted for Internal Assessment	Total marks
Part I	II	Mechanics I	45 + 5	25	10	100
		Heat	36 + 4	20		
		Thermodynamics	36 + 4	20		
		Electrostatics	27 + 3	15		
		Current Electricity and Magnetism I	18 + 2	10		

Mechanics-I (25 marks, 50 Lectures)

1. Velocity and acceleration in different coordinate system (3L):
Velocity and acceleration of a particle in plane polar, cylindrical and spherical polar co-ordinate systems; Tangential and normal components of acceleration.

2. Dynamics of a particle (4L):
Critical review of Newton's laws of motion; Galilean invariance; path integral of force: work and energy, conservative and dissipative force, concept of potential, conservation of mechanical energy; time integral of force: impulse, conservation of linear momentum, impulsive force; angular momentum and torque, conservation of angular momentum.

3. Dynamics of a system of particles (8L):
Centre of mass, calculation of position of c.m. in simple symmetrical cases; idea of laboratory and centre of mass frames of reference; external force and forces of interaction between particles; motion of centre of mass under external force; kinetic energy and angular momentum about centre of mass and laboratory frames; torque-angular momentum relation; potential energy, conservation of mechanical energy;

Motion of system of variable mass: rocket motion, falling chain, falling raindrop, etc.

4. Rotating frame of reference (4L):
Non-inertial frames and fictitious forces; rotating frames of reference - coriolis and centrifugal forces, coriolis deflection of vertically thrown or falling particles and particles moving originally in straight lines horizontally. Effect of coriolis force on nature: sense of rotation of cyclones.

5. Rigid body motion (Total 10L):

A. Plane motion of rigid bodies:
Moment of inertia, radius of gyration; kinetic energy and angular momentum; parallel and perpendicular axes theorems; calculation of moment of inertia for simple symmetric systems; rolling cylinder and sphere on horizontal and inclined plane. (5L)

B. Space motion of rigid bodies:
Product of inertia; angular momentum; kinetic energy; principal axes and principal moments of inertia; expression of moment of inertia about an axis in terms of moments and product of inertia about coordinate axes; ellipsoid of inertia and inertia tensor; classification of rigid bodies into three types of top; Euler's equation; force and torque free motion of symmetric top. (5L)

6. Gravitation (6L):
Gravitational potential and intensity, potential & intensity due to a spherical body, their graphical representation; gravitational self-energy, gauss's theorem, Laplace's equation and Poisson's equation for potential; application of Gauss's theorem and Laplace's equation; artificial satellites (geosynchronous and geostationary); theory of compound pendulum.

7. Central forces (10L):

Two-body problem, reduction to one-body problem, reduced mass; definition and nature (conservative nature, spherically symmetric potential) of central force, features of motion under central force field; differential equation of orbit; energy expression, simple derivations of nature of force from equation of orbit and vice versa; motion under inverse square attractive force: polar equation of conics, dependence of nature of orbits on energy, Kepler's laws, Newton's law of gravitation from Kepler's law; Laplace-Runge-Lenz vector; nature of orbit under inverse square repulsive force; equivalent one dimensional motion, stability of orbit.

8. Tutorial: (5L)

Heat (20 marks, 40 Lectures)

1. Kinetic Theory of Gases (10L):

Ideal gas, basic assumptions of kinetic theory, pressure exerted by ideal gas, its relation with average kinetic energy; kinetic interpretation of temperature; ideal gas law; Maxwell's distribution law both in terms of velocity and energy, average, root mean square and most probable speeds; direct and indirect evidence of Maxwell's law (proof not required); degrees of freedom, equipartition of energy (detailed derivation not required); evaluation of C_p and C_v for gases with monatomic, diatomic, polyatomic molecules; limitation of kinetic theory in the interpretation of specific heat; finite size of molecules: collision probability, distribution of free paths and mean free path from Maxwell's distribution.

2. Transport phenomena (5L):

Non-equilibrium gas, property of non-equilibrium gas; viscosity, thermal conduction and diffusion in gases; dependence of transport-coefficients on temperature and pressure, Brownian motion: Einstein's theory, Perrin's work to determination of Avogadro number.

3. Real Gases (10L):
Deviation from ideal gas as implied by Andrew's and Amagat's experiment; nature of intermolecular interaction, Van der-Waals equation of state, derivation (simple theory) and its comparison with experiment; critical constants, Boyle temperature, virial coefficients; reduced equation of state; law of corresponding state, virial theorem (statement only), derivation of ideal gas equation there from; Van der-Waals equation in powers of P and $1/V$ and implication. Brief survey of other equations of state.

4. Heat Transfer (11L):
4.A. Conduction: Variable and steady state of heat flow, thermal conductivity, thermal receptivity, thermometric conductivity; thermal conductivity of a composite; Fourier's equation for heat conduction – its solution for rectilinear and radial, spherical and cylindrical flow of heat; measurement of thermal conductivity for good and bad conductors. (5L)

4.B. Radiation and convection: Spectral emissive and absorptive powers, Kirchhoff's law, blackbody radiation, energy density, radiation pressure; Stefan-Boltzmann law, Newton's law of cooling, Wien's and Rayleigh-Jeans law; Planck's law (no detailed derivation); solar temperature & radiation pyrometer; importance of convection in atmospheric physics, adiabatic lapse rate. (6L)

5. Tutorial: (4L)

Thermodynamics (20 marks, 40 Lectures)

1. Basic Concepts (3L):
Microscopic & macroscopic point of view, thermodynamic system, system and surroundings, thermodynamic variables of a system - intensive and extensive, state function and path function, exact and inexact differential, quasi static process, reversible and irreversible process; isothermal and adiabatic process.

2. First law of Thermodynamics (5L):
Thermal equilibrium, zeroth law & concept of temperature; thermodynamic equilibrium, internal energy, interaction of heat and work, first law of thermodynamics and its application, specific heat of gas and their ratio, work done in isothermal and adiabatic changes in perfect & real gases.

3. Second law of Thermodynamics and Entropy (11L):
Conversion of heat into work: reversible and irreversible processes; second law, equivalence of statements; heat engine & efficiency, Carnot theorem, indicator diagram, Carnot cycle, efficiency of Carnot engine and Carnot refrigerator, absolute scale of temperature, relation to perfect gas scale.
Entropy, change of entropy in simple reversible and irreversible process, entropy of ideal gas, entropy change in mixing of ideal gases, entropy of V.W gas, Clausius inequality, principle of increase in entropy, entropy and disorder, probabilistic interpretation of entropy, entropy and available energy, principle of degradation of energy.

4. Thermodynamic Functions (6L):
Thermodynamic potentials: internal energy, enthalpy, Helmholtz and Gibb's free energies, Maxwell's relations and different types of deductions using these relations, thermodynamic equilibrium and free energies.

5. Change of State & Production of low temperature (11L):
Equilibrium between phases, triple point, Gibbs' phase rule (proof not required) and applications, First and Higher order phase transition, Erenfest criterion, Clausius and Clapeyron's equation, variation of latent heat with temperature, Joule-Thomson effect, adiabatic expansion of gases, regenerative cooling & cascade cooling, liquification of gases, Production and measurement of low temperature, adiabatic demagnetization; second order phase transition, Nernst heat theorem and third law of thermodynamics.

6. Tutorial: (4L)

Electrostatics (15 marks, 30 Lectures)

1. Electrostatic field and potential (10L):
Coulomb's law, intensity and potential, superposition theorem; Gauss's law, Poisson's and Laplace's equations, uniqueness theorem; application of Gauss's law, and Laplace's equation in simple cases of symmetric charge distribution, potential and field due to different charge distributions - line charge, planar charge, spherical shell, etc.
Multi pole expansion of scalar potential – monopole, dipole and quadruple; potential and field due to a dipole, torque on a dipole in an uniform field, work done in deflecting a dipole, dipole – dipole interaction, force on dipole in a non homogeneous field.

2. Dielectrics: (5L)
Dielectric Polarization, electric displacement vector (D), Gauss's theorem in dielectric media, boundary conditions, energy associated with electric field; capacitors – parallel plate, spherical and cylindrical capacitors containing dielectrics (uniform and symmetric nonuniform.

3. Electrical Images (6L):
Solution of field problems by the method of images: a point charge i) near an infinite grounded conducting plane, ii) outside an earthed conducting sphere iii) & iv) outside an insulated conducting sphere with and without charge, v) inside an earthed conducting spherical surface.

4. Boundary value problems using Laplace's equation (6L): Point charge near an infinite earthed conducting plane and outside an earthed conducting sphere. Conducting and dielectric spheres in an initially uniform external field.

