West Bengal State University

B. Sc. (PHYSICS HONOURS) SYLLABUS

(draft)

This course is divided into three parts, each of one year duration. One University level examination will be held at the end of the each year. Each paper can be subdivided in two half papers hereafter called units. Each unit carries 50 marks. Part I consists of three theoretical units (IA, IB and IIA) and one practical unit (Paper IIB). Part II consists of three theoretical units (IIIA, IIIB and IVA) and one practical unit (IVB). Part III consists of five theoretical units(VA,VB,VIA, VIB and VIIA) and three practical units (VIIB, VIIIA and VIIIB). Final result will be determined on the basis of the three examinations out of a grand total of 800 marks.

THEORETICAL UNITS

Each theoretical unit is divided into one or more groups and each group is subdivided into a number of topics. A broad guideline of the material to be covered in each topic has beengiven together with the expected number of class room lecture periods (each of 45 min.duration) which is given within parentheses at the end of each topic. This is intended as a guideline to individual teachers for the depth and extension of the material to be covered.

A number of tutorial periods has been included for each unit. During these tutorial periods, group discussions will be conducted by the teacher on the topic taught earlier to remove any difficulty that the students may face. Part of such tutorial periods will also be used for solving problems on the topics of that particular group. No additional subject other than those covered in the syllabus should be introduced in the tutorial classes.

PHYSICS HONOURS
THEORETICAL

PART - I

PAPER I

[The setting of questions from different groups is as follows;
Question No 1 will be of short answer type carrying 2 marks each. 10 out of 16 questions distributed uniformly over the entire syllabus are to be answered.
Questions 2,3,4,5,6: 5 Questions to be set and 3 to be answered from Group A
Questions 7, 8: 2 Questions to be set and 1 to be answered from Group B
Questions 9,10,11: 3 Questions to be set and 2 to be answered Group C
Questions 12,13,14: 3 Questions to be set and 2 to be answered Group D

Each question from question Nos 2 to 14 will carry 10 marks.]

UNIT IA

Total Marks : 50 Total No. of Lectures : 70

GROUP A : MATHEMATICAL METHODS OF PHYSICS (44 Lectures)

1. Preliminary Topics

Infinite sequences and series - convergence and divergence, conditional and absolute convergence, ratio test for convergence. Complex-valued functions - analytic functions defined in terms of Taylor series expansion. Functions of several real variables - partial differentiation,
Taylor's series, multiple integrals. Random variables and probabilities - statistical expectation value, variance; Binomial distribution, Gaussian distribution and Poisson distribution – simple examples. (9)

2. Vector Analysis

Transformation properties of vectors; scalar and vector products; Differentiation and integration of vectors; Concept of tensors; Line integral, volume integral and surface integral involving vector fields; Gradient, divergence and curl of a vector field; Gauss' divergence theorem, Stokes' theorem, Green's theorem - application to simple problems; Orthogonal curvilinear co-ordinate systems, unit vectors in such systems, illustration by spherical and cylindrical polar systems. (9)

3. Differential Equations

(a)Ordinary Differential Equations :

Solution of second order linear differential equation with constant coefficients and variable coefficients by Frobenius' method; Solution of Legendre and Hermite equations about x=0; Legendre and Hermite polynomials - orthonormality properties. (8)

(b) Partial Differential Equations :

Solution by the method of separation of variables; Laplace's equation and its solution in Cartesian, spherical polar (axially symmetric problems), cylindrical polar (`infinite cylinder' problems) coordinate systems; Wave equation and its plane and spherical wave

solutions.(8)

4. Fourier Series

Fourier expansion – statement of Dirichlet's condition, analysis of simple waveforms with Fourier series. Introduction to Fourier transforms; the Dirac-delta function and its Fourier transform; other simple examples.(5)

5. Matrices

Hermitian adjoint and inverse of a matrix; Hermitian and unitary matrices; Eigenvalue and eigenvector; Similarity transformation; diagonalisation of real symmetric matrices with non-degenerate eigenvalues.(5)

GROUP B : CLASSICAL MECHANICS (21 Lectures)

1. Mechanics of a Single Particle

Velocity and acceleration of a particle in (i) plane polar coordinates - radial and crossradial components (ii) spherical polar and (iii) cylindrical polar co-ordinate system; Time and path integral of force; work and energy; Conservative force and concept of potential;Dissipative forces; Conservation of linear and angular momenta.(6)

2. Mechanics of a System of Particles

Linear momentum, angular momentum, and energy - centre of mass decompositon; Equations of motion, conservation of linear and angular momenta.(6)

3. Rotational Motion

Moment of inertia, radius of gyration; Energy and angular momentum of rotating systems of particles; Parallel and perpendicular axes theorems of moment of inertia; Calculation of moment of inertia for simple symmetric systems; Ellipsoid of inertia and inertia tensor;Setting up of principal axes in simple symmetric cases. Rotating frames of reference – Coriolis and centrifugal forces, simple examples. Force-free motion of rigid bodies - free spherical top and free symmetric top.(9)

Tutorials on Problems and Discussions (5)

UNIT IB

Total Marks 50 Total No. of Lectures : 70

GROUP C GENERAL PROPERTIES OF MATTER (33 Lectures)

1. Gravitation

Newton's law of Gravitation; Gravitational potential and intensity - application of Gauss' theorem and Laplace's equation in simple symmetric problems.(5)

2. Central Force Problem

Motion under central force; Nature of orbits in an attractive inverse square field; Kepler's laws of planetary motion. Rutherford scattering.(6)

3. Elasticity

Stress and strain tensors at any point in a continuous medium; Small deformations, Hooke's law, Interrelations of elastic constants for an isotropic solid. Torsional rigidity; Bending moments and shearing forces, cantilever; Beam supported at both ends; strain energy.(9)

4. Mechanics of Ideal Fluids

Streamlines and flowlines; Equation of continuity; Euler's equation of motion; Streamline motion - Bernoulli's equation and its applications.(5)

5. Surface Tension

Surface energy and surface tension; Angle of contact; Excess pressure on a curved liquid surface; Capillary rise; Saturation vapour pressure on a curved surface.(4)

