M.Sc. Previous Physics

PAPER - I: CLASSICAL MECHANICS AND MATHEMATICAL METHODS IN PHYSICS

Max.Marks :100   Duration : 3hrs.

Note: In all Ten questions are to be set, Five from each section. Candidates are required to attempt five questions in all, taking at least two questions from each section.

Section- A

1.Holonomic and nonholonomic constraints:
D-Alembert's Principle,Generalized.coordinates,Lagrangian, Lagrange's equation and its applications, Velocity dependant:potential in Lagrangian formulation.Generalized momentum, Legendre transformation, Hamiltonian, Hamilton's Canonical equation.

2.Calculus of variations and its application to simple problems, Hamilton's variational principle,   Derivation of Lagrange's and Hamilton. Canonical equation from Hamilton's variational principle.   Extension of Hamilton's Principle for nonconservative and nonholonomic systems. Method of Lagrange's multipliers, Conservation principle and Noether's theorem. Conservation of energy, linear momentum and angular momentum as a consequence of homogeneity of time and scope and isotropy of space respectively.

3.Canonical transformation, integral invariants of poincare: Lagrange's and Poisson brackets as canonical invariants. Equation of motion in Poisson bracket formulation, Infinitesimal contact transformation and generators of symmetry, Liouville's theorem, Hamilton Jacobi equation and its applications.

4. Action angle, variable adiabatic invariance of action variable : The Kepler problem in action angle variables,theory of small oscillation in Lagrangian formulation,normal coordinates and its applications,Orthogonal transformation,Eulerian angles,Euler theorem, Eigenvalues of the inertia tensor, Euler equations. Force free motion of a rigid Body.

Section - B

5.Coordinate transformation in N- dimensional space: Contravriant and covariant tensor, Jacobian. Relative tensor, pseudo tensors (Example: change density, angular momentum) Algebra of tensors,   Metric theorem, Associated tensors,Reimannian space (Example: Euclidean space and 4-D Minkowski space), Christoffelas symbols, transformation of Christoffel symbols, Covariant differentiation: Ricci's theorem, Divergence, Curl and Laplacian in tensor form. Stress-and Strain tensors. Hooke's law in tensor form. Lorentz Covariance of Maxwell equation.

6. Group of transformations :(Example: symmetry transformation of square), Generators of a finite group, Normal subgroup, Direct product of groups.. Isomorphism and Homomorphism. Representation theory of finite groups, Invariant subspace and reducible representations, irreducible representation, Crystallo-graphic point groups. Irreducible representation of C_{4v} Translation group and the reciprocal lattice.

7. Fourier Transforms: Development of the Fourier integral from the Fourier series, Fourier and inverse Fourier transform: Simple applications: Finite wave train, wave train with Gaussian amplitude, Fourier transform of Derivatives,Solution of wave equation as an application, Convolution theorem, intensity   in terms of spectral density for quasi-monochromatic EM waves, momentum representation. Application of Hydrogen Atom and Harmonic Oscillator problems. Application of Fourier Transform to Diffraction Theory; Diffraction pattern of one two slits.

8.Laplace transforms : and their properties, Laplac transform of derivatives and integrals of laplace   transform, Laplace, Convolution theorem,Impulsive function Application of laplace transform in   solving linear differential equations with constant coefficient with variable coefficient and linear partial differential equation.

Reference Books:
1. Goldstein - Classical Mechanics.
2. Landau.and Lifshitz - Classical Mechanics.
3. A. Raychaudhuri - Classical Mechanics.
4. Mathematical Methods for Physicists: George Arkfen
   (AcademicPress).
5. Applied Mathematics for Engineers and Physicists: L. A. Pipe
   (McGraw Hill)
6. MathematicalMethods-Potter and Goldberg (Prentice Hall of fudia).
7. Elements of Group Theory for Physicists: A. W. Joshi
   (Wiley Eastern Ltd.)
8. VectorAnalysis (Schaum Series) (McGraw Hill).

PAPER -II : CLASSICAL ELECTRODYNAMICS

Note: In all Ten questions are to be set, Five from each section. Candidates are required to attempt five questions in all, taking at least two questions from each section.

Max. Marks:100   Duration: 3 Hrs.

1. Electrostatics: Electric field; Gauss law, Differential form of Gauss law. Another equation of electrostatics and the scalar potential, surface distribution of charges and dipoles and discontinuities in the electric field and potential, Poisson and-Laplace equations, Green's Theorem, Uniqueness of the solution with Dirichlet or Neumann Boundary conditions, Formal solution of Electrostatic Boundary value problem with Green's Function, Electrostatic potential energy and energy density, capacitance.

Boundary- Value Problems in Electrostatics: Methods of Images, Point charge in the presence of a grounded conducting sphere point charge in the presence of a charge insulated conducting sphere, Point charge near a conducting sphere at fixed potential, conducting sphere in a uniform electric field by method of images, Green function for the sphere, General solution for the potential, Conducting sphere with Hemispheres at different potential, orthogonal functions and expansion.