4. Tutorial: (3L)

Current Electricity and Magnetism I (10 marks, 20 Lectures)

1. Magnetic field (9L):

1.A. Lorentz force and concept of magnetic field **B**, solenoidal nature: magnetic vector potential; origin of magnetic field, magnetic field due to current: Biot-Savart's law; calculation of magnetic field and magnetic vector potential in simple cases: straight wire, circular current and solenoid, motion of charged particle in uniform electric, magnetic field and crossed fields.

1.B. Ampere's equivalence theorem, current loop as magnetic dipole, magnetic scalar potential, torque on a current loop, magnetic field due to a current loop at a large distance.

1.C. Ampere's circuital law, application to calculate magnetic field in simple cases: straight wire, long solenoid, toroid, force between two parallel current carrying conductors, Ampere's law in differential form.

2. Magnetic materials and magnetostatics (9L):

2.A. Free current and bound current, surface and volume density of current distribution, intensity of magnetization, Ampere's law in terms of free current density and introduction of magnetic intensity **H**, line integral of **H** in terms of free current; relation between **B, H** and **M**, magnetic susceptibility and permeability, constitutive relations; elementary idea of dia-, para- and ferro- magnetism, statement of Curie's law; energy stored in magnetic field, hysteresis in ferromagnetic materials, magnetic circuits: elementary discussion.

2.B. Boundary conditions on **B** and **H**, magnetic boundary value problems, applications of Laplace's equation to the problem of magnetic sphere in initially uniform magnetic field.

3. Tutorial: (2L)

Paper III

Year	Paper	Topic	No. of Lectures + Tutorial Classes / Practical Classes	Weight of marks for University written Examination	Marks allotted for Internal Assess-ment	Total marks
Part II	III	Mathematical Methods II	45 + 5	25	10	100
		Current Electricity and Magnetism II	36+4	20		
		Quantum Mechanics I	27 + 3	15		
		Electromagnetic Theory	36 + 4	20		
		Relativity	18 + 2	10		

Mathematical Methods II (25 Marks, 50 Lectures)

1. Matrices (8L): Definitions of row & column matrices (vectors), transpose of a matrix, real, square, symmetric & skew-symmetric, hermitian & skew-hermitian, singular & non-singular matrices, inverse, submatrices, rank, orthogonal, unitary, normal, SO & SU with examples e.g. matrix for active or passive rotation of a vector.

Eigen values and eigen vectors, similarity transformation, diagonalisation of matrix, unitary transformation, orthonormality of eigen vectors for normal matrices, completeness theorem, spectral decomposition method.

2. Probability & Statistics (8L): Introduction, statistical distributions, second moments and standard deviation, definitions of probability,

fundamental laws of probability, discrete probability distributions, combinations and permutations, the binomial, Poisson and normal distributions.

3. Hermite Polynomial (4L): Introduction from (i) the solution of Hermite differential equation about origin by Power series $y = \sum_{\lambda=0}^{\infty} a_\lambda x^\lambda$. Conversion into Sturm-Liouville equation to find the weight function e^{-x^2} (ii) Generating function – recurrence relation – orthonormality, only mention of Rodrigue's formula.

4. Fourier Analysis (7L): Fourier series of some typical wave forms e.g. square wave pulses, triangular waveform, waveforms of the output of a half-wave and a full-wave rectifiers, sawtooth – Half-range expansions, Parseval's identity, Complex form of Fourier series, Fourier expansion of f(x) in the interval $(-l, +l)$ with $l \to \infty$, Fourier integral, Fourier tranforms pair, Fourier transforms of simple functions occuring in physical applications.

5. Tensors (6L): Space of n-dimensions, summation convention, contravariant and covariant vectors, invariants, contravariant, covariant and mixed tensors, the Kronecker delta, symmetric and skew- symmetric tensors, algebra of tensors, quotient law, Metric tensor and some simple examples of it related to Special Theory of Relativity.

6. Complex Variables (12L): Functions of a complex variable, analytic functions, Cauchy-Riemann relations, Harmonic Functions, Single and Multivalued functions, Statements of Taylor and Laurent series, singularities and zeroes, Cauchy's integral theorem (no proof is required) for simply connected regions, Cauchy's integral formulae, Poles, Residue at a pole of order 'n', Cauchy's residue theorem (statement only), Preliminary idea of Contour integration, Evaluation of real integrals with the help of residue theorem (simple examples restricted to improper integrals of rational functions).

7. Tutorial : (5L)

Current Electricity and Magnetism II (20 Marks, 40 Lectures)

1. Electromagnetic induction (10L):

Electromagnetic induction, Faraday's laws, Lenz's law, motional e.m.f. - simple problems; differential form of Faraday's laws, vector and scalar potentials in time varying electromagnetic field; calculation of coefficients self and mutual induction in simple cases, inductances in series and parallel; elementary theory of transformers. Elementary idea on construction and principle of dead-beat and ballistic galvanometers.

2. D.C circuits (11L):

2.A. Potential difference and electromotive force, electric current, continuity equation; metallic conduction and Ohm's law, analysis of resistive network, Kirchhoff's laws in analysis of multi-loop circuits.

2.B. Superposition principle, current and voltage sources, Thevenin's and Norton's theorems (statements and explanations) and reduction of two-terminal networks, maximum power transfer theorem and matching of network; T and π networks.

2.C. Wheatstone bridge principle and calculation of galvanometer current by Thevenin's Theorem in an unbalanced Wheatstone bridge connected to ideal voltage source; Calendar and Griffith bridge; Potentiometer principle.

2.D. Circuit elements, passive an active, linear and nonlinear, thermistor, LDR.

3. Varying current (5L):

Growth and decay of current in LR, CR and LCR circuits.

4. Alternating current (10L):

Frequency, amplitude, phase, r.m.s. and peak-to-peak value of A.C. voltage and current; reactance, complex impedance, LR, CR, LCR series and parallel circuits, Phasor diagrams, resonance, Q factor, power dissipation; A. C. bridge (Anderson's).

5. Tutorial: (4L)

Electromagnetic Theory (20 Marks, 40 Lectures)

1. Fundamentals of electromagnetic theory (10L):

Generalisation of *Ampere's Law*, 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 theorem.

2. EM Waves in an isotropic dielectric (9L):

Wave equation, 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.

3. EM waves in conducting medium (8L):

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).

4. Dispersion (5 L):

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 frequencies, band width.

5. Scattering (4L):

Scattering of radiation by a bound charge, Rayleigh's scattering (qualitative ideas), blue of the sky, absorption.

6. Tutorial: (4L)

Quantum Mechanics I (15 Marks, 30 Lectures)

1. Old quantum theory (5L):

Origin of the quantum theory - difficulties with the classical theory, Rayleigh-Jean's law and Wien's law for black body radiation, Plank's formula for black body radiation, short review of the line spectra, Photo-electric effect, Compton effect, Bohr atom and quantization of energy levels.

2. **Basic Quantum Mechanics (22L):**

De Broglie hypothesis, electron double-slit experiment, Davisson-Germer experiment, Heisenberg's uncertainty principle (statement) with illustrations, concept of wave packet (qualitative), physical concept of wave function as describing the dynamical state of a single particle, group & phase velocities, classical velocity of a particle and the group velocity of the wave representing the particle, complementary principle, principle of superposition, Schrodinger equation, probabilistic interpretation, normalization, orthonormality and orthogonality, equation of continuity, probability current density, boundary conditions on the wave functions, time dependent and time independent Schrodinger equation as an operator equation – operators, observables & measurements, Simple applications of Quantum mechanics - one-dimensional infinite potential well, its

extension in 2D and 3D (derivation not required) and concept of degeneracy.

3. Tutorial: (3L)

Relativity (10 marks, 20 Lectures)

1. Introduction (4L):

Newtonian relativity, Galilean transformation and invariance of Newton's law of motion, non-invariance of Maxwell's equations, Michelson-Morley experiment and explanation of null result.

2. Special Theory of Relativity (14L):

Concept of inertial frame, Postulates of special theory, simultaneity, Lorentz transformation, length contraction, time dilation and velocity addition theorem, Doppler effect in light, Variation of mass with velocity, energy momentum relation, mass energy equivalence. Four vectors (coordinate and momentum only), Invariance of an interval time like, space like and light like intervals, light cone, causality.