6. Viscosity

Steady flow of Newtonian fluids; Poiseuille's equation for incompressible fluids; Statement of Stokes' law - terminal velocity; effect of temperature on viscosity; Reynold's number - turbulent flow and critical velocity.(4)

GROUP D : VIBRATIONS, WAVES AND ACOUSTICS (32 Lectures)

1. Vibrations

Linear harmonic oscillator - differential equation and its solution . Free and forced vibrations of a damped harmonic oscillator; resonace; sharpness of resonance. A pair of linearly coupled harmonic oscillators - eigenfrequencies and normal modes. Lissajous figure; Vibrations of a weakly anharmonic oscillator - generation of harmonics, frequency shift. Basic principle underlying the production of combination tones.(10)

2. Waves

Linear equation of plane progressive wave motion in one dimension, and in three dimensions; plane wave and spherical wave solutions; intensity of a plane progressive wave; dispersion in wave propagation - group velocity and phase velocity.(7)

3. Transverse vibrations in stretched strings

Wave equation in the linear approximation; eigenfrequencies and eigenmodes for plucked and struck strings; energy of transverse vibrations.(6)

4. Velocity of acoustic waves in isotropic solids, liquids and gases

Derivation of the respective expressions with explanation of the approximations made.(4)

5. Doppler effect in acoustics

Derivation of expression for Doppler shift in frequency.(3)

6. Ultrasonics

Basic principles of generation and detection.(2)

Tutorials on Problems and Discussions (5)

PAPER IIA

UNIT IIA

[The setting of questions from different groups is as follows;
Question No 1 will be of short answer type carrying 2 marks each. 5 out of 8 questions distributed uniformly over the entire syllabus are to be answered.
Questions 2,3: 2 Questions to be set from GroupA
Questions 4,5,6,7: 4 Questions to be set from Group B
Question no 1 and 4 other Questions are to be answered taking at least 1 from group A

Each question from question Nos 2 to 7 will carry 10 marks.]

Total Marks 50 Total No. of Lectures : 70

THERMAL PHYSICS

Group A: Heat (20Lectures)

1. Kinetic Theory of Gases

Basic assumptions of kinetic theory, Ideal gas approximation, deduction of perfect gas laws. Maxwell's distribution law (both in terms of velocity and energy), root mean square and most probable speeds. Finite size of molecules : Collision probability, Distribution of free paths and mean free path from Maxwell's distribution. Degrees of freedom, equipartition of energy (detailed derivation not required) : application to specific heat, Dulong and Petit's law.(10)

2. Transport Phenomena

(a) Viscosity, thermal conduction and diffusion in gases. (b) Brownian Motion : Einstein's theory, Perrin's work, determination of Avogardo number.(5)

3. Real Gases

Nature of intermolecular interaction : isotherms of real gases. van der-Waal's equation of state, Other equations of state (mention only), critical constants of a gas, law of corresponding states; Virial Coefficients, Boyle temperature; limitations of van der-Waal's equation of state.(5)

Group B: Thermodynamics (45 lectures)

1. Basic Concepts

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

2. Zeroth Law of Thermodynamics

Thermal equilibrium,. Zeroth Law and the concept of temperature. (1)

3. First Law of Thermodynamics

Thermodynamic equilibrium, internal energy, external work, quasistatic process, first law of thermodynamics and applications including magnetic systems, specific heats and their ratio, isothermal and adiabatic changes in perfect and real gases.(5)

4. Second Law of Thermodynamics

Reversible and irreversible processes, indicator diagram. Carnot's cycles-efficiency, Carnot's theorem. Kelvin's scale of temperature, relation to perfect gas scale, second law of thermodynamics – different formulations and their equivalence, Clausius inequality, entropy, change of entropy in simple reversible and irreversible processes, entropy and disorder; equilibrium and entropy principle, principle of degradation of energy.(10)

5. Thermodynamic Functions

Enthalpy, Helmholtz and Gibbs' free energies; Legendre transformations, Maxwell's relations and simple deductions using these relations; thermodynamic equilibrium and free energies. (5)

6. Heat Engines
External combustion engine - Rankine cycle, internal combustion engines – Otto and Diesel cycles.(3)
7. Change of State
Equilibrium between phases, triple point : Gibbs' phase rule (statement only) and simple applications. First and higher order phase transitions, Ehrenfest criterion. Clausius-Clapeyron's equation. Joule-Thomson effect; inversion temperature, regenerative cooling.(7)
(c) Heat Transfer
Thermal conductivity, diffusivity. Fourier's equation for heat conduction – its solution for rectilinear and radial (spherical and cylindrical) flow of heat.
Radiation :
Spectral emissive and absorptive powers, Kirchoff's law, blackbody radiation, energy density, radiation pressure. Stefan-Boltzmann law, Planck's law (no detailed derivation), solar temperature and radiation pyrometer.
Convection :
Importance in atmospheric physics (qualitative), adiabatic lapse rate.(12)
Tutorials on Problems and Discussions (5)

BOOKS

Mathematical Methods

1. Introduction to Mathematical Physics - C. Harper (Prentice-Hall of India).
2. Mathematical Methods - M. C. Potter and J. Goldberg (Prentice-Hall of India).
3. Vector Analysis - M. R. Spiegel, (Schaum's Outline Series) (Tata McGraw-Hill).
4. Tatwiya Padartha Bidyar Bhumika – S. Sengupta, Asok Ghosh and D. P. Roychaudhuri
(W.B. State Book Board (WBSBB)).

Classical Mechanics and General Properties of Matter

1. Theoretical Mechanics - M. R. Spiegel, (Schaum's Outline Series) (McGraw-Hill).
2. Mechanics - K. R. Symon (Addison-Wesley).
3. Introduction to Classical Mechanics - R. G. Takwale and P. S. Puranik (Tata McGraw-Hill).
4. The General Properties of Matter - F. H. Newman and V. H. L. Searle (Radha Publ. House).
5. Mechanics and General Properties of Matter – D. P. Roychaudhuri and S. N. Maiti (Book Syndicate).
6. Padarther Dharma - D. P. Ray Chaudhuri (West Bengal State Book Board).
7. The Feynman Lectures on Physics – Vol I (Addison-Wesley).
8. An Introduction to Mechanics – D. Keppner and R.J. Kolenkow (Tata McGraw-Hill).