2. Multipoles, Electrostatics of Macroscopic Media Dielectrics: Multiple expansion, multipole expansion of the energy of a charge distribution in an external field, Elementary treatment of electrostatics with permeable media, Boundary value problems with dielectrics. Molar polarizability, and electric susceptibility. Models for molecular polarizability, Electro-static energy in dielectric media.

3. Magnetostatics: Introduction and definition, Biot, and Savart law, the differential equation of magnetostatics and Ampere's law, Vector potential and Magnetic induction for a circular current loop,Magnetic fields of a localized current distribution, Magnetic moment, Force and torque on and energy of a localized current distribution in an external magnetic induction, Macroscopic equations. Boundary conditions on B and H. Methods of solving Boundary-value problems in magnetostatics, Uniformly magnetized sphere, Magnetized sphere in an external field, Permanent magnets, Magnetic shielding,spherical shell of permeable material in a uniform field.

4. Time varying fields, Maxwell's equations Conservation Laws:Energy in a magnetic field, Vector and Scalar potentials. Gauge transformations, Lorentz gauge, Coulomb gauge, Green functions for the wave equation, Derivation of the equations of Macroscopic Electromagnetism, Poynting's theorem and conservation of energy and momentum for systems of charged particles. and EM fields. Conservation laws for macroscopic media. Electromagnetic field tensor. Transformation of .four ,potentials.and four currents. Tensor description of Maxwell's equation.

Section-B

5. Plane Electromagnetic Waves and Wave Equation : Plane wave in a nonconducting medium. Frequency dispersion characteristics of dielectrics, conductors and plasmas, waves in a conducting or dissipative medium, superposition of waves in one dimension,group velocity,casualty connection between D and E. Kramers-Kroning relation.

6. Magnetohydrodynamics and Plasma Physics : Introduction and definitions, MHD equations Magnetic diffusion viscosity and pressure; Pinch effect. instabilities in a pinched plasma column. Magnetohydrodynamic waves; Plasma oscillations, short wavelength limit of plasma oscillations and Debye shielding distance.

7. Covariant Form of Electrodynamic Equations : Mathematical properties of the space-time special relativity, Invariance of electric charge covariance of electrodynamics, Transformation of electromagnetic fields.

Radiation by moving.charges : Lienard-wiechert Potentials for a point charge, Total power radiated by an accelerated charge ,Larmour'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 charges, Thomson scattering and radiation, Scattering by quasi free charges, coherent and incoherent scattering, Cherenkov radiation.

8. Radiation damping, self fields. of a particle, scattering and absorption of radiation by a bound system: Introductory considerations, Radiative reaction force from conservation of energy, Abtaham Lorentz evaluation of the self force, difficulties with abraham Lorentz model;Integro-differential equation of motion including radiation damping,. Line Breadth
and level shift of an oscillator, Scattering and absorption of radiation. by an oscillator, Energy transfer to a harmonically bound charge.

Reference Books :
 1. J.D. Jackson-.-Classical Electrodynamics
 2. Panofsky andPhilips Classical Electricity and Magnetism'
 3. Introduction to Electrodynamics-Griffiths
 4. Landau and Lifshitz--Classical Theory of Field
 5. Landau and Lifshitz.:.Electrodynamics of Continuous Media

PAPER -III : QUANTUM MECHANICS, ATOMIC AND MOLECULAR PHYSICS

Max.Marks :100   Duration : 3hrs.
Note: In all Ten questions are to be set, Five from each section. Candidates are required to attempt five questions in all, taking at least two questions from each section.

Section - A

1.(a) States, Amplitudes and Operators: States of a quantum mechanical system, representation of quantum,- mechanical states, properties. of quantum mechanical amplitude;operators and change of state, a complete set of basis states,.products of linear operators, language of quantum mechanics, postulates, essential definitions and commutation relations.

(b) Observable and description of system: Process of measurement,expectation values,time dependence of quantum mechanical amplitude, observables with no classical analogue, spin. dependence of quantum-mechanical amplitude on position. the wave function, superposition of amplitudes, identical particles.

2.Hamiltonian matrix and the time evolution of Quantum mechanical States: Hermiticity of the Hamiltonian matrix, Time independent perturbation of an arbitrary system, simple matrix examples of time-, independent perturbation, energy given states of a two state system, diagonalizing of energy matrix, time independent perturbation of two state system the perturbative solution: Weak field and strong field cases, general description of two state system. Pauli matrices. Ammonia molecule as an example of a two state system.

3.Transition Between Stationary States: Transitions in a two state system, Time independent perturbations-The Golden rule, phase space, emission and absorption of radiation,induced dipole transition and Spontaneous emission. of radiation. energy width of a quasi stationary state.
The Coordinate Representation: Compatible observables, quantum conditions and uncertainty relation, Coordinate representation,of operator &; position,momentum and angular momentum, time dependence of expectation values, the Ehrenfest's theorem; the time evolution of wave function, the Schrodinger equation, energy quantization, ,periodic potential as an example.