3. Tutorial: (2L)

Paper IV

Year	Paper	Topic	No. of Lectures + Tutorial Classes / Practical Classes	Weight of Marks allotted for University written Examination	Marks allotted for Class Test	Total marks
Part II	IV	Mechanics II	45 + 5	25	10	100
		Atomic, Molecular Phys with LASER	36 + 4	20		
		Electronics II	45 + 5	25		
		Nuclear Physics I	36 + 4	20		

Mechanics II: (50L) **25 Marks**

1. Mechanics of Ideal Fluids (7L):

Definition of fluid, liquid and gas, ideal and non ideal fluids; local, substantial and commoving rate of change; equation of continuity; stream lines, stream tubes vorticity vector, vortex lines, vortex tubes, Euler equation; Bernoulli's equation, simple applications and explanation of everyday experience.

2. Lagrangian formulation (16L):

A. Lagrange's Equation: Degrees of freedom; constraints, holonomic, non-holonomic, schleronomous and rheonomous constraints; generalised coordinates; virtual displacement and virtual work, principle of virtual work; D' Alembert's principle; Lagrange's equation for holonomic systems (from D' Alembert's principle) – for conservative systems and for systems with velocity dependent potentials, application of Lagrange's equation in simple cases. (11L)

B. Small oscillations: Theory of small oscillations (up to calculation of eigen frequencies and relative amplitudes), simple applications: spring mass systems, diatomic molecules, linear vibration of symmetric linear triatomic molecules. (5L)

3. Hamiltonian Formulation (22L):

A. Hamilton's Equations: Generalised momentum, cyclic coordinates and its relation with conservation principles, symmetries and the law of conservation (Homogeneity and isotropy of space and homogeneity of time), definition of Hamiltonian, Hamilton's equation, derivation of Hamilton's equation by Legendre transformation; kinetic energy in terms of generalised velocities and generalised coordinates, Hamiltonian and total energy for systems with schleronomous and rheonomous constraints, application of Hamiltonian Formulation to simple cases. (7L)

B. Hamilton's principle: Variational principle, Euler-Lagrange equation; Hamilton's principle, derivation of Lagrange's equation from Hamilton's principle, application to brachistochrone problem. (4L)

C. Canonical transformations: Contact transformation and canonical transformation, generating function, conditions for transformation to be canonical, simple problems. (6L)

D. Poisson bracket: Fundamental Poisson brackets, fundamental properties of Poisson bracket, equations of motion in Poisson bracket form, Poisson bracket and integrals of motion, Poisson bracket of angular momentum components, Poisson bracket and canonical transformation. (5L)

4. Tutorials: (5L)

Atomic, Molecular& Laser Physics: (40L) 20 Marks

1. Atomic models:

Bohr model, ionization and excitation potentials, correction due to finite mass of nucleus, limitations of Bohr model, Sommerfeld's model (no derivation), limitations of Sommerfeld's model. (3L)

2. Electron magnetic moments and vector atom model:

Orbital angular momentum and orbital magnetic moment of electron: Classical expression, gyromagnetic ratio.

Orbital angular momentum quantum number, quantum mechanical expression of orbital angular momentum and orbital magnetic moment of electron, Larmour precession.

Electron Spin & space quantization of magnetic moments: Stern-Gerlach experiment, electron spin, spin angular momentum quantum number, spin magnetic moment, space quantization of spin and orbital magnetic moment – orbital and spin magnetic moment quantum numbers.

Vector atom model: Total angular momentum, total angular momentum quantum number, vector atom model. (4L)

3. Spectra of single electron atom (Hydrogen):

Four quantum numbers, Degeneracy, Selection rules for transition in Hydrogen atom, Fine structure, Removal of degeneracy by spin orbit interaction. Lamb shift, Lamb-Rutherford experiment. (2L)

4. Many-electron atom:

Pauli exclusion principle, shell structure, maximum number of electrons in a shell and a sub shell, Electronic configuration. L-S coupling; Multiplicity of state, Spectroscopic term symbol of atomic states of many electron atoms, Selection rules. J-J coupling. Hund's rule. (4L)

5.A. Spectra of alkali atoms:

Hydrogen-like nature of monovalent atoms, Screening effect, doublet structure of alkali spectra. (3L)

5.B. Spectra of Helium and alkali earth atoms:

Energy levels and transitions of Helium and alkali earth atoms, singlet and triplet states. (3L)

6. Effect of magnetic field on atomic spectra:

Effect of magnetic field on energy levels, Lande g factor, Normal & Anomalous Zeeman effect, Paschen-Back effect. (3L)

7. X-ray Spectra:

Continuous & Characteristic X-ray, Duane & Hunt limit, Moseley's law, Doublet fine structure, H-like character of X-Ray states, X-Ray absorption spectra. (4L)

8. Molecular Spectra:

Basic ideas about molecular spectra, Diatomic molecules – rotational and vibrational energy levels – rotation and vibration spectra, Raman effect (Preliminary idea). (5L)

9. Laser Physics:

Population inversion, Einstein's A & B co-efficient, feedback of energy on a resonator, 3-level & 4-level systems, He-Neon and Semiconductor laser. (5L)

10. Tutorials (4L)

Electronics II: (50L) **25 Marks**

1. Field effect transistors (FET): Classification of various types of FETs, construction of junction FET, drain characteristics, biasing, operating region, pinch-off voltage. JFET amplifier: CS, CD amplifier. MOSFET: construction of enhancement and depletion type, principle of operation and characteristics. Elementary ideas of CMOS and NMOS. (8L)

2. Operational Amplifier (OPAMP): Introduction to differential amplifier, Characteristics of ideal and real OPAMP, concept of virtual ground, applications of OPAMP as inverting amplifier, non-inverting amplifier, Mathematical operation - addition, subtraction, integration and differentiation, solution of differential equations and linear algebraic equations. (8L)

3. **Feedback in Amplifier:** Voltage and current gain, principle of feedback, positive and negative feedback, advantages of negative feedback. (2L)

4. Multistage amplifier: Classification of amplifier, Principle of Multistage amplifier, R-C coupled BJT amplifier (two stage only): Analysis in low, mid, and high frequency range, gain and band width and

Bode plot, Analysis of single tuned voltage amplifier, Requirement of power amplifiers, Class B push-pull amplifier. (6L)

5. Oscillators: Barkhausen criteria, Hartley, Colpitts, Wien Bridge, Phase shift and Crystal oscillators, relaxation oscillators - Astable, monostable (with transistor, IC555, OPAMP) and bistable multivibrators. (8L)

6. Combinational logic - Half adder, full adder, digital comparator, decoder, encoder (ROM), digital to analog conversion, analog to digital conversion, multiplexer. (4L)

7. Sequential logic - Flip - Flops - RS, D, JK, JKMS, edge triggering and locked operation, shift registers, ripple counter (binary and decade). (5L)

8. Electronic measuring instruments: CRO – Block diagram of CRO, Deflection and focusing systems, time base circuit, measurement of voltage, frequency and phase with a CRO; Electronic voltmeter and Digital multimeter. (4L)

9. Tutorials (5L)

Nuclear Physics I: (40L) **20 Marks**

1. Bulk properties of nuclei: Nuclear charge, mass, binding energy, mass defect, packing fraction, binding fraction, size. Spin, magnetic dipole moment, electric quadrupole moment, isospin, Isotopes, Isobars & isotones, mass spectrometer (Bainbridge) and its uses. (6L)

2. Nuclear models: Neutron- proton hypothesis, Nature of forces between nucleons, Nuclear stability & nuclear binding. Liquid drop model (descriptive) and Bethe-Weizsacker mass formula – application of mass

formula to stability consideration, mass parabola, Nuclear shell model (qualitative discussions), Single particle states in nuclei, Application of extreme single particle shell model (qualitative discussion with emphasis on phenomenology with examples), Theory of nuclear forces. (12L)

3. Unstable nuclei (18L):

A. Radioactivity: Survival equation, Half-life, Mean-life, Transient and secular equilibrium, radioactive dating. (2L)

B. α-decay: Alpha particle spectra – velocity and disintegration energy of α-particles. Range of α-particles, Geiger-Nuttal law – Gamow's explanation, Fine structure of the α-ray spectra. (5L)

C. β-decay: Detection of the β-energy, Nature of β-ray spectra, the neutrino, energy levels & decay schemes, positron emission & electron capture, selection rules, beta absorption & range of beta particles, Kurie plot, Sergent diagram. (5L)

D. γ-decay: Detection of the γ-ray energy, γ-ray spectra & nuclear energy levels. γ-absorption in matter – photoelectric process, Compton scattering, e^- - e^+ pair production (qualitative discussions). Selection rule for gamma decay, Positronium atom and pair annihilation, Radiative transitions in nuclei - multipolarity of transition and selection rules (no derivations). Internal conversions, Auger transition and Bremstralung radiation (qualitative discussions). (6L)