Vibrations, Waves and Acoustics

1. Advanced Acoustics - D. P. Ray Chaudhuri (Chayan – Kolkata).
2. Waves and Oscillations - Rathin N. Chaudhury (New Age Publ.).

Thermal Physics

1. Heat and thermodynamics - Zemansky and Ditman (Mc Graw Hill, Kugakusha).
2. Kinetic theory of gases - Leob (Radha Publ. House).
3. Thermodynamics – F. Fermi.
4. Tapgatividya – Asoke Ghosh (W.B.S.B.B).
5. A Treatise on Heat - Saha and Sribastava (The Indian Press Ltd).
6. Gaser Anabik Tattwa- Pratip Kumar Chaudhuri (W. B. S. B. B).
7.Thermal Physics – S. Garg, R. M. Bansal, C. K. Ghosh (Tata Mc Graw Hill).
8.Heat and Thermodynamics – H. P. Roy and A. B. Gupta.

PART II

PAPER III

[The setting of questions from different groups is as follows;
Question No 1 will be of short answer type carrying 2 marks each. 10 out of 16 questions distributed uniformly over the entire syllabus are to be answered.
Question Nos 2, 3, 4, 5, 6, 7: 6 Questions are to be set, 4 to be answered from Group A
Question Nos 8,9 : 2 Questions are to be set from Group B
Question Nos 10,11 : 2 Questions are to be set from Group c
Question Nos 12,13 : 2 Questions are to be set from Group D
Four questions are to answered taking at least one from each of the Groups B, C, D

Each question from question Nos 2 to 13 will carry 10 marks.]

UNIT IIIA

Total Marks 50 Total No. of Lectures : 70

GROUP A

ELECTRICITY I (65 Lectures)

(SI system should be followed)

1. Units and dimensions

CGS, Gaussian and SI units; conversion between Gaussian and SI units; dimension of various quantities. (2)

2. Electrostatics

Coulomb's law of electrostatics, intensity and potential; Gauss' theorem – its application; Poisson and Laplace's equations; deduction from Gauss's theorem; Uniqueness theorem. Superposition theorem (statement only). Application of Laplace's equation to simple cases of symmetric spherical charge distribution.(9)

3. Multipole expansion

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

4. Dielectrics

Polarisation, electric displacement vector (D); Gauss's theorem in dielectric media; boundary conditions; electrostatic field energy; computation of capacitance in simple cases (parallel plates); spherical and cylindrical capacitors containing dielectrics – uniform and nonuniform.(6)

5. Electrical Images

Solution of field problems in case of a point charge near a grounded conducting infinite plane. Boundary value problem : in uniform external field for (i) conducting spherical shell and (ii) dielectric sphere.(6)

6. Steady current

Ohm's law – Differential form, Kirchoff's Law; Wheatstone bridge – its sensitivity (qualitative discussion only).(4)

7. Magnetic effect of steady current

Lorentz force and concept of magnetic induction; force on linear current element; Biot-Savart's law. Ñ. B=0; magnetic vector potential; calculation of vector potential and magnetic induction in simple cases – straight wire, magnetic field due to small current

loop; magnetic dipole; field due to a dipole; magnetic shell; Ampere's theorem; Ampere's circuital law illustration (straight wire); force between long parallel current carrying conductors; ÑxB = mJ; comparison between static electric and magnetic fields. (12)

9. Field and magnetic materials

Free current and bound current; surface and volume density of current distribution; magnetisation; nonuniform magnetisation of matter; Jb = ÑxM ; Ampere's law in terms of free current density and introduction of H; line integral of H in terms of free current; boundary conditions for B and H; permanently magnetized body; magnetic scalar potential; application of Laplace's equation to the problem of a magnetic sphere in uniform magnetic field; hysteresis and energy loss in ferromagnetic material; magnetic circuit; energy stored in magnetic field.(12)

10. Electromagnetic induction

Faraday's and Lenz's law; motional e.m.f.-simple problems; calculation of self and mutual inductance in simple cases; inductances in series and parallel; reciprocity theorem. (5)

11. Network

Thevenin Theorem, Norton theorem, Maximum power transfer theorem, Superposition principle, T and P networks (3)

Tutorials on Problems and Discussions (5)

UNIT – IIIB

Total Marks : 50 Total No. of lectures : 70

GROUP B ELECTRICITY II (17 Lectures)

1. Transients in D.C.

Growth and decay of current-charging and discharging of capacitors in L-C-R circuits; oscillatory discharge; time constant; energy stored in an inductance.(4)

2. Alternating current

L-C-R circuits in sinusoidal e.m.f.; application of imaginary operator; phase diagram; power; power factor; resonance in series and parallel circuits; Q-factor; filter selectivity; elementary theory of transformer. A.C. bridge – principle of generalized A.C. bridge; Anderson bridge. Theory of rotating magnetic field – induction motor. (13)

GROUP C : ELECTROMAGNETIC THEORY (25 Lectures)

1. Generalization 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's theorem, boundary conditions. (8)

2. EM Waves in an isotropic dielectric; 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.(6)

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

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

5. Scattering : Scattering of radiation by a bound charge, Rayleigh's scattering (qualitative ideas), blue of the sky, absorption. (3)

GROUP D : ELECTRONICS I (23 Lectures)

1. Diodes

Conductor, insulator and semiconductor (distinction on the basis of band theory of solids – qualitative study); concept of hole, extrinsic semiconductor, p-n junction – space charge and electric field distribution at junctions, forward and reversed bias junctions, depletion region, avalanche and Zener breakdown; I-V characteristics and use of Zener as voltage regulator; light emitting diode; analysis of half-wave and full-wave rectifiers; bridge rectifier with C and P filter.(7)

2. Bipolar Junction Transistors (BJT)

Current component in junction transistor; characteristics in CB and CE configuration, cut off, saturation and active regions; a and b of a transistor and their relations. Output characteristics; load line and Q point; biasing of a transistor – stability factors; hybrid parameters and small signal single stage low frequency CE amplifier (analysis with h-parameter model)-current and voltage gains; input and output impedances, effect of source resistance, power gain; comparison of CB, CC & CE amplifiers (qualitative discussion); emitter follower.(9)