4.Symmetries and Angular momentum: (a) Compatible observables and constants of motion, symmetry' transformation and conservation laws, invariance,under space and time translations and space rotation and conservation of momentum, energy and angular momentum. Angular momentum operators and, their eigenvalues, matrix representations of the angular momentum operators and their eigenstates, coordinate representations of the orbital angular momentum operators and their eigen state (spherical harmonics), composition of angular momentum, Clebsch- Gordon coefficients tensor operators anq Winger Expart theorem, commutation relations, of J_x, J_y, J_z with reduced spherical tensor operator, matrix elements of vector operators, time reversal invariance and vanishing of static electric dipole moment of a stationary state.

Section-B

5.Hydrogen Atom : Gross structure energy spectrum, probability distribution of radial and angular ($l =1,2$) wave ,functions (no derivation), effect of spin, relativistic correction to energy levels and fine structure,magnetic dipole interaction and hyperfine structure, the Lamb shift (only an qualitative description)

6.Interaction with External Fields: Non degenerate first order stationary perturbation method, atom in a weak uniform external electric field and first and second order Stark effect, calculation of the polarizability of the ground state of H-atom and of an isotropic harmonic oscillator, Degenerate stationary perturbation theory. Linear Stark effect for H-atom levels, inclusion of spin-orbit and weak magnetic field, Zeeman effect, strong magnetic field and calculation of interaction energy.

7.Systems with Identical Particles: Indistinguishability and , exchange symmetry, many particle wave functions and Pauli's exclusion principle, spectroscopic terms for atoms. The Helium atom, Variational method and its use in the calculation of ground state and excited state energy, Helium atom. The Hydrogen molecule, Heitler-London method for molecule, WKB method for one dimensional problem, application to bound states (Bohr-Sommerfield quantization) and the barrier penetration (alpha decay, problems.

8.Spectroscopy(qualitative) : General features of the spectra of one and two electron system singlet,doublet and triplet characters of emission spectra,general features of Alkali spectra,rotation and vibration band spectrum of a molecule, PQ and R branches, Raman spectra for rotational and vibrational transitions,comparison with infrared spectra. general features of electronic spectra. Frank and Condon's principle.

ReferenceBooks:
1. Ashok Das and A.C. Melissinos. Quantum Mechanics-A modern Approach(Gordon and Breach Science Publishers).
2. P.A.M.Dirac, Quantum Mechanics.
3. E. Merzbacher, Quantum Mechanics, Second Edition (John Willey and Sons).
4. L.P.Landau aridH.M. Lifshitz, Quantum Mechanics-Non relativistic theory (pergamon Press)
5. A..Ghatak and S. Lokanathan.- Quantum Mechanics:Theory and , Applications,Third Edition(MacMillan India Ltd.) ,
6. G. K. Woodgate,ElementaryAtomic Structure, Second Edition Clarendon Press Oxford. 7. T.A. Littlefield- Atomic and Molecular Physics.
8. Eistanberg and Resnick-QuantumPhysicsof Atoms. Molecules,Solids and Nuclear Particles.
9. White - Atomic Spectra.
10.Herzberg- Molecular Spectra.

PAPER. IV: ELECTRONICS, NUMERICAL METHOD AND COMPUTER PROGRAMMING

Max.Marks :100   Duration : 3hrs.

Note: 1.In all Ten questions are to be set, Five from each section. Candidates are required to attempt five questions in all, taking at least two questions from each section. 2. Simple Calculator is allowed in the examination hall

Section-A

1. Operational Amplifiers: .Differential amplifier - circuit configurations-dual input, balanced output differential amplifier. DC analysis - AC analysis, inverting and noninverting inputs, CMRR - constant current bias level translator.
 Block diagram of a typical Op-Amp-analysis.Open loop configuration,inverting and non-inverting amplifiers.Op-amp with negative feedback - voltage series feedback -effect of feed back on closed loop gain, input resistance, output resistance, bandwidth and output offset voltage - voltage follower.
 Practical op-amp-input offset voltage -input bias current -input offset current, total output offset voltage, CMRR frequency response. DC and AC amplifier, summing, scaling and averaging amplifiers, instrumentation amplifier, integrator and differentiator.

 2.Oscillators and Wave Shaping Circuits: Oscillator Principle- Oscillator types, Frequency stability, response, The Phase shift oscillator, Wein bridge OScillator,LC tunable oscillators, Multivibrators Monostable and Astable, Comparators, Square wave and Triangle wave generation, Clamping and Clipping. Voltage regulators- fixed regulators, Adjustable voltage regulators, Switching regulators.

 3.Digital Electronics: Combinational Logic :The transistor as a switch;circuit Realization of OR,AND,NOT, NOR and NAND gates, Exclusive OR gate,Boolean algebra - Demorgan's theorems Adder, Subtractor, Comparator, Decoder /Demultiplexer ,Data selector/ multiplexer -Encoder.Sequential Logic: Flip -Flops: one-bit memory; The RS Flip Flop, JK Flip- Flop, JK master slave Flip - Flops, T Flip -Flop, D Flip- Flop, Shift registers - synchronous and asynchronous counters- cascade counters,Binary counter, Decade counter.Basic concepts about fabrication and characteristics of integrated circuits.

4. Microprocessors : Introduction to microcomputer: memory input/output - Interfacing devices 8085, CPU-Architecture -BUS timings-Demultiplexing the address bus generating control signals- Instruction set-addressing modes-Illustrative programmes,writing assembly language programmes looping, counting and indexing, Counters and timing delays track and subroutine.