4. Tutorials: (4L)

Paper- V (Practical)

Group A : Non-electrical Practical
(50 Marks: Expt. – 40, LNB – 5, Viva - 5)

1. Study of flexure of a bar.
2. Study of flow of liquid through capillary tube (radius to be measured by microscope directly)
3. Focal length of a concave lens by combination method
4. Determination of wavelength by Newton's ring experiment
5. Calibration of spectrometer and determination of unknown wavelength
6. Dispersive power of a prism
7. Single slit experiment
8. To study interference & diffraction in case of a wire by using LASER
9. Calibration of polarimeter and study of optical rotation of solution
10. Determination of thermal conductivity of a bad conductor by Lee's and Chorlton's method
11. Deflection Magnetometer experiment to determine earth horizontal Magnetic field

Group B : Electrical and Electronics Practical
(50 Marks: Expt. – 40, LNB – 5, Viva - 5)

1. Measurement of resistance of voltmeter and ammeter by half deflection method and their conversion (range and meter) with calibration
2. Measurement of temperature coefficient of resistance by Carey Foster bridge

3. Verification of Thevenin and Norton Theorems
4. Calibration of a thermocouple and find thermoelectric power
5. Study of the thermistor characteristics
6. Platinum resistance thermometer
7. Study of variation of mutual inductance of a coaxial coil
8. Study of magnetic flux using a search coil
9. Study of the impedance of a capacitor of varying frequency to measure capacitance
10. Study of response curve of LCR series resonance
11. Study of regulation characteristics of a bridge rectifier (i) without using a filter and (ii) using a filter
12. Study of the reverse and regulation characteristics of a Zener diode
13. To draw the characteristics of a transistor in CE mode
14. Construction of OR, AND, NOT and NAND gates with basic components and verification of truth tables

Paper – VI

Year	Paper	Topic	No. of Lectures + Tutorial Classes / Practical Classes	Weight of Marks allotted for University written Examination	Marks allotted for Class Test	Total marks
Part-III	VI	Quantum Mechanics II	45 + 5	25	10	100
		Nuclear Physics II	36 + 4	20		
		Statistical Mechanics	36 + 4	20		
		Solid State Physics	45 + 5	25		

Quantum Mechanics II : (50L) **25 Marks**

1. Operator formulation: Basic postulates of quantum mechanics, linear operators, Hermitian operators, Hermitian adjoints, eigenvalues and eigenfunctions, Momentum, energy and angular momentum operators, commutating and non-commutating operators, commutation relations between operators, expectation values, time evolution of expectation

values, compatible observables and simultaneous measurements, Ehrenfest theorem. (9L)

2. Simple application to quantum mechanics: Step potential, Penetration through one-dimensional rectangular potential barrier, Reflection and transmission coefficients – explanation of alpha decay.

Linear harmonic oscillator: energy eigenvalues and eigenfunction from Hermite Differential equation. Energy eigenvalues and eigenfunctions using raising and lowering operators, zero point energy, parity of wavefunction, comparison with classical theory. (18L)

3. Angular momentum and spin: Orbital angular momentum operators and their commutation relations, L_+ & L_- as Ladder operators, Eigen values of L^2 and L_z, Angular momentum operators in spherical polar coordinates, evaluation of eigenfunctions, Schrodinger equation of hydrogen atom, Reduction of two body problem into single body, separation of variables in spherical polar coordinates, spherical Harmonics, wavefunction and energy eigenvalues, degeneracy, parity of spherical Harmonics.

Pauli spin matrices and their commutation relation, eigenvalues and eigenvector of spin operators (only spin ½ particle). Representation of general spin state of spin ½ particle. (18L)

4. Tutorials (5L)

Nuclear Physics II: (40L) 20 Marks

1. Nuclear reactions: Conservation principles in nuclear reactions. Q-values and thresholds, nuclear reaction cross-sections, Relativistic correction to the Q-value expression, examples of different types of

reactions and their characteristics. Bohr's postulate of compound nuclear reaction, Ghoshal's experiment. (8L)

2. Nuclear fission and fusion: Discovery and characteristics, explanation in terms of liquid drop model, fission products and energy release, prompt and delayed neutrons, spontaneous and induced fission, condition for the spontaneous fission, transuranic elements. Chain reaction, four-factor formula and basic principle of nuclear reactors. Nuclear fusion: energetics in terms of liquid drop model. Basic principles of Atom bomb and H-bomb. (8L)

3. Cosmic ray: Nature and origin of primary and secondary rays, latitude and altitude variations, hard & soft components, muon, pion, mesons & hyprons, Mean life of muon & pion. extensive air shower, solar modulation of primary ray, effect of Earth's magnetic fields. East-West Effect, Van Allen radiation belt, Aurora Borealis. (4L)

4. Elementary particles:

A. Natural units, four basic interactions in nature and their relative strengths, examples of different types of interactions. Quantum numbers – mass, charge, spin, isotopic spin, intrinsic parity, Baryon number, Lepton number, Strangeness, hypercharge. Gell-Mann Nisijima formula, Charge conjugation, Time reversal, Symmetries and Conservation laws (qualitative (6L)

B. Classifications of elementary particles – Leptons, Quarks and Mediators. Standard Model (qualitatively). Hadrons: Baryons and Mesons. Antiparticles, Neutrinos, Strange Particles. Elementary ideas about quark structure of hadrons – Weight diagrams, The Quark structure of hadrons octet and decuplet families. (6L)

5. Particle Accelerator and Detector: Cyclotron – basic theory, GM counter, Accelerators and Neutrino observatory in India (basic idea). (4L)

6. Tutorials (4L)

Statistical Mechanics: (40L) **20 Marks**

1. Probability Distribution: *Random Walk and Binomial Distribution:* The simple random walk problem in one dimension, General discussion of mean values, Calculation of mean values for the random walk problem, Probability distribution for large N, Gaussian probability distributions, General discussion of the random walk. (4L)

2. Microstates and macrostates: Concept of phase space; microstates and macrostates, statistical weight of a macrostate; classical description in terms of phase space and quantum description in terms of wave functions; calculation of phase volumes; hypothesis of equal a priori probability for microstates of an isolated system in equilibrium; Interactions 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; concept of ensembles. (10L)

3. Classical statistical mechanics: Maxwell-Boltzmann distribution law (derivation as the most probable distribution) and its applications. Calculation of thermodynamic quantities for ideal gases using partition function. (4L)

4. Motivations for quantum statistics: Gibbs' paradox; identical particles and symmetry requirement; indistinguishablity of small particles; derivation of BE & FD statistics as the most probable distributions (micro-canonical ensemble). Classical limit of quantum statistics and its region of validity, reduction to Maxwell distribution, comparison between photon, phonon, electron and the ideal gas. (10L)

5. Application of quantum statistical mechanics: Bose Einstein statistics: Application to radiation – Planck's law, Rayleigh Jeans and Wien laws as limiting cases, Stefan's law. Bose-Einstein condensation; liquid Helium and its phase transition (qualitative discussion); third law of thermodynamics.

Fermi-Dirac 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. Electron specific heat of metals at low temperature. Thermionic emission. Saha equation for thermal ionization and its application to astrophysics. (8L)

6. Tutorial: (4L)

Solid State Physics: (50L) 25 Marks

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. (9L)

2. Structure of solids: (a) – Different type of binding: ionic, covalent, metallic and van-der-Waals and hydrogen. (b) - Free electron theory of metals - free electron model, Fermi energy and momentum, density of

states, Wiedemann - Franz law, Hall effect in metals. (c) - Band theory of solids: Bloch Theorem, Physical origin of energy gap, Kronig-Penny Model and its consequence, effective mass, conductor, semiconductors and insulators. (d) Semiconductor: carrier distribution, drift current, mobility and conductivity in intrinsic semiconductor. (14L)

3. Lattice vibrations: Elastic and atomic force constants; Dynamics of a chain of similar atoms, Introduction to phonon (Qualitative), Einstein's and Debye's theories of specific heats of solids. (4L)

4. Dielectric properties of materials: Electronic, ionic and dipolar polarisability, local field, Claussius - Mosotti relation, orientational polarisation. (5L)

5. Magnetic Properties of Materials: Dia-, para-, and ferro-magnetic properties of solids, Langevin's theory of diamagnetism, Quantum theory of paramagnetism. Curie's law, Spontaneous magnetisation and its temperature dependence, Curie-Weiss law of ferromagnetism, Curie temperature domain structure, explanation of Hysteresis. (10L)

6. Superconductivity: Introduction, critical temperature, Meissner effect, critical field, Type I and Type II superconductors. (3L)

7. Tutorials (5L)

Paper : VII (Electronics Practical)
(Expt. - 80, LNB - 10, Viva - 10)

Group A: Analog Electronics Experiments (50 Marks)

1. Construct a regulated power supply on a bread board (a) using a power transistor as pass element and, (b) a second transistor as feedback amplifier (c) a zener diode as a reference voltage source and to study its operational characteristics
2. Study the effects of negative feedback on frequency response of a RC coupled amplifier
3. To construct and study the frequency response of voltage amplifier using a transistor in CE mode & to find its band width.
4. To design a circuit and test the following related to OPAMP -
   (a) Offset parameters
   (b) Inverting and non-inverting amplifier
   (c) Integrator
   (d) Differentiator & differential amplifier
   (e) Adder & Subtractor
5. Design and construction of a phase shift oscillator.
6. To construct Wien bridge oscillator on a bread board using OPAMP and to study the waveform of the oscillator and frequency determination using CRO.