3. Boolean Algebra

Binary, decimal and hexadecimal systems; conversion from one system to another system; 1's complement and 2's complement of a binary number; binary addition and subtraction. (2)

4. Logic Gates

AND, OR, NOT gates – truth tables, circuits of AND and OR gates using diodes and transistors; circuit of NOT gate using transistor; NAND and NOR as universal gate. Combination of gates for obtaining different Boolean function. de Morgan's theorem – simplification of Boolean's expressions. (5)

Tutorials on Problems and Discussions (5)

PAPER IVA

UNIT IVA

[The setting of questions from different groups is as follows;
Question No 1 will be of short answer type carrying 2 marks each. 5 out of 8 questions distributed uniformly over the entire syllabus are to be answered.
Question Nos 2,3,4: 3 Questions are to be set from Group A
Question Nos 5, 6, 7: 3 Questions are to be set from Group B
4 Questions are to be answered taking at least 1 from each group
Each question from question Nos 2 to 7 will carry 10 marks.]

Total Marks : 50 Total No. of lectures : 70

OPTICS (65 Lectures)

Group A : Ray Optics

1. Light as electromagnetic waves wave normals and rays : short wavelength limit and ray(geometrical) optics.(2)

2. Fermat principle, application to reflection and refraction at curved surfaces.(3)

3. Cardinal points of an optical system : two thin lenses separated by a distance, equivalent lens, different types of magnification : Helmholtz and Lagrange, paraxial approximation, introduction to matrix methods in paraxial optics – simple application. (5)

4. Dispersion : Dispersive power of optical systems, dispersive power of prism, chromatic aberration – methods of reduction, achromatic lens combination.(3)

5. Seidel aberration : (only qualitative discussion) Nature and cause of different seidel aberrations, methods of reducting these. (3)

6. Optical instruments : Field of view, entrance and exit pupil microscope, eyepieces-

Ramsden and Huygen.(4)

Group B: Physical Optics

1. Wave theory of light : Huygen's principle; deduction of law of reflection and refraction.(5)

2. Interference of light waves : Young's experiment; spatial and temporal coherence; intensity distribution; Fresnel's biprism, interference in thin film; fringes of equal inclination and equal thickness; Newton's ring. Michelson's interferometer, application in fine structure study. Multiple beam interference – reflected and transmitted pattern. Fabry-Perot interferometer and application to fine structure study. (15)

3. Diffraction of light waves : Fresnel and Fraunhofer class, Fresnel's half period zones; explanation of rectilinear propagation of light; zone plate. Fraunhofer diffraction due to a single slit, double slit and circular aperature (qualitative). Plane diffraction grating (transmission). Rayleigh criterion of resolution; resolving power of prism, telescope, microscope and transmission grating. (15)

4. Polarisation : Different states of polarisation; double refraction (Explanation from Electromagnetic theory), Huygen's construction for uniaxial crystals; polaroids and their uses. Production and analysis of plane, circularly and elliptically polarised light by retardation plates and rotatory polarisation and optical activity; Fresnel's explanation of optical activity; Biquartz and half shade polarimeter. (10)

Tutorials on Problems and Discussions (5)

BOOKS

Electricity and Magnetism and Electromagnetic Theory

1. Introduction to Electrodynamics – D. J. Griffith, (Prentice Hall, India Pvt. Ltd).
2. Berkeley Series Vol II (Electricity and Magnetism) Purcell (Mc. Graw Hill).
3. The Feynman Lectures on Physics – Vol. II (Addison – Wesley).
4. Electricity and Magnetism - J. H. Fewkes and J. Yarwood (Oxford Univ. Press, Calcutta).
5. Electricity and Magnetism – Chatterjee and Rakshit.
6. Electromagnetic Theory - Reitz, Milford and Christy (Addison – Wesley).

Electronics

1. Integrated Electronics – J. Millman and C. C. Halkias (Mc Graw Hill).
2. Electronic Fundamentals and Applications – D. Chattopadhyay and P. C. Rakshit
3. Electronics Fundamentals and Applications – J. D. Ryder (PHI Pvt. Ltd).
4. Electronic Device and Circuit Theory – R. Boylestad and L. Nashelsky (Prentice – Hall).

Ray Optics and Wave Optics

1. Fundamentals of Optics - F. A. Jenkins and H. E. White (Mc Graw Hill, Kogakusha).
2. Geometrical and Physical Optics - B. S. Longhurst (Orient Longmans).
3. Optics – A. K. Ghatak (Tata Mc Graw Hill).
4. Optics – Hecht and Zajac.
5. Optics – B. K. Mathur.
6. Bhauta Alok Bigyan – B. S. Basak (WBSBB).

Part III

B.Sc. Part III Theoretical

Paper V

[The setting of questions from different groups is as follows;
Question No 1 will be of short answer type carrying 2 marks each. 10 out of 16 questions distributed uniformly over the entire syllabus are to be answered.
Question Nos 2, 3, : 2 Questions are to be set from Group A, 1 to be answered.
Question Nos 4, 5: 2 Questions are to be set from Group B, 1 to be answered.
Question Nos 6, 7, 8: 3 Questions are to be set from Group C, 2 to be answered.
Question Nos 9, 10, 11, 12: 4 Questions are to be set from Group D, 3 to be answered.
Question Nos 13and 14: 2 Questions are to be set from Group E, 1 to be answered.
Each question from question Nos 2 to 14 will carry 10 marks for each question.]

Each question from question Nos 2 to 14 will carry 10 marks for each question.]

Unit VA (No of Lectures: 65)

Group A: ADVANCED CLASSICAL MECHANICS (20 Lecture periods)

Advanced Classical Mechanics: Generalized coordinates, constraints and degrees of freedom; D'Alembart's principle; Lagranges equation for conservative systems and its application to simple cases; Idea of cyclic coordinates, its relation with conservation principles; Definition of Hamiltonian, Hamilton's equation (Statement, Derivation by Legendre transformation) and its application to simple cases. Canonically conjugate variables, canonical transformations, Poisson brackets. Small Oscillation- normal modes and eigen frequencies, simple examples.