Section-B

5. Errors in numerical analysis: Source of error, Round off error, Computer Arithmetic, Error Analysis,   Condition and stability,Approximation, Functional and Error analysis, the method of,Undetermined Coefficients.
Use of interpolation formula, Iterated interpolation. Inverse interpolation,Hannite interpolation and Spline interpolation, Solution of Linear equations , Direct and Iterative methods, Calculation of eigenvalue and eigenvectors for symmetric matrices.

6.Solution of Nonlinear equation: Bisection method, Newton's method,.modified Newton's method, method of Iteration, Newton's method and method of iteration for a system of equations Newton's method for the case of complex roots.
Integration of a function: Trapezoidal and Simpson's rules. Gaussian quadrature formula, Singular integrals, Double integration.

7.Integration of Ordinary differential equation: Predictor - corrector methods, Runga-Kutta method, Simultaneous and Higher order equations Numerical Integration and Differentiation of Data, Least-Squares Approximations, Fast   FourierTransform. Some elementary information about computers: CPU, Memory, Input/ Output devices, Super, Mini and Micro systems, MS-DOS operating system, High Level Languages, Interpreter and Compiler. Programming: Algorithm and Flowchart.

8.Fortran 77: Variable, Expression, jumping. Branching and looping statement ,Input / Output statement Statement for handling Input / Output Files, Subroutine, External, Function Special statements ,COMMON,ENTRY FORMAT,PAUSE,Equivalent . Programming of simple problems involving use of interpolation differentiation, Integration, matrix inversion and least square analysis.

Reference Book
 1. Ryder-Electronic Fundamentals and applications.
 2. Millman and Taub-Pulse, Digital and Switching waveforms.
 3. Millman and Halkias-Integrated Electronics.
 4. Ryder-network Lines and Fields.
 5 Bapat-Electronics Devices and Circuits.
 6. A. Ralston and P. Rabinowitz, A First Course in Numerical Analysis, McGraw Hill
 (1985) 7. S.S. Sastry, Introductory Methods of Numerical Analysis. Prentice hall of
 India (1979). 8. Ram Kumar, Programming with Fortran 77, McGraw-Hill (1986).
 9. "Electronic Devices and circuit theory by Robert Boylested and Louis Nashdsky
 PHI,New Delhi. 1100001, 1991 .
 10."OPAmps& Linear integrated circuits, by Ramakant A. Gayakwad PHI, Second
 Edition, 1991.
 11. Digital principles and Applications by A.P. Malvino and Donald P.Leach, Tata Mcgraw
 Hill company, New Delhi, 1993.
 12. Microprocessor Architecture, Programming and applications with 8085/8086 by
 Ramesh S. Gaonkar,Wiley - Eastern Ltd., 1987.

LIST OF EXPERIMENTS FOR M.Sc. PREVIOUS

Scheme: The examination will be conducted for two days, 6 hrs. each day. The distribution of the marks will be as Follows:

	Marks
Two experiments	: 120
Viva	: 40
Record	: 40
Total	: 200
Minimum Pass Marks	: 72

List of Experiments (any eighteen) :

1. To design a single stage amplifier of a given voltage gain and lower cutoff frequencies.
2. To determine Lo. Co. and Rf of a given coil and to study the variations of Rf with frequency.
3. To design a RC coupled two stage amplifier of a given gain and the cutoff frequencies.
4. To study the Hartley oscillator.
5. To Study Transistor Bias Stability.
6. To design a Multiv~bratorof given frequency and study its wave shape.
7. To study the characteristics ofFET and use it 0 design a relaxation oscillator and measure its frequency.
8. To Study the characteristics of an operational amplifier.
9. To study the characteristics of a UJT and use it to design a relaxation oscillator and measure its frequency.
10. To study the addition, integration and differentiation properties of an operational amplifier.
11. Determine Plack constant using solar Cell.
12. To determine Plack constant and work function by a photo-cell.
13. To study regulated power supply using (A) Zener diode only (b) Zener diode with a series transistor (c) Zener diode with a shunt transistor.
14. To verify Fresnel's formula;
15. To study the percentage regulation and variation of Ripple factor, with load for a full wave rectifier.
16. To study analog to digital and digital to analog conversion.
17. To study a driven mechanical oscillator.
18. To verify Hartmann's formula using constant deviation spectrograph.
19. To find e/m of electrons using Zeeman effect.
20. Study of CH Bands.
21. Salt Analysis / Raman effect (Atomic).
22. Design and study of pass filters.
23. Michelson Interferometer.
24. Fabry perot Interferometer.
25. Determination of velocity of Ultrasonic waves.
26. Study of Elliptically polarized light by Babinet Compensator.
27. Verification of Cauchey's Dispersion relation.
28. Study of DC gate control characteristics and Anode current characteristics of SCR.
29. To find Dissociation energy to I.

PAPER -V : ADVANCED QUANTUM MECHANICS AND INTRODUCTORY QUANTUM FIELD THEORY

Note: In all Ten questions are to be set, Five from each section. Candidates are required to attempt five questions in all, taking at least two questions from each section.

Max. Marks:100   Duration:3 Hrs.