Group B: Digital Electronics Experiments (50 Marks)

1. Verify various Boolean expressions using IC gates
2. NAND & NOR Gates circuits using IC.
3. Multiplexer & Demultiplexer using IC.
4. Half adder & full adder circuits using IC.
5. Design and verify the following flip flop operations

(i) RS (ii) Clocked JK (iii) D

6. Study of Modulo- 3, Modulo - 5, Modulo - 7 binary counters.
7. Construction of AND, OR, NOT Gates using diodes, transistors and verification of Truth table.
8. Multivibrators using transistors & IC555.

Practical Paper : Non-electronic experiments
Paper VIIIA (50 Marks) (Expt. - 40, LNB - 5, Viva - 5)

1. Study of Resolving power of a grating. Difference of D1 & D2 lines by a grating
2. Biprism experiment
3. B - H loop
4. Anderson bridge
5. Study of Fourier spectrum of – (a) Square; (b) triangular; C) half sinusoidal wave form; (by CRO)
6. To determine the Stefan's constant

7. Spectrum of hydrogen & Rydberg constant
8. Magnetic susceptibility of $FeCl_3$ solution.
9. Hall probe in magnetic field measurement
10. To determine Planck's constant
11. To study the intensity distribution of grating pattern by Laser & LDR
12. Use of P-N junction for measurement of bandgap energy

Practical Paper:
Paper VIIIB (20 Marks) (Program writing with algorithm and showing result – 16, LNB – 4)

Apart from executing the computer programmes 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.).

Computer 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.

i. Sorting.
ii. Read N numbers, find their mean, median, mode
iii. Find whether a number is prime
iv. Factorize a number
v. Sum of different types of series term by term with a specified accuracy
vi. Matrix operations (addition, subtraction, multiplication, transpose, trace)
vii. Finding zeroes of a given function by the method of bisection and Newton-Raphson
viii. Integration by trapezoidal and Simpson's rule

The above basic types of programs should be explained in practical classes before performing the experiments. Each student will have to solve one problem of 15 marks during the examinations.

Project:
Paper VIIIC (30 Marks)

This work should be an experimental one with special reference to the techniques into practical classes. This may be application oriented or some simple law / experimental verification.

1. The project will be centrally evaluated by the coordinators of Papers VII & VIII in consultation with supervisors and internally by Head of the department of the College. The co-ordinator of Paper VIII will average the mark and submit to the University. The Board of Study will recommend the centre for central evaluation of the project work.

2. Distribution of marks -

(a) Nature of work	- 10
(b) Presentation	- 10
(c) Viva	- 10
Total	- 30

PHYSICS (GENERAL COURSE)

The entire course is divided into four papers with total 400 marks to be studied in three years. At the end of first year there will be Part I examination of one theoretical paper (Paper I), at the end of 2nd year one theory paper (Paper II) and one practical paper (Paper III) of 100 marks each in Part II examination. At the end of the 3rd Year there will be one theoretical paper (Paper IV) of 75 marks and one practical paper (Paper V) of 25 marks in Part III examination.

Three tire Examination pattern:

Part I	Part II	Part III
Theory - 100	Theory – 100	Theory – 75
	Practical - 100	Practical - 25

Part I Examination : Paper I - Theoretical Full Marks – 100
(University written Exam 90 + College Internal Assessment 10),
Time – 3 Hrs.

Part II Examination: Paper II - Theoretical Full Marks – 100
(University written Exam 90 + College Internal Assessment 10),
Time – 3 Hrs.

Paper III - Practical Full Marks – 100 = 90+10,
Time – 6 hrs.

A. - Experiment Gr. A (35 marks)
B. - Experiment Gr. B (45 marks)
C. - LNB – 10, D – Viva – 10

Part III Examination: Paper IV (A) - Theoretical Full Marks – 75 (University written Exam 67+ College Internal Assessment 8), Time – 3 Hrs.

Paper IV (B) - Practical Full Marks – 25, Time 3 hrs.

B. Sc. PHYSICS (GENERAL COURSE)

Part – I

Paper – I [150 Lectures + 10 Tutorials]

Time – 3 Hrs.

Full Marks – 100 (University written Exam 90 + College Internal Assessment 10), Time – 3 Hrs.

Group - A

1. Vector Analysis : [10L]

Scalar and Vector, dot product and cross product, scalar triple product and vector triple product. Scalar and vector fields, gradient, divergence and curl, statement of Gauss's divergence theorem and Stokes' theorem.

2. Mechanics: [25L]

Newton's laws of motion, motion in uniform field, velocity components in 2D Cartesian and Polar co-ordinate systems. Motion under a central force: Definition, statement of properties, Kepler's law. Principle of conservation of linear momentum, time and path integral of force, conservative force field, concept of potential, conservation of total energy. [12L]

Rotational motion, angular velocity, angular acceleration, angular momentum, torque, fundamental equation of rotational motion, principle of conservation of angular momentum, radial and cross-radial acceleration. [6L]

Moment of inertia (MI) and radius of gyration - their physical significance, theorems of parallel and perpendicular axes, rotational kinetic energy, calculation of moment of inertia for some simple symmetric systems. Physical significance of MI. [7L]

3. **SHM, Simple & Compound pendulums, torsional pendulum : [10L]**

Superposition of two simple harmonic motions of some frequency along the same line, interference, superposition of two mutually perpendicular simple harmonic vibrations of same frequency, Lissajous figures, forced oscillator and damped oscillator, critical damping.

4. **General Properties of Matter: [25 L]**

Gravitation : Gravitational potential and intensity due to thin uniform spherical shell and solid sphere of uniform density, escape velocity. [5L]

Elasticity : Elasticity, small deformation, Hooke's Law, elastic constants of an isotropic solid – interrelations. Torsion of a cylinder, bending moment, cantilever, simply supported beam with concentrated load at the centre, strain energy. [5L]

Viscosity : Viscous fluids, Streamline and turbulent motion, Poiseuille's formula, critical velocity, Reynolds number, Bernoulli's theorem, Reynold's number, Stokes' law. [5L]

Surface Tension : Surface tension and surface energy, molecular theory, angle of contact, elevation and depression of liquid columns in a capillary tube, excess pressure in a spherical bubble and spherical drop. [5L]

Group - B

5. **Kinetic Theory of Gases : [25L]**

Ideal gas, kinetic model, deduction of Boyle's law, interpretation of temperature, rms speed of molecules. Brownian motion,

Avogadro number, equipartition of energy, specific heats of gases. [7L]

Real Gas: van der Waal gas equation, nature of van der Waal forces, comparison with experimental P – V curves critical constants. Joule's experiment of ideal and van der Waal gas, Joule coefficient, estimate of J – T cooling. [6L]

Liquefaction of gases: Boyle temperature and inversion temperature. Regenerative cooling and cascade cooling, liquefaction of hydrogen and helium. Refrigeration cycles, efficiency. [5L]

Transport phenomena : Molecular collision, mean free path, collision cross section. Molecular diameter and man free path. Transport of mass, momentum and energy and inter relationship, dependence of temperature and pressure. [7L]

6. Thermodynamics : [25L]

Zeroth law, indicator diagram, work done by and on the system, first law, internal energy as state function and other applications. Reversible and irreversible changes, carnot cycle, it's efficiency, Carnot's theorem. Second law– Different statements. Entropy, principle of increase of entropy. Thermodynamic scale of temperature – identity with perfect gas scale. Third law of thermodynamics. [8L]

Thermodynamic relationships–Thermodynamic variables – extensive and intensive, Maxwell's general relationship, application to J – T cooling and adiabatic cooling in a general system (van der Waals gas), Clausius – Claypron equation. [10L]

