



Maharaja Surajmal Brij University

Bharatpur (Raj.)

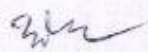
SYLLABUS

PHYSICS

M.Sc. (P & F)

Session 2021-22

Only For Session
2020-21


अकादमिक प्रभारी
महाराजा सुरजमल बृज विश्वविद्यालय
भरतपुर (राज.)

M.Sc PHYSICS PREVIOUS

Paper –I: Classical Mechanics and Mathematical Method in Physics	Max. Marks 100
	Time 3 hrs.
Paper II: Classical Electrodynamics	Max. Marks 100
	Time 3 hrs.
Paper III: Quantum Mechanics, Atomic and Molecular Physics	Max. Marks 100
	Time 3 hrs.
Paper IV: Electronics, Numerical Methods and Computer Programming	Max. Marks 100
	Time 3 hrs.

PAPER – I

CLASSICAL MECHANICS AND MATHEMATICAL METHOD IN PHYSICS

Max. Marks: 100

Duration : 3 Hrs.

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 question from each section.

Section – A

1. Holonomic and nonholonomic constants Alembert's Principle, Generalized coordinates Lagrangian, Lagrange's equation and its applications, Velocity dependent 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 and Hamilton Canonical equation from Hamilton's variational principle, Extension of Hamilton's Principle for nonconservative and nonholonomic systems Method of Lagrange's multipliers.
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 applications.
4. Action angle, variable adiabatic invariance of action variable: The Kepler problem in action angle variables, theory of small oscillations in Lagrangian formulation, normal coordinates and Its applications.

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Section B

5. Group of transformations. (Example: symmetry transformations 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, Crystallographic point groups Irreducible representation of C_4 Translation group and the reciprocal lattice.
6. **Fourier Transform:** Development of the Fourier integral from the nger series, Fourier and inverse Fourier transform Simple applications Finite wave to hve train with Gaussian amplitude, Fourier transform of Derivatives, Solution of wave quation as an application. Convolution theorem, intensity in term of spectral density for quasi-monochromatic EM waves, momentum representation. Application of Hydepan Atom and Harmonic Oscillator problems, Application of Fourier Transform to DARrion ivory, Diffraction pattern of one and two slits.
7. Laplace transforms, and their properties, Lapide ransform of derivatives and integrals derivatives and integrals of Laplace transform Laplace transform of periodic functions, inverse Lapince transform, Convolution that 'Impulsive Function, Application of Laplace trans forms in solving linear differential syuations with constant coefficients, with variable coefficients and linear partial differential equation.

Reference Books

1. Goldstein - Classical Mechanics.
2. A Raychoudhary Classical Mechanics.
3. Mathematical Methods for Physicists George Arklen (AcademicPress)
4. Applied Mathematics for Engineers and Physicists L.A. Pipe (McGraw Hill)
5. Mathematical Methods-Potter and Goldberg (Prentice Hall of India)
6. Elements 8f Group Theory for Physicists: A W Joshi (Wiley Eastern Ltd)
7. Vector Analysis (Schaum Series) (Mc Graw Hill).

PAPER - II

CLASSICAL ELECTRODYNAMICS

Max. Marks: 100

Duration : 3 Hrs.

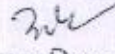
Note: In all ten questions are to be set, five form each section. Candidates are required to attempt five questions in all, taking at least two question from each section.

Section - A

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, Theorem, Uniqueness of the solution with Dirichlet or Neumann Boundary conditions. Formal solution of Electrostatic

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Boundary value problem 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 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 mages, Green function for the sphere, General solution for the potential. Conducting sphere with Hemispheres at different potential, orthogonal functions and expansion.