Section-A

1. Scattering (non-relativistic): Differential And total scattering cross section, transformation from CM frame to Lab frame, solution of scattering problem by the method of partial wave analysis, expansion of a plane wave into a spherical wave and scattering amplitude, the optical theorem,

Applications.- scattering from a delta Potential,square well potential and the hard sphere scattering of identical particles, energy dependence and resonance scattering. Breit Wigner formula,quasi stationarystates.The Lippman-Schwinger equation and the Green's function approach for scattering problem, Born approximation and its validity for scattering problem, Coulomb Scattering Problem under first Born approximation in elastic scattering.

2.Relativistic Formulation and Dirac Equation: Attempt for relativistic formulation of quantum theory,The Klein-Gordon equation, Probability density and probability current density,solution of free particle KG equation in momentum representation,interpretation of negative probability density and negative energy solutions.

Dirac equation for a free particle, properties of Dirac matrices and algebra of gamma matrices, non-relativistic correspondence of the Pauli equation (inclusive of electromagnetic interaction). Solution of the free particle. Dirac equation, orthogonality and completeness relations for Dirac spinors, interpretation of negative energy solution.

3.Symmetries of Dirac Equation : Lorentz covariance of Dirac equation,proof of covariance and derivation of Lorentz boost and rotation matrices for Dirac spinors, Projection operators involving four momentum and spin, Parity (P), Charge.conjugation(C), time reversal (T) and CPT operators for Dirac spinors,Bilinear covariants, and their transformations behavior underLorentz transformation, P,C,T and CPT, expectation values of coordinate and velocity, involving only, positive energy solutions and the associated problems, inclusion of negative energy solution, Zitterbewegung, Klain paradox.

4.The Quantum Theory of Radiation : Classical radiation field, transversality condition, Fourier decomposition and radiation oscillators, Quantization of radiation oscillator,creation, annihilation and number operators; photon states, photon as a quantum mechanical excitations of the radiation field, fluctuations and the Uncertainty relation, validity of the classical description,matrix element for emission and absorption, spontaneous emission in the-dipole approximation, Rayleigh scattering. Thomson scattering and the -Raman effect, Radiation damping and Resonance fluorescence.

Section-B

5.Scalar and vector fields: Classical Lagrangian field theory, Euler-Lagrange's equation, Lagrangian density for electromagnetic field. Occupation number representation for simple harmonic oscillator,linear array of coupled oscillators,second quantization of identical bosons, second quantization of the real Klein Gordon field and complex ,Klein-Gordon field, the meson propagator.

6.The occupation number representation for fermions, second quantization of the Dirac field, the fermion propagator, the e.m. interaction and gauge invariance, covariant quantization of the free electromagnetic field, the photon propagator.

7.S-matrix, theS-matrix expansion,Wick's theorem, Diagrammatic representation in configuration space, the momentum representation, Feynman diagrams of basic processes, Feynman rules of QED.

8.Applications of S.matrix formalism: the Coulomb scattering, Bhabha scattering, Moller scattering, Compton scattering and pair production.

Reference Books :
1. Ashok Das and A.C. Millissiones : Quantum Mechanics -A Modern Approach.(Garden and Breach Science Publishers)
2. E. Merzbacher : Quantum Mechanics, Second Edition (John Wiley and sons)
3. Bjorken and Drell : Relativistic Quantum Mechanics (MCGraw Hill)
4. J.J. Sakuri : Advanced Quantum Mechanics (John Wiley)
5. F. Mandal & G. Shaw, Quantum Field Theory (John Wiley)
6. J,M. Ziman, Elements of Advanced Quantum Theory,(Cambridge UniversityPress).

PAPER - VI : NUCLEAR PHYSICS

Max.Marks :100   Duration : 3hrs.

Note: In all Ten questions are to be set, Five from each section.Candidates are required to attempt five questions in all, taking at least two questions from each section.

Section-A

1. Two Nucleon system and Nuclear Forces: General nature of the force between nucleons, saturation of nuclear forces, charge independence and spin dependence, General forms of two nucleon interaction, central, noncentral and velocity dependent potentials, Analysis of the   ground state (3S1)of deuteron using a square well potential,range-depth relationship, excited   states of deuteron, Discussion of the ground state of deuteron under non central force, calculation of the electric quadrupole and magnetic dipole moments and the D-state admixture.

2.Nucleon-Nucleon Scattering and Potentials : Partial wave analysis of the neutron-proton scattering at low energy assuming central potential with square well shape, concept of the scattering length, coherent scattering of neutrons by protons in (ortho and para) hydrogen molecule; conclusions of these analyses regarding scattering lengths, range and depth of the potential; the effective range theory (in neutron-proton scattering) and the shape

Independence of nuclear potential; A qualitative discussion of proton proton scattering at low energy: General features of two-body scattering at high energy Effect of exchange forces:Phenomenological Hamada- Johnston hard core potential and Reid hard core and soft core potentials; Main features of the One boson Exchange Potentials (OBEP) no derivation.