Black Body Radiation - Temperature dependence – Stefan-Boltzman law, pressure of radiation, special distribution of Black Body radiation. Wien's displacement law, Rayleigh – Jeans law, Plank's quantum postulates – Plank's law – fit with experiment. [7L]

Group - C

7. Waves : [11 L]

Speed of transverse waves on a string, speed of longitudinal waves in fluid, energy density and energy transmission in waves – measurement, gravity waves and ripples, group velocity and wave velocity – measurements. [6L]

Standing waves – normal modes of bounded systems examples, Harmonics and quality of sound examples. [4L]

8. Acoustics : [9 L]

Noise and music, human ear its responses, audibility, intensity and loudness, Bel and decibel, musical scale, temperament and musical instruments. [2L]

Reflection and refraction sound, acoustic impedance, percentage reflection and refraction at a boundary. [2L]

Measurements of frequency, wave form, intensity and velocity. Acoustics of halls, reverberation, Sabine's formula. [4L]

9. Geometrical Optics : [10 L]

Reflection and refraction : Fermat's Principle, laws of reflection and refraction at a plane surface, refraction at a spherical surface,

lens formula. Combination of thin lenses - equivalent focal length. [5L]

Optical instruments: Dispersion and dispersive power, chromatic aberration and its remedy, different types of Siedel aberration (qualitative) and their remedy. Eye-piece : Ramsden and Huygen's type. [5L]

10. Tutorials [10 L]

Part – II (General)

Paper – II [150 Lectures + 10 Tutorials]

Full Marks – 100

(University written Exam 90 + College Internal Assessment 10)

Group-A

1.Electrostatics: Coulomb's law in free space, calculations of E for simple distribution of charges at rest, electric dipole, torque on a dipole in an uniform field & its energy. [5L]

Work done on a charge in an electrostatic field, conservative nature of the field, electric potential φ, $E = -\nabla\varphi$, flux of electric field, Gauss's law and its applications for symmetric charge distributions, field at the surface of a conductor, capacitors, electrostatic field energy, force per unit area at the surface of a charged conductor. [10 L]

Dielectrics - Parallel plate capacitor with a dielectric, dielectric constant, Polarization, Polarization vector and displacement vector. [5 L]

2. Steady electric current: Current density, equation of continuity, condition for the steady current, Kirchhoff's laws and analysis of multi-loop circuits. [5L]

Group-B

3. Magnetostatics: Force on a moving charge, Lorentz force and definition of B, force on a straight current carrying conductor in a uniform magnetic field, torque on a current loop. Biot-Savart law, Ampere's circuital law, determination of magnetic fields (B) due to a straight current carrying conductor, a circular coil, a solenoid, magnetic field due to a small current loop, concept of magnetic dipole as a tiny current loop. [10L]

Magnetic fields in matter- magnetization (M), relation between B, H, and M, magnetic susceptibility and permeability, diamagnetic, paramagnetic and ferromagnetic materials, Curie's law, hysteresis in ferromagnetic material. [5L]

4. Electromagnetic induction and Maxwell's Equations: Faraday's law (both the integral and the differential forms), self and mutual inductances, transformers, energy stored in a coil of self inductance L, displacement current, Maxwell's equations. [10L]

5. Transients in DC: Growth and decay of current in LR circuit, charging and discharging of capacitor in CR circuit, time constants. [5L]

6. Alternating current: LR and CR circuits, complex number and their applications in AC circuits, impedance and reactance, series and parallel resonances, Q– factor, power dissipation in AC circuit, power factor. [5 L]

Group-C

7. Physical optics: Interference - Interference of light, principle of superposition, Young's double slit experiment, intensity distribution, conditions of interference, optical path retardation, lateral shift of fringes, interference in thin films, Newton's ring experiment. [14 L]

Diffraction - Fresnel's diffraction, half period zones, rectilinear propagation, zone plates.

Fraunhofer different, diffraction at a single slit, double slit (no derivation), intensity distribution.

Diffraction grating, diffraction at N parallel slits, intensity distribution, plane diffraction grating. Rayleigh criterion, Resolving powers of a grating and a prism. [10 L]

Polarization - Polarization of light, uniaxial crystals, Brewster's law, Double refraction phase retardation plates. Optical activity, rotation of plane of polarization, right-handed and left-handed active substances (definitions and examples only), specific rotation. [6 L]

8. Electronics: p-n junction diode, diode as a rectifier, bridge rectifier, Zener diode, Zener diode as a voltage regulator. [8L]

Transistors - characteristics of a transistor in CE mode, graphical analysis of CE configuration, d.c. biasing-selection of Q-point. [8L]

Digital Electronics- binary number system, coversion from decimal to binary and vice versa. Logic gates- OR, AND, NOT gates, truth tables, de Morgan's theorem, NOR and NAND universal gates. [14L]

Group-D

9. Relativity: Postulates of special theory of relativity; length contraction and time dilation (derivations are not required), velocity addition theorem (statement only), variation of mass with velocity and mass-energy equivalence (derivations are not required). [5L]

10. Atomic Physics: Bohr model, Spectra of hydrogen atom, Vector Atom model, concept of quantum numbers, Pauli exclusion principle. [3L]

10. Quantum mechanics: Wave particle duality - de Broglie hypothesis and matter waves; Compton effect, Heisenberg uncertainty principle, wave-function Ψ (x,t), probability density, normalization, Schrodinger equation in one-dimension, application to particle in a one dimensional box, eigenfunctions and eigenvalues. [8L]

11. Nuclear Physics: Structure of a nucleus- shell model, concept of binding energy, nuclear reactions, stability, fission and fusion, energy production in stars, nuclear reactors. [7L]

12. Solid State Physics: Crystal structures, lattice and basis, unit cell, cubic crystal system- sc, fcc, and bcc, packing fractions, X-ray diffraction – Laue Equations (statement only) and Bragg's law. [7L]

Energy band structure of solids - Distinction of insulators, semiconductors and metals.

13. **Tutorials [10 L]**

Paper – III [Practical] Full Marks – 100 Time – 6 Hrs.

Group – A (35 Marks)

1. To determine the *moment of inertia* of a heavy cylinder about its axis of symmetry by torsional oscillation method.

2. Determination of *rigidity modulus* of material in the form of cylindrical wire by dynamical method. The mass of the heavy metallic oscillator should be supplied at venue.

3. Determination of *Young's modulus* of material of a bar using method of bending beam loaded at middle of the bar.

4. Determination of *temperature coefficient of linear expansion* of rod by optical liver method.

5. Determination of *coefficient of viscosity* at room temperature using capillary flow method.

6. Measurement of the *resistance of suspended coil galvanometer* by *half deflection method*.

7. To measure unknown resistance using *Carry Foster's bridge*.

8. To determine the unknown EMF of a cell by *potentiometer* with the help of a milli-ammeter.

9. To determine the current through a resistance by *potentiometer*.

10. Study of the *current-voltage characteristics* of simple *resistor* and forward biased *P-N junction Diode* and compare.

Group – B (45 Marks)

1. Measuring the *focal length of a concave lens* by combination method.

2. Determination of the *refractive index* of (a) material of the lens (b) a wettable liquid.

3. Determination of *refractive index* of material of a prism by spectrometer using method of minimum deviation.

4. To measure the *horizontal component of earth's magnetic field* by magnetometer.

5. Study of *Newton's ring* and determination of *wavelength* of source (radius of curvature of the lens be supplied).

6. Use of *bridge rectifier* and study of its load regulation characteristics

7. To study the *forward and reverse bias* characteristics of a *Zener diode* and determination of dynamic resistance before and after breakdown.