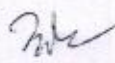
2. **Magnetostatics:** Introduction and definition, Biot, and Savart law, the differential equation of Magnetostatics and Ampere's law. Vector potential and Magnetic induction for a circular current loop. Magnetic fields of a localized current distribution. Magnetic moment Force and torque on and energy 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 an uniform field.
3. **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 conservations of energy and momentum for a system 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

4. **Plane Electromagnetic Waves and Wave Equation:** Plane wave in a nonconducting medium Frequency dispersion characteristics of dielectrics, conductors and plasmas wives in a conducting or dissipative medium, superposition of waves in one dimension, group velocity, casualty connection between D and E. Kramers-Kroning relation.
5. **Magneto-hydrodynamics and Plasma Physics:** Introduction and definitions, MHD equations Magnetic diffusion viscosity and pressure, Pinch effect, instabilities in a pinched plasma column. Magneto-hydrodynamic waves. Plasma oscillations, short way length limit of plasma oscillations and Debye shielding distance.
6. **Covariant Form of Electrodynamics:** Equations: Mathematical properties of the space time special relativity, Invariance of electric charge covariance of felettrodynamics. Transformation of electromagnetic fields.

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- 4.
7. **Radiation damping, self fields of a particle scattering and absorption of radiation by a bound system:** Introductory consideration Radiative reaction force from conservation of energy. Abraham Lorentz evaluation of 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 and Philips Classical Electricity and Magnetism.
3. Introduction 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

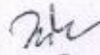
Note: In all ten questions are to be set five from each section. Candidates are required to attempt five questions in all, taking at least two questions from each section.

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) **Observables 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, super-position 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 two state systems.

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3. **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 conservations of momentum, energy and angular momentum.
- (b) 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 eigenstates (spherical harmonics). composition of angular momentum, Clebsch-Gordon coefficients tensor operators and Wigner eckart 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

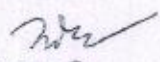
4. **Hydrogen Atom :** Effect of spin, relativistic correction to energy levels and fine structure, magnetic dipole interaction and hyperfine structure, the Lamb shift (only a qualitative description).
5. **Interaction with External Fields:** Non degenerate first order stationary perturbation method, atom in a weak uniform external electric field and first and second order Stark effect, Degenerate stationary perturbation Linear Stark for H atom levels, inclusion of spin-orbit and weak magnetic magnetic field and calculation of interaction energy.
6. **Systems with Identical Particles:** and exchange many particle wave functions and Pauli's exclusion principle, for The Helium atom. Variational method and its use in the of ground state and excited state Helium atom. The Hydrogen Heitler London method for molecule, WKB method for one dimensional problem.
7. **Spectroscopy (qualitative) :** General of of one and two electron system-singlet, doublet and triplet characters spectra, general features of Alkali spectra, rotation and vibration band and R Raman spectra for rotational and vibration comparison with general features of electronic spectra, Frank Condon's principle.

Reference Books:

1. Ashok Das and Quantum Mechanics-A modern Approach (Gordon and Breach Science Publishers).
2. P.A.M. Dirac, Quantum Mechanics.
3. Merzbaker, Mechanics, Second Edition (John Willey and Sons).
4. Quantum Mechanics-Non relativistic theory (pergamon Press).
5. A. Ghatak and S. Lobnathan. – Quantum Mechanics: Theory and, Applications, Third Edition (Mac Millan India Ltd.)
6. G.K. Woodgate, Elementary Atomic Structure, Second Edition Clarendon

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Press, Oxford.

6.

7. T A Littlefield - Atomic and Molecular Physics.
8. Eistanberg and Rasmik - Quantum Physics of Atom 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:

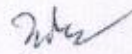
1. In all ten questions are to be set. five form each section. Candidates are required to attempt five questions in all, taking at least two questions from each section.
2. Simple calculator is allowed in the examination hall

Section A

1. **Operational Amplifiers:** Differential amplifiers - circuit configurations - dual input, balanced output differential amplifier. DC analysis - AC analysis, inverting and non inverting 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 feedback 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:** Principle- Oscillator types, Frequency stability, response, The Phase shift oscillator, Wein bridge Oscillator, LC tunable oscillators, Multivibrators- Monostable or Astable, Comparators, Square wave and Triangle wave generation, Company and clipping.
Voltage regulators- fixed regulators, Adjustable voltage regulators, switching regulators.
3. **Digital Electronics:** Comhinationl Logic The transistor as a switch, circuit Realisation of OR AND NOT, NORand NAND gates, Exclusive OR gate, Boolean algebra - Demongan's theorems Adder. Subtractor, Comperator, Decoder/Demultiplexer, Data selector/ multiplexer -Encoder.