Group B: SPECIAL THEORY OF RELATIVITY (15 Lecture periods)

Special theory of relativity: Velocity of light: Micleson Morley Experiment and Newtonian Relativity. Postulates of special theory of relativity; simultaneity; Lorentz transformation along one of the axes- length contraction, time dilation and velocity addition theorem. Fizeau's experiment. Four vectors; relativistic dynamics- variation of mass with velocity. Energy momentum and mass energy relations.

Light cone: space like, time like and light like four vectors, light cone, causality

Group C: STATISTICAL PHYSICS (25 Lecture Periods)

1. Statistical Mechanics: microstates and macrostates-classical description in terms of phase space and quantum description in terms of wave functions. Idea of ensemble. Hypothesis of equal a priori probability for microstates of an isolated system in equilibrium.: Microcannonical ensemble. Ergodic hypothesis. Interactions between two systems- thermal, mechanical and diffusive. Statistical definition of temperature, pressure, entropy and chemical potential. Cannonical and Grand cannonical ensemble. Partition function of a system in thermal equilibrium with heat bath. Law of equipartition of energy, its limit of validity and application.

2. Classical Statistics: Maxwell-Boltzmann (MB) distribution law: Derivation (microcannonical) , Calculation of thermodynamic quantities for ideal monatomic gases.

3. Quantum Statistics: Gibbs' Paradox, Identical particle and symmetry requiremnetnt. Derivation of FD and BE statistics as the most probable distributions (micro-cannonical ensemble). Classical limit of quantum statistics.

5

4. Bose Einstein (BE) distribution law: Derivation, Application of BE statistics to derive Planck's law. Rayleigh Jean's and Wien's law as limiting cases of Planck's law. Phonons and lattice, specific heat of solids: Einstein and Debye's theory, Bose-Einstein condensation (qualitative discussion)

5

5. Fermi-Dirac (FD) distribution law: Derivation, Fermi distribution at zero and nonzero temperatures. Expression for Fermi energy in terms of particle density, Degenerate and non-degenerate Fermi gases. Application of FD statistics to derive specific heat of electrons in metals at low temperatures. Richardson Dushman equation of thermoionic emission.

5

Tutorials on Problems and discussions

5

Unit VB (No of Lectures: 65)

[The setting of questions from different groups is as follows;

Group D: QUANTUM MECHANICS (36 Lecture Periods)

1. Basic Quantum Mechanics: de Broglie hypothesis, Compton effect, Davision-Germer experiment, Heisenberg uncertainty principle. Concept of wave function as describing the dynamical state of a single particle. Group velocity and phase velocities. Classical velocity of a particle an teh group velocity of the wave representing the particle. Principle of superposition. Schrödinger equation, Probabilistic interpretation, equation of continuity, probability current density, Boundary conditions on wave function.

9

2. Operators in quantum mechanics: Basic postulates of quantum mechanics, Dynamical variables as linear hermitian operators, eigenvalue equation satisfied by them. Momentum energy and angular momentum operators. Results of measurement of variables. Expectation values. Commutation relations between the operators. Compatible observables and simultaneous measurements. Ehrenfest theorem.

9

3. Time dependent and time independent Schrödinger equation. Solutions, eigenstates, normalization and orthonormality of wave function.

4

4. Simple application of Quantum Mechanics:

One dimensional potential well, boundary condition.

Penetration of rectangular potential barrier in one dimension: derivation of reflection and transmission coefficients.-explanation of alpha decay.

Box normalization. Momentum eigenfunction for a free particle.

Linear Harmonic Oscillator (LHO). Solution of the equation of LHO (by the method of solution of Hermite differential equation approach), zero point energy. Parity of wave function.

Angular momentum operator and their commutation relation. eigen values and eigen functions of L2 and Lz Theorem of addition of angular momenta (statement with example). Hydrogen atom problem. Schrödinger equation for hydrogen atom

problem, Solution of the radial part and energy eigenvalues (Laguerre polynomial solution to be assumed). Degeneracy of the energy eigenvalues.

18

Group E: ATOMIC SPECTRA, MOLECULAR SPECTRA, X-RAY (24 Lecture Periods)

Atomic Spectra: Spectrum of hydrogen atom. Spectra of alkali metal atoms and its relation to hydrogen spectra. Stern Gerlach experiment and intrinsic spin of electron. Spectra of sodium atom. Doublet structure of D lines of sodium. coupling schemes: L-S, j-j and intermediate coupling.

Magnetic moment of electron, Lande g factor, Vector atom model, space quantization, Normal and Anomalous Zeeman effect.

Pauli exclusion principle, shell structure, Hund's rule. Spectroscopic terms of many electron atoms in the ground state.

16

Molecular spectra: Diatomic molecules-rotational and vibrational energy levels. Basic ideas about molecular spectra. Raman effect and its application (qualitative)

3

X-Ray: Continuous and Characteristic X-rays, Mosley’s law and its explanation from Bohr theory.

. 2

Tutorials on Problems and discussions

5

Paper VI

[The setting of questions from different groups is as follows;
Question No 1 will be of short answer type carrying 2 marks each. 10 out of 16 questions distributed uniformly over the entire syllabus are to be answered.
Question Nos 2, 3, 4 and 5: 4 Questions are to be set from Group A, 3 to be answered.
Question Nos 6 and 7 : 2 Questions are to be set from Group B, 1 to be answered.
Question Nos 8, 9, 10 and 11: 4 Questions are to be set from Group A, 3 to be answered.
Question Nos 12 and 13 : 2 Questions are to be set from Group B, 1 to be answered.
Each question from question Nos 2 to 13 will carry 10 marks for each question]
]

Unit VI A (No of Lectures: 65)

Group A: NUCLEAR PHYSICS (40 LECTURE PERIODS)