3.Interaction of radiation and charged particle with matter (No derivation): Law of absorption and attenuation coefficient; Photoelectric effect, Compton scattering, pair production;   Klem-Nishima cross sections for polarized and unpolarized radiation, angular distribution of scattered photon and electrons, Energy loss of charged particles due to ionization, Bremsstrahlung; energy target and projectile dependence of all three processes, Range-energy curves; Straggling.

4.Experimental Techniques: Gas filled counters; Scintillator counter, Cerenkov counters; Solid state detectors; Surface barrier detectors; Electronic circuits used with typical nuclear detectors;   Multiwire proportional chambers; Nuclear emulsions, techniques of measurement and analysis of tracks; Proton synchrotron; Linear accelerations; Acceleration of heavy ions.

Section-B

5.Nuclear shell model: Single particle and collective motions in nuclei: Assumptions and justification of the shell model, average shell potential, spin orbit coupling; single particle wave functions and level sequence; magic numbers; shell model predictions for ground state parity; angular momentum, magnetic dipole and electric-quadrupole moments; and their comparison with experimental data; configuration mixing; single particle transition probability according to the shell model; selection rules; approximate estimates for the transition probability and Weisskopf units: Nuclear isomerism.

6.Collective nuclear models: Collective variable to describe the the cooperative modes of nuclear motion; Parametrization of nuclear surface; A brief description of the collective model Hamiltonian (in the quadratic approximation); Vibrational modes of a spherical nucleus, Collective modes of a deformed even-even nucleus and moments of,inertia; Collective spectra and electromagnetic transition in even nuclei and comparison with experimental data; Nilsson model for the single particle states in deformed nuclei.

7.Nuclear gamma and beta decay: Electric and magnetic multipole moments and gamma decay probabilities in the nuclear system (no derivations),Reduced transition probability, Selection rules & internal conversion and zero. zero transition.
General characteristics of weak interaction; nuclear beta decay and lepton capture; electron energy spectrum and Fermi- Kurie plot; Fermi theory of beta decay (parity conserved selection rules Fermi and Gamow-Teller) for allowed transitions; ft-values; General interaction Hamiltonian for beta decay with parity conserving and non conserving terms; Forbidden transitions ,Experimental verification of parity violation; The V-A interaction and experimental evidence

8.Nuclear Reactions: Theories of Nuclear Reactions; Partial wave analysis of reaction Cross section; Compound nucleus formation and breakup,Resonance scattering and reaction- Breit Wigner dispersion formula for S-waves (l= 0), continuum cross section; statistical theory of nuclear reactions,evaporation probability and cross section for specific reactions; The optical model,Stripping and pick-up reactions and their simple theoretical description (Butler theory) using plane wave Born approximation (PWBA) Shortcomings of PWBA nuclear structure studies with deuteron stripping (d,p) reactions.

Reference Books :
1.J. M Blatt and V.E. Weisskopf: Theoretical Nuclear Physics
2. Statistical theory of nuclear reactions, Exaparation probability and cross section for specific reaction.
3. L.R.B Elton: Introductory Nuclear Theory, ELBS Pub. London, 1959
4. B.K. Agrawl : Nuclear Physics, Lokbharti Pub, Allahabad. 1989
5. M.K. Pal: Nuclear Structure, Affiliated East-West Press, 1982).
6. RR Roy and B.P.Nigam, Nuclear Physics, Willey-Easter, 1979
7. M.A. Preston & RK Bhaduri-Structure of the Nucleus, Addision Wesley,
1975 8. RM. Singru : Introductory Experimental Nuclear Physics
9. England - Techniques on Nuclear Structure (Vol.D
10. RD. Evans-TheAtomicNucleus(McGraw-Hills, 1955)
11. H. Enge -Introduction to Nuclear Physic~,Addition-Wesley, 1970
12. W.E.Burcham- Elements of NuclearPhysics,ELBS, Longman, 1988
13. B.L. Cohen - Concept of Nuclear Physics Tata Mc-Graw Hills, 1988
14. E. Segre - Nuclei, Particles Benjamin, 1977
15. I. Kaplan - Nuclear Physics, Addison Wesley, 1963
16. D. Halliday - Introductory Nuclear Physics, Wiley, 1955.
17. Harvey - Introduction of Nuclear Physics and Chemistry

PAPER-VII: STATISTICAL AND SOLID STATE PHYSICS

Max.Marks :100   Duration : 3hrs.

Note: In all Ten questions are to be set, Five from each section. Candidates
      are required to attempt five questions in all, taking at least two questions
      from each section.

Section-A

1.Basic Principles, Canonical and Grand Canonical ensembles: Concept of statistical distribution, phase space, density of states, Liouville's theorem, systems and ensemble, entropy in statistical mechanics Connection between thermodynamic and statistical quantities micro canonical ensemble, equation of state, specific heat and entropy of a perfect gas, using micro canonical ensemble.
Canonical ensemble, thermodynamic functions for the canonical ensemble, calculation of mean values, energy fluctuation in a gas, grand Canonical ensemble, thermodynamic functions for the grand canonical ensemble, density fluctuations.

