M.SC. PHYSICS

SEMESTER-I

Paper	Name of paper	Theory	Internal	Total marks
PAPER-I	MATHEMATICAL PHYSICS	80	20	100
PAPER-II	CLASSICAL MECHANICS		20	100
PAPER-III	QUANTUM MECHANICS	80	20	100
PAPER-IV	ELECTRONICS-I	80	20	100
PRACTICAL				200

SEMESTER-II

Paper	Name of paper	Theory	Internal	Total marks
PAPER-I	ELECTRODYNAMICS AND PLASMA PHYSICS	80	20	100
PAPER-II	STATISTICAL MECHANICS		20	100
PAPER-III	QUANTUM MECHANICS-II	80	20	100
PAPER-IV	ELECTRONICS-II	80	20	100
PRACTICAL				200

SEMESTER-III

Paper	Name of paper	Theory	Internal	Total marks
PAPER-I	CONDENSED MATTER PHYSICS	80	20	100
PAPER-II	NUCLEAR AND PARTICLE PHYSICS		20	100
PAPER-III	ATOMIC AND MOLECULAR PHYSICS	80	20	100
PAPER-IV	ELECTRONICS-III	80	20	100
PRACTICAL				200

SEMESTER-IV

Paper	Name of paper	Theory	Internal	Total marks
PAPER-I	COMPUTATIONAL METHODS AND PROGRAMMING	80	20	100
PAPER-II	LASER AND LASER APPLICATION		20	100
PAPER-III	ELECTRONICS -IV	80	20	100
PAPER-IV	ELECTRONICS-V	80	20	100
DISSERTATION AND VIVA				200

SEMESTER-I
PAPER-I
MATHEMATICAL PHYSICS

Vector space and Matrices, Linear independence, Bases, dimensionality, Inner product, Linear transformation, matrices, Inverse, Orthogonal and Unitary matrices, Independent element of a matrix, Eigen values and eigen Vectors, Diagonalization, Complete orthonormal sets of functions.

Complex Variables: Cauchy- Riemann condition, analytic functions,Cauchy's theorem, Cauchy integral formula, Laurent series, singularities, residue theorem, contour integration, evaluation of definite integrals, problems.

Differential equations, first order differential equation, second order differential equation with constant coefficients, second order linear ODEs with variable coefficients, Solution by series expansion, nonhomogenous differential equations and solution by the method ofGreen's functions.

Special functions, Legendre, Bessel, Hermite and Laguerre functions with their physical applications, generating functions, orthogonality conditions, recursion relations,

Integral transforms, Fourier integral and transforms, inversion theorem, Fourier transform of derivatives, convolution theorem, Laplace Transform(LT), LT of Derivatives, Inverse LT, Fourier series; properties and applications, discrete Fourier transform.

TEXT AND REFERENCE BOOKS

1. Mathematical Methods for Physics, by G. Arfken.
2. Matrices and Tensors for Physicist, by A. W. Joshi.
3. Advanced Engineering Mathematics, by E. Kroyazig.
4. Special Functions, by E. B. Rainville.
5. Special Functions, by W.W. Bell.
6. Mathematical Method for Physicist and Engineers, by K. F. Relly, M. P. Hobson and S. J. Bence
7. Mathematics for Physicists, By Marry L. Boas.

SEMESTER-I
PAPER – II
CLASSICAL MECHANICS

Preliminaries, Newtonian mechanics of one and many particle systems, Conservation laws,Constraints & their classification, Principle of virtual work, Generalized coordinates, D'Alembert's principle and Lagrange's equations, Velocity-dependent potentials and dissipation function, Simple applications of the Lagrangian formulation, Hamilton's principle, Lagrange's equations from Hamilton's principle, Conservation theorems and Symmetry properties, Energy function and the conservation of energy.

The Hamiltonian formulation of mechanics, Legendre transformations and the Hamilton's equations of motion, Cyclic coordinates and Conservation Theorems, Hamilton's equations from Hamilton's principle, The principle of least action, Simple applications of the Hamiltonian formulation.

Canonical transformations with examples, The harmonic oscillator, Poisson's brackets, Equations of motion and conservation theorems in the Poisson Bracket formulation. Hamilton-Jacobi (HJ) theory: The HJ equation for Hamilton's principal function, Harmonic oscillator as an example of the HJ method, The HJ equation for Hamilton's characteristic function, The actionangle variables

The Central force: Two-body central force problem and its reduction to the equivalent one-body problem, The equations of motion and first integrals, The equivalent one-dimensional problem and classification of orbits, The differential equation of the orbit, Closure and stability of orbits, The Kepler problem, Scattering in a central force field: Rutherford scattering.