1. Gross Properties of nuclei:
   Nuclear mass, charge, size, binding energy, spin and magnetic moment. Isobar, isotope and isotones. Mass spectrometer (Bainbridge). Binding energy per nucleon versus mass number curve and its characteristics.
   5
2. Nuclear Structure:
   Nature of forces between nucleons, nuclear stability and nuclear binding, the liquid drop model (descriptive), Bethe Weizsacker mass formula, application to stability considerations, extreme single particle shell model (qualitative discussions with emphasis on phenomenology with examples)
   9
3. Unstable Nuclei:
   (a) Alpha decay: Alpha particle spectra, velocity and energy of alpha particles, Geiger Nuttal law.
   3
   (b) Beta Decay: nature of beta ray spectra, the neutrino, energy levels and decay schemes, positron emission and electron capture, selection rules, beta absorption and range of beta particles, Curie plot.
   4
   (c) Gamma decay: gamma ray spectra and nuclear energy level, isomeric states, multipolarity transition and selection rules (no derivation). Gamma absorption in matter- photoelectric process, Compton scattering and pair production (qualitative)
   4
4. Nuclear Reaction:
   (a)Conservation principles in nuclear reactions, Q value, Q equation, Threshold energy, nuclear reaction cross-sections, examples of different types of reactions and their characteristics, Bohr's postulate of compound nuclear reaction, verification of Bohr's compound nucleus hypothesis, stripping and pick up reactions (qualitative discussion).
   4
   (b)Neutron Physics and Nuclear fission:
   Neutrons: discovery, properties and decay of isolated neutrons.
   Discovery of nuclear fission, Explanation of nuclear fission using liquid drop model, fission products and energy release. Spontaneous and induced fission transuranic

elements. Chain reaction and basic principle of reactors.

4

5. Elementary Particles:

Four basic interactions in nature and their relative strengths, examples of different types of interactions, Quantum numbers-mass, charge, spin, isotropic spin, intrinsic parity, hypercharge, Charge conjugation. Conservation of various quantum numbers, Classification of elementary particles, hadrons and leptons, baryons and mesons, elementary idea about quark structure of hadrons, octet and decuplet families

7

Group B: Instrumental Method (20 LECTURE PERIODS)

1. Vacuum Techniques: Production of vacuum. Condunctance and pumping speed. Rotary oil pump. Mercurt diffusion pump. Measurement of high vacuum. McLeod, Penning and Pirani gauges. Leak detector. 6

6. Particle Accelerators:

Linear Accererators, Simple theory, Usefulness, Cyclotron, basic theory, synchrotron. Electron storage ring (ESR).

8

7. Nuclear Detectors:

GM counter, semiconductor detector for charge particles and γ-rays, phodiodes, charge coupled device camera for detection of em Radiation.

6.

Tutorials on Problems and discussions

5

Unit VI B (No of Lectures: 65)

Group C: SOLID STATE PHYSICS (38 LECTURE PERIODS)

1. Crystal Structure:

Crystalline and Amorphous solids, translational symmetry. Elementary idea about crystal structure, lattice and bases, unit cell, reciprocal lattice, fundamental types of lattices, Miller indices, simple cubic, f.c.c. and b.c.c. lattices, Laue and Bragg equation-simple deduction.

6

2. Structure of Solids:

Different types of binding, ionic, covalent, metallic and van der Wall's. Band theory of solids, Kronig-Penny Model, energy band structure. Electrons and holes. conductors, semiconductors and insulators. Free electron theory of metals, effective mass, drift current, mobility and conductivity, Wiedemann-Franz law, Hall effect in metals. 12

3 Dielectric properties of materials:

Electronic, ionic and dipolar polarizability, local fields, induced and oriented polarization-molecular field in dielectric, Clasius-Mosotti relation. 5

4 Magnetic Properties of materials:

Dia, para and ferromagnetic properties of solids, Langevin's theory of diamagnetism, Classical and quantum theory of paramagnetism, Curie's law, spontaneous magnetization and domain structure, spontaneous magnetization and its temperature dependence. Curie-Weiss law, explanation of hysteresis.15

GROUP D: LASER AND FIBRE OPTICS (22 Lecture Periods)

1. Laser: Principle of Laser action, Population Inversion, Einstein's A and B coefficients, feedback of energy in a resonator,3 level and 4 level systems, Helium-Neon and Semiconductor Lasers. Application of Laser. Principle of holography (basic

principle), isotope separation. Precision measuemnets (frequency and distance)

12

2.Fibre Optics: Optical fibre, core and cladding, total internal reflection, optical fibre as waveguide, step index and graded index fibre, communication through optical fibres, energy loss, band width and channel capacity for a typical system, attenuation and dispersion, splicing and couplers, Fibre optic sensors.

10

Tutorials on Problems and discussions

5

Paper VI

Unit VIIA (No of Lectures: 65)

[The setting of questions from different groups is as follows;
Question No 1 will be of short answer type carrying 2 marks each. 5 out of 8 questions distributed uniformly over the entire syllabus are to be answered.
Question Nos 2, 3, 4, 5,6 and 7: 6 Questions are to be set, 4 to be answered.]

ELECTRONICS II (60 LECTURE PERIODS)

1. Field Effect Transistors (FET):
   JFET structure, JFET operation, static, drain and transfer characteristics, pinch off Common source FET amplifier, small signal low frequency equivalent circuit-voltage gain. MOSFET-enhancement and depletion type,principle of operation,drain and transfer characteristics,idea of CMOS 8
2. Feedback in amplifier:
   Principle of feedback, negative and positive feedback, voltage and current feedback, advantages of negative feedback. 5
3. Multistage Amplifier:
   Idea of multistage amplifiers, frequency response of a two stage R-C coupled amplifier. Gain and bandwidth. Class A, B, AB and C amplifiers. Analysis of a single tuned votage amplifier. Operating points, principle of operation of power amplifiers. Class B push pull amplifier. 8
4. Oscillators:
   Barkhausen condition of sustained oscillation, sinusoidal oscillators-Hartley, Colpit, Wien bridge and crystal oscillators. Relaxation Oscillators-astable, monostable and bistable multivibrators. 8
5. Operational Amplifiers:
   Ideal OP-AMP characteristics, concept of virtual ground, Definition of important terms in connection with OP-AMP: Offset voltage, CMRR, slew rate. Application of OP-AMP: Design of Inverting and non-inverting amplifier, Differential amplifier, Schmitt trigger, Integrator and Differentiator, comparator and function generator and half wave rectifier.. Solution of linear algebraic equation using OP-AMP. 8
6. Combinational Logic:
   Half adder, full adder, digital comparator, decoder, encoder (ROM), multiplexer. Digital to analog and Analog to digital conversions 6
7. Sequential Logic:
   Flip flops-RS, D, JK, edge triggering and clocked operations. Idea about the 5
   construction of shift registers and counters.
8. Communication Principles:
   Modulation - elementary theory of Amplitude Modulation (AM) and Frequency Modulation (FM) modulation index. Detection of AM and FM waves. 6
9. Electronic Measuring Instruments: Electronic multimeter; digital voltmeter; CRO-cathod ray tube-electron emission mechanism, brightness and focussing control, fluorescent of volatge frequency and phase with CRO. 6
   Tutorials on Problems and discussions 5