8. To study the *load regulation characteristics* of the Zener Diode with specific reference voltage.

9. To draw the *output characteristic of a transistor* in CE mode.

10. To verify truth tables of OR, AND and NOT gates.

Physics (General)

Paper-IV (A) :: 75 (Th - 67; IA - 8) [110L]
Project – IV (B) :: 25

A. Mechanics and Thermodynamics [10L]

1. Production and Measurement of High Vacuum: Rotary and diffusion Pump, Mcleod Gauge, Pirani and Penning Gauge [5L]
2. Heat Engines: Thermal Efficiency, Indicated Horse Power, Brake Horse Power, Otto cycle, Diesel Cycle, Four –Stroke Petrol and Diesel engine, efficiency, Comparison.[5L]

B. Sound and Acoustics [8L]

1. Ultrasonics and its application. [3L]
2. Microphones and speakers, Recording and reproduction of sound including digital system. [5L]

C. Electricity [15L]

1. Conversion of galvanometer to ammeter and voltmeter; Digital Multimeter [3L]
2. Electric Generator. Elementary theory of transformer, A.C. bridges, theory of rotating magnetic field-induction motor, Three-phase electrical power supply. [7L]
3. Elementary Concepts on electrical wiring; Wiring a room having a tube light, a filament lamp and a ceiling fan; Wiring a house having 3-Bed rooms, dressing room, kitchen; Polarity test, continuity test, earth and ground test. [8L]

D. LASER and Modern Optics [14L]

1. LASER principle: Einstein A,B coefficient, Population Inversion, Feedback energy in resonator. [4L]
2. LASER type: Solid state LASER-Ruby, Semi conductor LASER. [2L]
3. LASER Application: Elementary idea on Holography, Medical Application, Isotope separation. [2L]
4. Basics of Camera and Photography. [2L]
5. Optical fiber: Core and cladding, total internal reflection, optical fiber as waveguide, acceptance angle and numerical aperture, step index fiber. [4L]

E. Electronics [30L]

1. p-n Junction and Zener diode characteristics (Review), Half Wave rectifier, Full Wave rectifier, Bridge rectifier, Filter, Use of Zener as Voltage regulator, Designing of dc power supply.[7L]
2. Bipolar junction transistors: Method of operation, current components input and output characteristics (Review only), Hybrid model, Basic transistor CE amplifier. [7L]
3. OPAMP and its use as inverting, non-inverting amplifier, adder, subtractor, differentiator, Integrator. [6L]
4. Digital electronics: XOR, XNOR gates, Half adder, full adder, Product of Sum (POS), Sum of Product (SOP) technique, simplification by Karnaugh Map [7L].
5. Communication principle: Basic idea about modulation and demodulation. [3L]

F. Computer Hardware, Software and application [20L]

1. Basic building blocks [2L]

2. Computer soft ware- Operating system, DOS, UNIX, WINDOWS [2L]
3. Elementary programming with Fortran: Flow chart, Control statement, do Loops, functions and subroutines, input output statements, simple programs –
   a. To find the area of a circle.
   b. To print out all natural even odd numbers between its limits.
   c. To find the maximum, minimum and range of a set of numbers.
   d. To evaluate mean of some numbers.
   e. To evaluate sum of finite series (simple series).

G. Overall tutorial- **[10L]**

Project – IV (B) :: 25

Project-type sample experiments (one should be performed / demonstrated at the time of examination):

1. To convert an ammeter into a voltmeter and a voltmeter into an ammeter.
2. To construct an adjustable voltage power supply using IC & to study its regulation.
3. To measure the internal resistance of an analog voltmeter and to increase its internal
resistance using on OPAMP.
4 To use OP AMP as inverting, non inverting, differential amplifier and as an adder.
6. To construct and verify the truth tables of half adder / full adder.
7. Computer programming – covering the content of the theoretical syllabus (Part III Gen).

The students are at liberty to do the project experiments, in consultation with the teacher, on any topic within the content of the theoretical syllabus (Part III Gen).

RECOMMENDED BOOKS
HONOURS COURSE

Mathematical methods:

1. Vector Analysis and an introduction to Tensor Analysis - M. R. Spiegel, (Schaum's Outline Series) (Tata McGraw-Hill).
2. Mathematical Methods of Physics - A. N. Konar (Shreetara Prakashani)
3. Mathematical Methods in the Physical Sciences - M. L. Boas (Wiley).
4. Mathematical Methods - M. C. Potter and J. Goldberg (Prentice-Hall of India).
5. Mathematical Physics – A. K. Ghatak, I. C. Goyal and S. J. Chua (Macmillan).
6. Mathematical Physics – P. K. Chattopadhyay (Wiley Eastern).
7. Introduction to Mathematical Physics - C. Harper (Prentice-Hall of India).
8. Mathematical Physics – H. K. Dass and R. Verma (S. Chand).
9. Complex Variables and Applications – Brown and Churchill (Tata McGraw-Hill).
10. Matrices and Tensors in Physics – A.W. Joshi (New Age International).
11. Advanced Engineering Mathematics - E. Kreszig (Wiley).
12. Mathematical Methods for Physicists – Arfken, Weber and Harris (Elsevier India).
13. Mathematical Methods for Physics and Engineering – K. F. Riley, M. P. Hobson and S. J. Bence (Cambridge University Press).
14. Tatwiya Padartha Bidyar Bhumika – S. Sengupta, Asok Ghosh and D. P. Roychaudhuri (WBSBB).

General Properties of matter

1. Classical Mechanics & General Properties of matter - S. N. Maiti and D. P. Ray Chaudhuri (New Age International).

2. A treatise on General Properties of Matter – R. Sengupta and H. J. Chatterjee (Central Book Agency).
3. Classical Mechanics and Properties of Matter - A. B. Gupta (Books & Allied).
4. Padarther Dharma - D. P. Ray Chaudhuri (WBSBB).
6. General Properties of matter - F. H. Newmann & V H L Searle.
7. Properties of Matter - C. J. Smith.

Vibration, Waves & Acoustics :

1. Vibration, Waves & Acoustics - D. Chattopadhyay and P. C. Rakshit (Books and Allied).
2. Waves and Oscillations - Rathin N. Chaudhury (New Age Publishers).
3. Advanced Acoustics - D. P. Ray Chaudhuri (Chayan – Kolkata).
4. Waves- J R Crawford (Tata McGraw-Hill).

Optics:

1. A text book on Light – B. Ghosh and K. G. Mazumdar (Shreedhar Publishers).
2. Optics – A. K. Ghatak (Tata McGraw-Hill).
3. Optics – Hecht (Pearson Education).
4. Fundamentals of Optics - F. A. Jenkins and H. E. White (Mc Graw Hill, Kogakusha).
5. Geometrical and Physical Optics - B. S. Longhurst (Orient Longmans).
6. Bhouta Alok Bijnan – B. S. Basak (WBSBB).

Electronics:

1. Integrated Electronics – J. Millman and C. Halkias and C. D. Parikh (McGraw-Hill).
2. Electronic Fundamentals and Applications – D. Chattopadhyay and P. C. Rakshit (New Age International).
3. Fundamentals Principles of Electronics – B. Ghosh (Books and Allied).

4. Electronic Device and Circuit Theory – R. Boylestad and L. Nashelsky (Prentice-Hall of India).
5. Electronic Devices and Circuits – B. P. Singh and R. Singh (Pearson Education).
6. Electronic Principles – A. Malvino and D. J. Bates (Mc Graw Hill - Special Indian Edition).
7. Electronics – R.K. Kar (Books and Allied).
8. Digital Computer Electronics – Malvino and Brown (Tata McGraw-Hill).
9. Digital Electronics – D. Ray Chaudhuri (Platinum Publishers).
10. Digital Logic and Computer Design – M. Moris Mano, (Prentice-Hall of India).
11. Electronics O Betar Bijnan Parichaya – Animesh Roy & Pradip Kr. Datta (WBSBB).

Classical Mechanics:

1. Theoretical Mechanics - M. R. Spiegel, (Schaum's Outline Series) (McGraw-Hill).
2. Classical Mechanics & General Properties of Matter - S. N. Maiti and D. P. Ray Chaudhuri (New Age International).
3. Classical Mechanics – J. Goldstein (Narosa).
4. Classical Mechanics and Properties of Matter - A. B. Gupta (Books & Allied).
5. Introduction to Classical Mechanics - R. G. Takwale and P. S. Puranik (Tata McGraw-Hill).
6. Classical Mechanics – G. Aruldhas (Prentice-Hall of India).
7. Classical Mechanics – N. C. Rana and P. S. Joag (Tata McGraw-Hill).
8. Classical Mechanics – A. K. Roychaudhuri (Oxford University Press).
9. Mechanics - K. R. Symon (Addison-Wesley).
10. An Introduction to Mechanics – D. Keppner and R.J. Kolenkow (Tata McGraw-Hill).
11. Uchhatara Gatividya - A. K. Roychaudhuri (WBSBB).
12. The Feynman Lectures on Physics – Vol I (Narosa).
13. Berkeley Physics Course (Vol. – I Mechanics) - McGraw-Hill.

Special Theory of Relativity:

1. Introduction to Special Theory of Relativity - R. Resnick (Wiley Student Edition).
2. The Special Theory of Relativity – S. Banerji and A. Banerjee (Prentice-Hall of India).
3. Introduction to Special Theory of Relativity – S. Datta (Allied Publishers Pvt. Ltd.).
4. Special Theory of Relativity - A. P. French (ELBS).