Rigid body dynamics, The Euler angles, Euler's theorem on the motion of a rigid body, Rate of change of a vector, The Coriolis force, Angular momentum and Kinetic energy of motion about a point, The Euler equations of motion of rigid bodies. Formulation of the problem of small oscillations, The eigen-value equation and the principal axis transformation, Frequencies of free vibration and normal coordinates, Free vibration of linear triatomic molecule.

TEXT AND REFERENCE BOOKS

1. Classical Mechanics, By N.C. Rana and P.S. Joag (Tata McGraw-Hill, 1991)
2. Classical Mechanics, by H.Goldstein (Addison Wesley, 1980)
3. Classical Mechanics, by H.Goldstein, C Poole & J Fafko (Pearson Education, Inc, 2002)
4. Mechanics, by A.Sommerfeld, (Academic press, 1952)
5. Introduction to Dynamics by Perceival and D.Richaeds(Cambridge University, press , 1982).

SEMESTER-I
PAPER – III
QUANTUM MECHANICS-I

Inadequacy of classical mechanics, Plank quantum hypothesis and radiation law, Photoelectric effect, de-broglie's theory. Schrödinger equation, continuity equation, Ehrenfest theorem, admissible wave functions, stationary states, one-dimensional problems; walls and barriers, Schrödinger equation for harmonic oscillator and its solution, uncertainty relations, states with minimum uncertainty product.

Superposition principle, general formalism of wave mechanics, representation of states and dynamical variables, commutation relationship, completeness and normalization of eigen functions, Dirac-delta function, Bra & Ket notation, matrix representation of an operator, harmonic oscillator and its solution by matrix method, Heisenberg equation of motion.

Angular momentum in quantum mechanics, commutation relationships, eigen values, Spin angular momentum, Pauli`s matrices, addition of angular momentum, Clebsch-Gordon coefficients.

Central force problem, spherically symmetric potentials in three dimensions, separation of wave equation, parity, three-dimensional square-well potential and energy levels, the hydrogen atom; solution of the radial equation, energy levels and stationery state wave functions, discussion of bound states, degeneracy.

Time- independent perturbation theory, non-degenerate case, first order and second perturbations with the example of an oscillator, degenerate cases, removal of degeneracy in second order, Zeeman effect without electron spin, first-order Stark effect in hydrogen, perturbed energy levels, correct eigen function, occurrence of permanent electric dipole moments.

TEXT AND REFERENCE BOOKS:

1. L.I. Schiff: quantum mechanics (McGraw-Hill).
2. S.Gasiorowicz, Quantum Physics (Wiley).
3. Landau and Lifshitz : Non-relativistic quantum mechanics.
4. B.Craseman and Z.D.Powell: quantum mechanics (Addison Wesley)
5. A.P. Messiah: Quantum Mechanics.
6. J.J. Sakurai : Modern Quantum Mechanics.
7. Mathews and Venkatesan : Quantum Mechanics.

SEMESTER-I
PAPER – IV
ELECTRONICS-I
BASIC ELECTRONICS AND ELECTRONIC DEVICES

Transistors Biasing: Different methods of biasing, Thermal stabilization and stabilization factor. Low frequency h parameters for transistor amplifier. Feedback in transistor amplifier, Advantages of negative feedback, Condition for oscillation. Hartley, Wien-Bridge and phase shift oscillator.

Junction Field Effect Transistor (FET) - N channel and P channel FET. Working principle, static and dynamic characteristic curves, pinched off voltage, Coefficient of FET and relation between different coefficients.

Metal Oxide Field Effect Transistor (MOSFET) - Depletion MOSFET and Enhancement MOSFET- construction and working principle, static and dynamic characteristics.

Uni-junction transistor (UJT) Basics structure, working principle, Voltage - Current characteristics and important parameters.

Microwave devices: Tunnel Diode - Introduction, Definition, Tunneling Phenomenon, Energy band Structure, Volt-Ampere Characteristics, Negative Resistance of tunnel diode (Characteristics of tunnel diode)

Transfer Electron Devices: Transfer Electron Effect, Gun Diode- Introduction and characteristics.