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Sequential logic Flip Flops: one-bit memory: The RS Flipflop, 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.

Section B

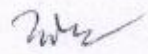
4. **Errors in numerical analysis:** Source of error, Round off error, Computer Arithmetic, Errors Analysis, Condition and stability, Approximation, Functional and Error analysis, the method of Undetermined coefficients.
Use of interpolation formula, Iterated interpolation, Inverse interpolation, Harnite interpolation and Spline interpolation, Solution of Linear equations, Direct and Iterative methods, Calculation of eigenvalues and eigenvectors for symmetric matrices.
5. **Solution of Nonlinear equation:** Bisection and 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.
6. **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 Fourier Transform.

Reference Book

1. Ryder-Electronic Fundamentals and applications.
2. Millman and Thub-Pulse, Digital and Switching Waveforms.
3. Millman and helkias- 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. Yashavant P. Kanetkar – Let Us C, BPB Publications, New Delhi.
9. “Electronic Devices and circuit theory By Robert Boylested and Louis Nashdsky PHI, New Delhi 1100001, 1991.
10. “OP Amps & Linear integrated Circuits,” by Ramakanth A. Gayakwad PHI, Second Edition, 1991.

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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, 6hrs. each day. The distribution of the marks will be as follows:

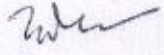
	Marks
Two experiments	120
Viva	40
Record	40
	Total 200
	Minimum Pass Marks 72

List of Experiments (any eight for the session 2020-21)

1. To design a single stage amplifier of a given voltage gain and lower cut of frequencies.
2. To determine Lo, Co and R of a given coil and to study the variation of R with frequency.
3. To design a RC coupled two stage amplifier of a given gain and the cut off frequencies.
4. To study Hartley oscillator.
5. To Study Transistor bias Stability
6. To design a Multivibrator of given free hand study its wave shape.
7. To study the characteristics of FE and use it to design an relaxation oscillator and measure its frequency.
8. To study the characteristics of an operational amplifier.
9. To study the characteristics a UJT and use it to design a relaxation oscillator and measure its frequency.
10. To study the integration and differentiation properties of an operational amplifier
11. Determine plaek contact using solar Cell
12. To determine Planck constant and work function by a photo-cell.
13. To study regulated power supply using (A) Zener diode only (6) Zener diode with a series transistor (c) Zener diode with a shunt transistor.
14. To verify Fresnel's formula;

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भारत

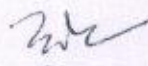
15. To study the percentage regulation and variation of Ripple factor, with load for a full wave rectifier.
16. To study analog to digital and digital to analog conversion.
17. To study a driven mechanical oscillator.
18. To verify Hartmann's formula using constant deviation spectrograph.
19. To find e/m of electron using Zeeman effect.
20. To find Dissociation energy of I.
21. Study of CH Bands.
22. Salt Analysis / Raman effect (Atomic).
23. Design and study of pass filters.
24. Michelson Interferometer.
25. Fabry parot Interferometer.
26. Determination of velocity of Ultrasonic waves.
27. Study of Elliptically polarised light by Babinet Compensator.
28. Verification of Cauchy's Dispersion relation.
29. Study of DC gate control characteristics and Anode current characteristics of SCR.

M.Sc. PHYSICS FINAL

Paper – V:	Advanced Quantum Mechanics and Introductory Quantum Field	Max. Marks 100 Time 3 hrs.
Paper VI:	Nuclear Physics	Max. Marks 100 Time 3 hrs.
Paper- VII:	Statistical and Solid State Physics	Max. Marks 100 Time 3 hrs.
Paper- VIII:	(A) Microwave Electronics	Max. Marks 100 Time 3 hrs.
OR		
Paper-VIII:	(B) Plasma Physics	Max. Marks 100 Time 3 hrs.

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 BUNDELKHAND
 UTTAR PRADESH

**ADVANCED QUANTUM MECHANICS & INTRODUCTORY
QUANTUM FIELD THEORY**

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 atleast two questions from each section.