2.Partition functions and Statistics: Partition functions and Properties, partition function for an ideal gas and calculation of thermodynamic quantities, Gibbs Paradox, validity of classical approximation, determination of translational, rotational and vibrational contributions to the   partition function of an ideal diatomic gas. Specific beat of a diatomic gas, ortho and para hydrogen.
Identical particles and symmetry .requirement, difficulties with Maxwell-Boltzmann statistics,quantum distribution functions, Bose-Einstein and Fermi-Dirac statistics, Boson statistics and Planck's formula, Bose Einstein condensation, liquid He as a Boson system, quantization of harmonic oscillator and creation and annihilation of Phonon operators, quantization of fermion operators.

3.Theory of Metals: Fermi- Dirac distribution function, density of states, temperature dependence of Fermi energy, specific heat, use of Fermi.
Dirac statistics in the calculation of thermal conductivity and electrical conductivity, Widemann -Franz ratio, susceptibility, width of conduction band, Drude theory of light, absorption in metals.

4.Band Theory: Block theorem, Kronig Penny model, effective mass of electrons, Wigner-Seitz approximation, NFE model, tight binding method and calculation of density for a band in simple cubic lattice, pseudo potential method.

Section-B

5.Lattice Vibrations and Thermal Properties: Interrelations between elastic constants C_{11}, C_{12} and C_{44} wave propagation and experimental determination of elastic constant of cubic crystal, vibrations of linear mono and diatomic lattices, Detennipation of phonon dispersion by inelastic scattering of neutrons.

6.Semiconductors: law of mass action, calculation of impurity conductivity,ellipsoidal energy surfaces in Si and Ge, Hall effect, recombination mechanism, optical transitions and Shockley Read theory excitons, photoconductivity, photo-Luminescence.Points line, planar and bulk defects, color centers, F-center and aggregate center in alkali halides.

7.Magnetism: Larmor diamagnetism.Paramagnetism,Curie Langevin and Quantum theories. Susceptibility of rare earth and transition metals. Ferromagnetism: Domain theory, Weiss molecular field and exchange,spin waves: dispersion relation and its experimental determination by inelastic neutrons scattering, heat capacity. Nuclear Magnetic resonance: Conditions of resonance, Black equations. NMR-experiment and characteristics of an absorption line.

8.Superconductivity: (a) Experimental results: Meissner effect, heat capacity, microwave and infrared properties, isotope effect, flux quantization, ultrasonic attenuation, density of states, nuclear spin relaxation, Giver and AC and DC, Josephson tunnelings.

(b) Cooper pairs and derivation of BCS Hamiltonian, results of BCS theory (no derivation).

Reference Books:
1. Huag : Statistical Mechanics
2. Reif : Fundamentals of Statistical and Thermodynamic Physics
3. Rice : Statistical mechanics and Thermal Physics
4. Kittle: Elementary statistical Mechanics
5. Kittle : Introduction to Solid State Physics
6. Patterson:Solid State Physics
7. Levy : Solid State Physics
8. Mckelvy: Solid State and Semiconductor Physics

PAPER-VIII : (A) MICROWAVE ELECTRONICS

Max.Marks :100   Duration : 3hrs.

Note: In all Ten questions are to be set, Five from each section. Candidates are required to attempt five questions in all, taking at least two questions from each section.

Section-A

1. Introduction to microwaves and its frequency spectrum, Application of microwaves. Wave guides: (a) Rectangular waveguides: Wave Equation & its solutions,TE TM modes.Dominant mode and choice of waveguide Dimensions Methods of excitation of waveguide.
(b) Circular waveguide-wave equation & its solutions, TE, TM & TEM modes.
(c) Attenuation - Cause of attenuation in waveguides, wall current & derivation of attenuation constant, Q of the wave guide.

2.(a) Resonators: Resonant Modes of rectangular and cylindrical cavity resonators, Q of the cavity resonators, Excitation techniques, Introduction to Microstrip and Dielectric resonators, Frequency meter.

(b) Farrites: Microwave propagation in ferrites, Faraday rotation, Devices employing Faraday rotation (isolator, Gyrator, Circulator). Introduction to single crystal ferromagnetic resonators, YIG tuned solid state resonators.

3. Microwave tubes: Spacecharge spreading of an electron beam, Beam focussings. Klystrons: Velocity Modulation, Two Cavity Klystron, Reflex Klystron Efficiency of Klystrons.
Magnetrons: types & description, Theoretical relations between Electric & Magnetic field of oscillations. Modes of oscillation & operating characteristics.
Gyrotrons: Constructions of different Gyrotrons, Field. -Particle Interaction in Gyrotron.

4. Microwave Measurement:
(a) Microwave Detectors: Power, Frequency, Attenuation, Impedance Using smith chart, VSWR, Reflectometer, Directivity, coupling using directional coupler.
(b) Complex permittivity of material & its measurement: definition of complex of Solids, liquids and powders using shift of minima method.

Section-B

5. (a) Avalanche Transit Time Device:Read Diode, Negative resistance of an avalanching p-n Junction diode IMPATT and TRAPATT Oscillator.
(b) Transferred Electron Device: Gunn effect, two valley model, High field Dotrutins, Different Modes for Microwave generation.
(c) Passive Devices: Termination (Short circuit and matched terminations) Attenuator, phase changers, E&H plane Tees, Hybrid Junctions. Directional coupler.