Backward Diode: Introduction and Characteristics.

IMPATT Diode: Introduction, Structure, Principle of operation, Static and Dynamic Characteristics.

Modulation: Definition, Types of Modulation, Mathematical expression of modulation, Percentage of modulation, Amplitude modulation,

TEXT AND REFERENCE BOOKS:

1. Principles of Electronics - V.K. Mehta, Rohit Mehta (S.Chand & Company Ltd.)
2. Basic Electronics (Solid state) - B.L. Theraja (S. Chand & Company Ltd.)
3. Electronic Devices and Circuits - Jacob Millman, Christos C. Halkias (Tata McGraw Hill)
4. foundation of Electronics - D. Chattopadhyay, P.C. Rakshit, B. Saha, N. N. Purkait.
5. Hand Book of Electronics - Gupta Kumar (Pragati Prakashan)
6. Physics of semiconductor Devices - S.M. Sze (Wiley Eastern Ltd.)

SEMESTER-II
PAPER-I
ELECTRODYNAMICS & PLASMA PHYSICS

Maxwell's equations, vector and scalar potentials and the wave equation, Gauge transformations, Lorenz gauge, Coulomb gauge, Green function for the wave equation, four-vectors, mathematical properties of the spacetime in special relativity, matrix representation of Lorentz transformation, covariance of electrodynamics, transformation of electromagnetic fields.

Radiation by moving charges, Lienard-Wiechert potential and fields for a point charge, total power radiated by an accelerated charge- Larmor's formula and its relativistic generalization, angular distribution of radiation emitted by an accelerated charge, radiation emitted by a charge in arbitrary extremely relativistic motion, distribution in frequency and angle of energy radiated by accelerated charge.

Bremsstralung: emission from single-speed electrons, thermal Bremsstralung emission and absorption, Synchrotron radiation: spectrum of synchrotron radiation, spectral index for power law electron distribution, transition from Cyclotron to Synchrotron emission, Cherenkov radiation

Plasma: definition, Debye shielding phenomenon and criteria for plasma, motion of charged particles in electromagnetic field; Uniform E & B fields, Electric field drift, Non-uniform magnetostatic field, Gradient B drift, Parallel acceleration and magnetic mirror effect, Curvature drift, adiabatic invariants.

Elementary concepts of plasma kinetic theory, the Boltzmann equation, the basic plasma phenomena, plasma oscillations. Fundamental equations of magneto-hydrodynamics (MHD), Hydrodynamics Waves; Magneto sonic and Alfven waves, Magnetic viscosity and magnetic pressure, plasma confinement schemes.

REFERENCE BOOK:

Jackson, classical electrodynamics.
Rybicki & Lightman: Radiative Processess in Astrophysics
Panofsky and Phillips: Classical electricity and magnetism.
Bittencourt, Plasma physics. 4 Chen: Plasma physics.

SEMESTER-II
PAPER-II
STATISTICAL MECHANICS

Foundation of statistical mechanics : macroscopic and microscopic states, contact between statistics and thermodynamics, physical significance of Ω(N, V, E), the classical gas, entropy of mixing and Gibb's paradox, phase space of classical system, Liouville`s theorem and its consequences, quantum states and phase space.

Elements of ensemble theory – A system in microcanonical, canonical, and grand canonical ensembles, partition functions, physical significance of statistical quantities, example of classical system, energy and energy-density fluctuations and mutual correspondence of various ensembles.

Formulation of quantum statistics – Quantum mechanical ensemble theory, density matrix, statistics of various quantum mechanical ensembles, system composed of indistinguishable particles. Theory of simple gases –Ideal gas in various quantum mechanical ensemble, Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac distributions, statistics of occupation number.

Ideal Bose and Fermi gases -Thermodynamic behavior of an ideal Bose gas, Bose-Einstein condensation and, elementary excitations in liquid helium II, Thermodynamic behavior of an ideal Fermi gas, the electron gas, nonrelativistic and relativistic degenerate electron gas, theory of white dwarf stars.

Statistical Mechanics of interacting systems – the method of cluster expansion for a classical gas, Virial expansion of the equation of state. Theory of phase transition – general remark on the problem of condensation, Fluctuations: thermodynamic fluctuations, Spatial correlation in a fluid Brownian motion: Einstein Smoluchowski theory of Brownian motion.