BOOKS

Mechanics

1. Classical Mechanics – J. Goldstein (Narosa Publ. House).

2. Classical Mechanics - R. G. Takwale and P. S. Puranik (Tata Mc Graw Hill).
3. Classical Mechanics – A. K. Roychaudhuri (O. U. P., Calcutta).
4. Berkeley Physics Course, Vol – I (Mechanics) (Mc Graw Hill).

Theory of Relativity

1. Introduction to Special Theory of Relativity - R. Resnick (Wiley Eastern).
2. Special Theory of Relativity - A. P. French (ELBS).
3. Apekshikata Tattwa - Sriranjan Bandyopadhyay (W. B. S. B. B).
4. The Feynman Lectures on Physics, Vol I (Addison – Wesley).

Statistical Physics

1. Statistical Physics, F. Mandle (ELBS).
2. Fundamentals of Statistical and Thermal Physics, F. Reif, (Mc Graw Hill).

Quantum Mechanics and Atomic Physics

1. Quantum Mechanics – J. L. Powell and B. Crasemonn, (Oxford, Delhi).
2. Quantum Mechanics – F. Schwabl (Narosa).
3. Quantum Mechanics – A. K. Ghatak and S. Lokenathan (Macmillan, Delhi).
4. Introductory Quantum Mechanics - S. N. Ghoshal (Calcutta Book House).
5. A Textbook of Quantum Mechanics – P. M. Mathews and K. Venkatesan (Tata Mc GrawHill).

Nuclear and Particle Physics

1. Nuclear Physics – Cottingham and Greenwood (Cambridge University Press).
2. Concepts of Nuclear Physcics – R. Cohen (Tata-Mc Graw Hill).
3. Paramanu o Kendrak Gathan Parichay – S. N. Ghoshal (WBSBB).
4. Atomic and Nuclear Physics – S. N. Ghoshal (S. Chand).
5. Nuclear Physics – S. B. Patel (New Age).
6. Nuclei and Particles – E. Segre (Benjamin).

Instrumental Methods

1. Introduction to Physics Applications edited by P. N. Ghosh (Calcutta University).
2. Nuclei and Particles – E. Segre (Benjamin).
3. Atomic and Nuclear Physics – S. N. Ghosal (S. Chand).

Electronics II

1. Integrated Electronics – J. Millman and C. C. Halkias (Mc Graw Hill).
2. Electronic Fundamentals and Applications – D. Chattopadhyay and P. C. Rakshit.
3. Digital Logic and Computer Design – M. Moris Mano, (PHI (Pvt.) Ltd.).
4. Microprocessor Architecture, Programming and Application – R. A. Gaonkar (Willey EasternLtd.).
5. Introduction to Microprocessor – Software, Hardware Programming – Laventhal (PHI Ltd.).
6. Electronics – R.K. Kar ( ).

Laser and Fibre Optics

1. Laser Principles and Applications – A. K. Ghatak and K. Tyagrajan (Tata – Mc Graw Hill).
2. Optics and Atomic Physics – B. P. Khandelwal (Siblal Agarwala).
3. Optical Electronic – A. K. Ghatak and K. Tyagrajan.
4. Introduction to Fibre Optics - R. A. Shotwell (EEE, Prentice Hall).

Solid State

1. Introduction to Solid State Physics, C. Kittel (Wiley Eastern).
2. Solid State Physics - D. L. Bhattacharyya (Calcutta Book House).

PRACTICAL PAPERS

Marks Distribution

Part- I:- Paper -IIB - 50.

Part- II:- Paper -IVB - 50,

Part-III:- Paper -VIIB - 50, Paper -VIIIA – 50, Paper -VIIIB - 50 :Total=150.

Laboratory Teaching Classes

One laboratory class (of 3 periods duration) per week should be devoted to teach the following topics during 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 early months of first year, students will get sufficient time to use computer in practical classes. 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 of paper-VII. This Computer Note Book[CNB] must be signed by the class teacher. During the practical examination of Paper VIIB, the examiners will check the CNB and ask questions on the report presented by the students in their CNB.

Laboratory Teaching

1. Demonstration lectures on use of vernier, micrometer, spherometer, barometer, common balance ,etc.; graph plotting -1 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) to be used in the laboratory -2 Lab-class
4. Computer-Fundamentals and Programing in C or Fortran -6 Lab-class

Total = 12 Lab-class

In practical classes all data should be recorded directly in the Laboratory Note Book and signed regularly by the attending teachers. This Note Book should be submitted at the time of final practical examination. No separate fair L.N.B. need be maintained.

PART – I PRACTICAL

PAPER – IIB

Total Marks 50 Time – 4 hours

Distribution of Marks : LNB-5, VIVA-10, Experiment-35; Total = 50.

1. Determination of Young's modulus of the material of a beam by the method of flexure.
2. Determination of moment of inertia of metallic cylinder / rectangular bar about an axis passing through its C.G. and to determine the rigidity modulus of the material of the suspension wire.
3. Determination of the coefficient of viscosity of water by Poiseuille's method.
4. To estimate the temperature of a torch bulb filament from resistance measurement and to verify Stefan's law.
5. Determination of thermal conductivity of a bad conductor of heat by Lee's and Chorlton's method.
6. To calibrate a thermocouple with the help of potentiometer and hence (i) to measure the thermoelectric power at a particular temperature , (ii) to measure an unknown temperature.
7. (a) Determination of the focal length of a concave lens by combination method
(b) To measure the radii of curvature of both the lenses by spherometer and hence to determine the refractive index of the material of the lenses.
(c) To Determine the refractive index of a liquid using a convex lens and a plane mirror.
8. To study the nature of dependence of refractive index (ì) of the material of a

prism on the wavelength (l) of the light used. Hence
(i) To verify the Cauchy relation ì(l) = A + B/ël 2 and to estimate the values of A and B.
(ii) To plot a graph between dì/dlë vs l. ë
9. To study the nature of dependence of dipolar field of a short bar magnet on distance with the help of a deflection magnetometer and to determine the horizontal component of the Earth's magnetic field.