6.Parametric Amplifier: Varactor, Equation of Capacitance in Linearly graded & abrupt pn junction, Manely Rowe relations, parametric upconverter and Negative resistance parametric amplifier,-use of circulator, Noise in parametric amplifiers.

7. Microwave Antennas: Introduction to antenna parameters, Magnetic Currents, Electric and magnetic current sheet, Field of Huygens source, Radiation from a slot antenna, open end of a wave guide and Electromagnetic Horns. Parabolic reflectors, Lens antennas.
Radiation fields of Microstrip waveguide, Microstrip waveguide, Microstrip antenna calculations, Microstrip design formulas.

8. Microwave Communication:
(a) LOS microwave systems, Derivation of LOS communication range, OTH microwave systems, Derivation of field strength of tropospheric waves, . Transmission interference and signal damping, Duct Propagation.
(b) Satellite Communication: Satellite frequencies allocation, Synchronous satellites,Satellite orbits, Satellite location with respect to earth and look angle, earth coverage and slant range, Eclipse effect, Link calculation, Noise consideration, Factors affecting satellite communication.

Reference Books:
1. Electromagnetic waves & Radiating Systems: Jordan & Balmain.
2. Theory and application of microwaves by A.B. Brownwell & RE. Beam (McGraw Hill)
3. Introduction to microwave theory by Atwater (McGraw Hill).
4. Principles of microwave circuit by G.C. Montgomery (McGraw Hill)
5. Microwave Circuits & Passive Devices by M.L. Sisodia and G.S. Raghuvanshi
   (New Age International, New Delhi)
6. Foundations of microwave engineering by RE. Collin. (McGraw Hill).
7. Microwave Semiconductor Devices and their Circuit applications by H.A. Watson
8. Microwave by M.L. Sisodia and Vijay Laxmi Gupta. New Age, New Delhi.
9. Antenna Theory, Part-I by RE. Collin & EJ. Zucker (McGraw Hill, NewYork)
10.Microstrip Antennas by Bahl & Bhartiya (Artech House, Messachausetts)
11. Antenna Theory Analysis by C.A. Balanis Harper & Row. Pub. & Inc.NewYork.
12. Antenna Theory Analysis by E.A. W01""(J. Willey & Sons)
13. Antenna Theory & Design by RS Elliott (LPHI Ltd. New Delhi)
14. Microwave electronics by RE Soohoo (Addison Wesley public company,).
15.Microwave Active Devices, Vacuums by M.L. Sisodia New Age International New Delhi. 16. Semiconductors & Electronics device by A. Barle vs (PHI, India).
17. Solid State physical electronics by A.Vanderziel, (PHI, India).
18. Handbook of microwave measurement Vol-II by M. Sucher & J.Fox (polytechnic
    Press, New York).
19. Microwave devices & circuits by S.Y.Liao(PHI, India).
20. Microwave Principles by H.J. Reich (CBS).
21. Simple microwave technique for measuring the dielectric parameters of solids & their powder by J.M. Gandhi, J.S. Yadav, J. of pure & applied physics Vol. 30, pp-427431, 1992.

LIST OF EXPERIMENTS FOR M.Sc. FINAL

Schema :
The examination will be conducted for two days, 6 hrs. each day. The distribution of the marks will be as Follows:

	Marks
Two experiments	: 20
Viva	: 40
Record	: 40
Total	: 200
Minimum Pass Marks	: 72

LIST OF EXPERIMENTS (any eighteen) :

1. To Determine half-life of a radioisotope using a GM counter.

2. To study absorption of particles and determine range using at least two sources.

3. To study characteristics of a GMcounter and to study the statistical nature of radioactive decay.

4. To study spectrum of -β particles using Gamma ray-spectrometer.

5. To calibrate a scintillation spectrometer and determine energy of γ-rays from an unknown source.

6. (a) To study variation of energy resolution for a Nai (T) detector.

    (b) To determine attenuation coefficient (u) for rays from a given source.

7. To study Compton scattering of γ-rays and verify the energy shift formula

8. To study temperature variation of resistivity or a semiconductor and to obtain band gap using four probe methods.

9. To study hall effect a:nd to determine hall coefficients.

10. To study the variation of rigidity of a given specimen as a function of the temperature.

11. To study the dynamics of a lattice using an electrical analog.

12. To study ESR and determine g -factor for a given spectrum.

13. To Determine ultrasonic velocity and to obtain compressibility for a given liquid.

14. Study, the characteristics of a gb len Klystron and calculate the mode number, E.T.S. and transit time.

15. Study the simulated L.C.R. tran:5 mission line (audio frequency) and to find out the value for and Zo experimentally from the graph.

16. Study the radiation pattern of a given Pyramidal horn by plotting it on a Polar graph paper. Find the Half power beam width and calculate its gain.

17. Find the dielectric constant of a gi yen solid (Teflon) for three different lengths by using a slotted section.

18. Find the dielectric constant of a given liquid (organic) using the slotted section of K band.

19. Verification of Bragg's law using microwaves.

20. Determination of Dielectric Constant of a liquid by lecher wire.

21. Study of a Heat Capacity of Solids.

22. Study of lattice dispersion