TEXT & REFERENCE BOOKS –

R. K. Pathria, Statistical Mechanics (Pergamon Press).
L. D. Landau & E. M. Lifshitz (Butter worth and Heinemann Press).
Federick Reif, Fundamental of statistical and thermal physics (McGraw-Hill publishers).
Kerson Huang, Statistical Mechanics (Wiley Eastern).

SEMESTER-II
PAPER-III
Quantum Mechanics- II

Variational method, expectation value of energy, application to excited states, ground state of He-atom, Zero point energy of one dimensional harmonic oscillator, Vander-waals interaction, the W.K.B. approximation, approximate solutions, asymptotic nature of the solution, solution near turning point, connection formulae, energy levels of a potential well and quantization rule.

Theory of scattering: differential and total scattering cross section, wave mechanical picture of scattering & the scattering amplitude, Green's functions and formal expression for scattering amplitude, The Born approximation and its validity, Partial wave analysis, asymptomatic behavior of partial waves and phase shifts, optical theorem, scattering by a square well potential, scattering by a hard sphere, scattering by a Coulomb potential.

Time-dependent perturbation theory, first order perturbation, Harmonic perturbation, Fermi`s Golden rule, Ionization of a H-atom, absorption and induced emission, Selection rules. Identical particles, symmetric and anti symmetric wave functions

Relativistic quantum mechanics, formulation of relativistic quantum theory, the Klein-Gordon equation; plane wave solutions, charge and current densities, The Dirac equation for a free particle, matrices alpha and beta, Lorentz covariance of the Dirac equation, free particle solutions and the energy spectrum, charge and current densities.

The spin of the Dirac particle, Dirac particle in electromagnetic fields and the significance of the negative energy state, Dirac equation for a central field : Spin angular momentum, approximate reduction, spin –orbit energy, separation of equation, the hydrogen atom, classification of energy levels and negative energy states.

TEXT AND REFERENCE BOOKS –

L.I. Schiff: Quantum Mechanics (McGraw-Hill).
S.Gasiorowicz: Quantum Physics (Wiley).
Landau and Lifshitz : Quantum Mechanics.
B.Craseman and Z.D.Powell : Quantum Mechanics (Addison Wesley)
A.P. Messiah: Quantum Mechanics.
J.J. Sakurai: Modern Quantum Mechanics.
Mathews and Venkatesan: Quantum Mechanics.
Bjorken and Drell : Relativstic Quantum Mechanics.

SEMESTER-II
PAPER-IV
ELECTRONICS- II
DIGITAL ELECTRONICS, PHOTONICS AND BASIC COMMUNICATION ELECTRONICS

Combinational Logic

The transistor as a switch, OR, AND and NOT gates. NOR and NAND gates. Boolean algebra Demerger's theorems exclusive OR gate, Decoder multiplexer data selector/multiplexer Encoder.

Sequential Logic

Flip Flop: A I-bit memory The RS Flip-Flop, JK Flip-Flop, JK master slave Flip-Hops, T Flip-Flop, D Flip-Flop. Shift registers synchronous and asynchronous counters cascade counters.

Microprocessors

Introduction to microcomputers, memory input/output interfacing devices. 8085 CPU architecture, BUS timings, Demultiplexing the address bus generating control signals,

Instructions set, addressing modes, illustrative programmers, writing assembly language, programmers looping, counting and indexing counters and timing delays stack and subroutine.

Photonic devices

photoconductive devices (LDR). diode photo detectors, solar cell (open circuit voltage and short circuit current, fill factor). LED (High frequency limit, effect of surface and indirect recombination current, operation of LED). diode lasers (Conditions for population inversion, in active region, light confinement factor. Optical gain and threshold current for lasing.)

Communication Electronics

Generation of Amplitude modulation. Demodulation, Demodulation of Amplitude modulated wave, side bands, band width, DSBSC modulation, Generation of DSBSC waves. SSB modulation, Generation and Detection of SSB waves, Multiplexing: Frequency division multiplexing (FDM)

TEXT AND REFERENCE BOOKS

Electronic Devices and Circuit Theory: Robert Boylested and Louis Nashdsky, PHL, New Delh1-110001, 1991

Microprocessor Architecture, Programming and Applications with 8085/80856: Ramesh S. Gaonkar, Wiley Eastem Ltd. 1987

Optical electronics by Ajay Ghatak and K.Thyagarajah, Cam.Univ. Press.

Opto electronics – An introduction: J.Wilson and JFB Hawkes (Eastern Economy Edition).