Part II Practical
Paper IVB
Total Marks 50 Time – 6 hours
Distribution of Marks : LNB-5, VIVA-10, Experiment-35; Total = 50

1. To calibrate a polarimeter and hence to determine the concentration of sugar solution.
2 .To determine the wave length of a monochromatic light by Newton's ring method.
3. Measurement of the slit width and the separation between the slits of a double slit by observing the diffraction and interference fringes.
4. To study the variation of mutual inductance of a given pair of co-axial coils by using a ballistic galvanometer.
5. To measure the voltage across the inductance (L), capacitance (C) and resistance(R) of a series LCR circuit for different frequencies of the input voltage with the help of an A.C millivoltmeter. Hence (i) to study the variation of impedance of L and C with frequency of the impressed voltage, (ii) to draw the resonance curve of the series LCR circuit and to determine the Q-factor of the circuit.
6. Verification of Thevenin, Norton and Maximum power transfer theorems using a resistive Wheatstone bridge, d.c. source and d.c. meters.
7. To calibrate a Hall probe with the help of a Ballistic Galvanometer and use the probe to study the variation of magnetic field of an electromagnet with (i) the magnetizing current and (ii) the distance between two pole-pieces.
8. To verify the truth tables of OR, AND & NOT gates using discrete components and that of NOR,NAND & Ex-OR gates using IC's. To establish NAND/NOR gates as universal gate.
To verify De Morgan's theorems.
9. To draw the forward and reverse characteristics of a zener diode and to study its regulation characteristics. Estimate the a.c. resistances of the diode for different diode currents in both forward and reverse bias conditions.
10. To draw the regulation characteristics of a bridge rectifier (i) without using any filter and (ii) using a filter. Determine the ripple factor in both cases by measuring the ripple voltage with the help of an ac meter.
11. To draw the output characteristics of a transistor in C-E and C-B mode.

PART – III PRACTICAL
Paper VIIB
Distribution of Marks: CNB-10 , VIVA: 10 Computer Programming: 15 +15
Total 50

A student has to write , compile and run two programs in the examination. programms using C/FORTRAN:

A student should learn the following aspects of the programming language: Constants and Variables, Controls, Standard I/O, 1-D and 2-D array, user defined functions, (subroutines), global and local variables. File I/O, Students are expected to use functions and subroutines in their program.

1. Sorting (bubble sort, selection sort)
2. Reading N numbers. To find their mean, median mode and central moments.

3. To sum a finite series, term by term.
4. To sum an infinite series, term by term with specified accuracy.
5. To find Roots of simple algebraic equations (Newton Raphson & bisection)
6. Integration by trapezoidal rule and Simpson's rule and Monte Carlo random dot.
7. Least square fitting (Generation of synthetic data according to a given function and parameter extraction by fitting . Visualization of the data and the fitted curve using any plotting softwares like gnuplot, xmgrace, python-matplotlib, microcal origin).
8. Matrix manipulation (addition, subtraction, multiplication, trace, transpose).

Note:

Target is to inculcate the ability to write programs by the students themselves. Each year problem sets will be different for each day of examination.

Paper-VIIIA

Total Marks 50 Time 6 hours

Distribution of Marks : LNB-5, VIVA-10, Experiment-35 ;Total=50.

1. To determine the wavelength of a monochromatic light by Fresnel's biprism
2.(a) To find the number of lines per centimeter of the transmission grating and hence to measure the wavelength of an unknown spectral line.
(b)To measure the wavelength difference between D1 and D2 lines of sodium using a slit of adjustable width.
3. Verification of Fresnel's equation of reflection of electromagnetic waves with the help of prism and two polaroids.
4. To draw the B-H loop for the material of an anchor ring by ballistic galvanometer and to estimate the energy loss per cycle of magnetisation.
5. (a) To measure the self inductance of two coils by Anderson bridge .To find the total inductance of the above two coils connected in series and hence estimate the coefficient of coupling between the coils.
(b)To study the variation of inductance of two coils in series with angle between their planes by Anderson bridge.
6. To determine Fourier spectrum of (i) square, (ii) triangular and (iii) half sinusoidal waveform by C.R.O.
7. To study the temperature dependence of reverse saturation current in a junction diode and hence to determine the band gap of semiconductor.
8. To study the diffraction pattern of a crossed grating with the help of a LASER source.

Paper-VIIIB

Total Marks 50 Time 6 hours

Part-B. Electronics Experiment : LNB-5, VIVA-10, Expt-35; Total = 50

1. To construct a regulated power supply on a bread board, using
(i) a power transistor as pass element,
(ii) a second transistor as a feedback amplifier and
(iii) a zener diode as a reference voltage source and to study its operational characteristics.
2. (a) To draw the output characteristics of a silicon transistor and to calculate hoe and hfe.
(b) To determine the hybrid parameters of a transistor using a.c. source.
3. To construct and study the frequency response of a voltage amplifier using a transistor in CE mode and to find its bandwidth.
4. To design and test the following circuits using an OPAMP
(i) Inverting and non inverting amplifier
(ii) Differential amplifier

(iii) Schmitt trigger
(iv) Integrator
(v) Differentiator.
5. (a) To verify various Boolean expressions using IC-gates.
(b) To design half- and full-adder circuits using basic gates and to verify the respective Truth tables.
(c) To design and to verify the following flip-flop operations using basic gates:
(i) S-R , (ii) J-K , (iii) D.
6. To construct Wein Bridge oscillator on a bread board using OPAMP and to study the wave form of the oscillator and calibrate it using CRO.
7 To design and fabricate a temperature controller and to study its performance characteristics.
USE OF PREFABRICATED CIRCUIT PROHIBITED