Heat & Thermodynamics:

1. Thermal Physics – H. P. Roy and A. B. Gupta (Books and Allied).
2. Thermodynamics - *P. C. Rakshit* (Current Distributors).
3. Thermal Physics – C. K. Ghosh, S. Garg, R. M. Bansal (Tata McGraw-Hill).
4. Basic Thermodynamics – Evelyn Guha (Alpha Science).
5. Tapgatividya – Asoke Ghosh (WBSBB).
6. Gaser Anabik Tattwa – P. K. Chaudhuri (WBSBB).
7. Heat and thermodynamics – M. W. Zemansky and R. H. Ditman (McGraw-Hill - Special Indian Edition).
8. A Treatise on Heat – M. N. Saha and B. N. Srivastava (Indian Press).
9. Thermodynamics - Fermi.
10. Thermodynamics – Callen.

Electricity and Magnetism and Electromagnetic Theory:

1. Foundations of *Electricity and Magnetism- B. Ghosh* (Books & Allied).

2. Electricity and Magnetism – D. Chattopadhyay and P. C. Rakshit (Central Book Agency).

3. Introduction to Electrodynamics – D. J. Griffiths (Prentice-Hall of India).

4. Electricity and magnetism - A. S. Mahajan & A. A. Rangwala (Tata McGraw-Hill).

5. Berkeley Series Vol II (Electricity and Magnetism) - E.M. Purcell (Tata McGraw-Hill).

6. The Feynman Lectures on Physics – Vol. II (Narosa).

7. Classical Electricity and Magnetism – M. Phillips and W. K. H. Panofsky (Dover Publications).

8. Electromagnetic theory - Reitz, Milford and Christy (Narosa).

9. Classical Electrodynamics – J. D. Jackson (Wiley India).

10. Poriborti Tarit-Prabaha – P. Sengupta (WBSBB).

Statistical Mechanics:

1. Thermal Physics – H. P. Roy and A. B. Gupta (Books and Allied).

2. Statistical Mechanics: An Elementary Outline – A. Lahiri (University Press).

3. Statistical Mechanics - S. L. Gupta and V. Kumar (Pragati Prakashan).

4. Fundamentals of Statistical and Thermal Physics - F. Reif (McGraw-Hill).

5. Statistical Mechanics – R. K. Pathria and P. D. Beale (Elsevier India).

Solid State Physics:

1. Solid State Physics - R.K. Puri and V.K. Babbar (S Chand)

2. Introduction to Solid State Physics - C. Kittel (Wiley Eastern).

3. Elementary Solid State Physics – M. Ali Omar (Pearson Education).

4. Solid State Physics – R. P. Singhal (Kedarnath Ramnath).

5. Solid State Physics – A. J. Dekker (Mc Millan).

6. Solid State Physics – S. O. Pillai (New Age International).

7. Solid State Physics: Structure and Properties of Materials – M. A. Wahab (Narosa).

8. Solid State Physics: Essential Concepts – D.W. Snoke (Pearson Education).

Quantum Mechanics:

1. Introductory Quantum Mechanics - S. N. Ghoshal (Calcutta Book House).

2. Introduction to Quantum Mechanics – D. J. Griffiths (Pearson Education).

3. Quantum Mechanics – J. L. Powell and B. Crasemann (Oxford, Delhi).

4. Quantum Mechanics Concepts and Applications – N. Zettili (Wiley)

5. Quantum Mechanics – A. K. Ghatak and S. Lokanathan (Macmillan, India).

6. Quantum Physics – S. Gasiorowicz (Wiley Student Edition).

7. Quantum Mechanics - B. H. *Bransden and* C. J. *Joachain* (Pearson Education).

8. Modern Quantum Mechanics – Sakurai (Pearson Education).

Atomic, Molecular Physics with LASER

1. Modern Atomic and Nuclear Physics- A.B. Gupta (Books and Allied).

2. Atomic Physics (Modern Physics) – S. N. Ghoshal (S Chand).

3. Perspectives of Modern Physics – Arthur Beiser (Tata McGraw-Hill).

4. Schaum's Outlines Modern Physics - R. Gautreau and W. Savin (Tata McGraw-Hill).

5. Optics and Atomic Physics – D. P. Khandelwal (Himalaya Publishing House).

6. Physics of Atoms and Molecules - B. H. *Bransden and* C. J. *Joachain* (Pearson Education).

7. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles – R. Eisberg and R. Resnick (Wiley Student Edition).

8. Atomic and Nuclear Physics – S. K. Sharma (Pearson Education).

9. Paramanu O Kendrak Gathan Parichaya (Vol. 1 & 2) – S. N. Ghoshal (WBSBB).

10. Fundamentals of Molecular Spectroscopy – C. M. Banwell, E. M. McCash (McGraw-Hill, India).

11. Optical Electronics – A. K. Ghatak and K. Thyagarajan (Cambridge University Press).

12. Laser Principles and Applications – A. K. Ghatak and K. Thyagrajan (Tata – McGraw Hill).

Nuclear Physics:

1. Modern Atomic and Nuclear Physics- A.B. Gupta (Books and Allied).

2. Atomic and Nuclear Physics – S. N. Ghoshal (S. Chand).

3. Nuclear Physics: Theory and Experiment - B. P. Nigam and R. R. Roy (New Age Publishers).

4. Nuclear Physics – Cottingham and Greenwood (Cambridge University Press).

5. Concepts of Nuclear Physics – R. Cohen (Tata McGraw-Hill).

6. Particle Physics – A. Seiden (Pearson Education).

7. Paramanu O Kendrak Gathan Parichaya (Vol. 1 & 2) – S. N. Ghoshal (WBSBB).

Practical (Honours):

1. Advanced Practical Physics – Vol. 1 & 2 - B. Ghosh and K. G. Majumder (Shreedhar Publishers).

2. An Advance Course in Practical Physics - D. Chattopadhyay and P. C. Rakshit (Central Book Agency).

3. A Laboratory Manual of Physics of Undergraduate Classes – D. P. Khandelwal (Vani Publishing House, New Delhi).

Computer Practical (Honours):

1. Computer Programming in FORTRAN 77- V. Rajaraman (Prentice-Hall of India).

2. FORTRAN 77 and Numerical methods - C. Xavier (New Age International).

3. Schaum's outline of theory and problems of programming with FORTRAN including structured FORTRAN - S. Lipschoutz and A. Toe (McGraw-Hill).

4. FORTRAN 77 – M. Pal (Asian Books Private Ltd).

GENERAL COURSE

For Part I and II:

1. Snatak Padartha Bijnan [A Handbook of Degree Physics] (Vol. 1 & 2) – C. R. Dasgupta (Book Syndicate).

2. Snatak Padarthabidya (Vol. 1 - 2) – M. D. Khan (Calcutta Book House).

3. Snatak Padarthabidya (Vol. 1 - 2) - A. B. Bhattacharya, R. Bhattacharya (Central Book Agency).

4. Undergraduate Physics (Vol. 1-2) - A. B. Bhattacharya, R. Bhattacharya (Central Book Agency).

5. College Physics (Vol. 1-4) – D. B. Sinha and J. M. Das Sharma (Modern Book Agency).

6. Paramanu O Kendrak Gathan Parichaya (Vol. 1 & 2) – S. N. Ghoshal (WBSBB).

7. College Physics (Vol. 1-2) – A. B. Gupta (Books & Allied).

For Part III:

1. Physics in Application (earlier published under the title, A General Course in Physics : III) – A. Lahiri (Grantha Bharati, Kolkata).

2. Snatakiya Padarthabidya (Vol. 3) – A. B. Bhattacharya, R. Bhattacharya (Central Book Agency).

3. Snatak Padartha Bijnan - P. Banerjee and A. Rudra (The New Book Stall).

4. Undergraduate Physics (Vol. 3) - A. B. Bhattacharya, R. Bhattacharya (Central Book Agency).

5. Snatak Padarthabidya (Vol. 3) – M. D. Khan and A . Pal (Calcutta Book House).

6. Introduction to Physics Application – Edited by P. N. Ghosh (University of Calcutta).

Practical (General):

1. Parikshamulak Padartha Bijnan [A Text Book on Practical Physics] – K. G. Mazumder and B. Ghosh (Shreedhar Publishers).

2. A Handbook of Practical Physics - C. R. Dasgupta and S. N. Maiti (Book Syndicate).

3. Parikshashrayee Padarthabidya (Vol. 1 & 2) – Debiprosad Sarkar (WBSBB).

Computer Practical (General):

1. Computer Programming in FORTRAN 77 - V. Rajaraman (Prentice-Hall of India).