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- Wigger formula, quasi stationary states.

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 K.G. 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 and hole theory.

3. **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

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4. **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

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oscillators second quantization of identical bosons, second quantization of the real Klein Gordan field and complex Klein-Gordan field, the meson propagator.

5. **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.
6. **S-matrix**, the S-matrix expansion. Wick's theorem, Diagrammatic representation in configuration space, the momentum representation, Feynman diagrams of basic processes, Feynman rules of QED.

Reference Books:

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

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 atleast 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 ($3S_1$) of deuteron using a square well potential, range-depth relationship, excited states of deuteron, Discussion of the ground state of deuteron under noncentral 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

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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.

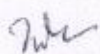
3. **Interaction of radiation and charged particle with matter (No derivation):** Law of absorption and attenuation coefficient; Photoelectric effect, Compton scattering, pair production; Klein-Nishina cross section for polarized and unpolarized radiation, angular distribution of scattered photon and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

Section - B

4. **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.
5. **Nuclear gamma and beta decay:** Electric and magnetic multipole moments and gamma decay probabilities in 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, l -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.
6. **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.

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Reference Books:

1. J. M Blatt and V.E. Weisskopf: Theoretical Nuclear Physics
2. Statistical theory of nuclear reactions, Exaporation probability and cross section 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 Structlire, Affiliated East-West Press, 1982).
6. RR Roy and Bop Nigam, Nuclear Physics, Willey-Easter, 1979
7. M.A. Preston & RK Bhaduri-Structure of the Nucleus, Addison Wesley, 1975
8. RM. Singru Introductory Experimental Nuclear Physics.
9. England - Techniques on Nuclear Structure (Vol.D)
10. RD. Evans-The Atomic Nucleus(McGraw-Hills, 1955)
11. H. Edge - Introduction to Nuclear Physics, Addition-Wesley, 1970.
12. W.E. Burcham- Elements of Nuclear Physics, 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. Hallidy - 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.**

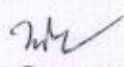
Note: In all ten questions are to be set, five from each section. Candidates are required to attempt five questions in all taking atleast two questions from each section.

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 thermodynamics 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 f gas, grand Canonical ensemble, thermodynamic functions for the grand canonical ensemble.
2. **Partition functions and Statistics:** Partition functions and Properties, partition function for an ideal gas and calculation of thermodynamic

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quantities, Gibbs Paradox, validity of classical approximation, determination of translational, rotational and vibrational contributions to the partition function of ideal diatomic gas. Specific heat of a diatomic gas,

Identical particles and symplectry requirement, difficulties with Maxwell-Boltzmann statistics, quantum distribution functions, Bose-Einstein and Fermi-Dirac statistics, Boson statistics and Planck's formula, Bose Einstein condensation.

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, Wiedemann-Franz ratio, susceptibility, width of conduction band, Drude theory of light, absorption in metals.
4. **Band Theory**: Bloch theorem, Kronig Penny model, effective mass of electrons, NFE model, tight binding method and calculation of density for a band in simple cubic lattice.

Section-B

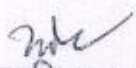
5. **Lattice Vibrations and Thermal Properties**: Interrelations between elastic constants C_{11} , C_{12} and C_{44} wave propagation and experimental determination of elastic constant of cubic crystal, vibrations of linear mono and diatomic lattices, Determination of phonon dispersion by inelastic scattering of neutrons.
6. **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, Bloch equations: NMR –experiment and characteristics of an absorption line.
7. **Superconductivity**: (a) Experimental results: Meissner effect, heat capacity, isotope effect, flux quantization ultrasonic attenuation. Giver and AC and DC. Josephson tunnelings.
(b) Cooper pair: Cooper pairs and derivation of BCS Hamiltonian, results theory (no derivation).

Reference Books:

1. Huang : Statistical Mechanics
2. Reif: Fundamentals of Statistical and Thermodynamical Physics.
3. Rice: Statistical mechanics and Thermal Physics.
4. Kittel: Elementary statistical Mechanics.
5. Kittel : Introduction to Solid State Physics.

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6. Patterson: Solid State Physics.
8. Mckelvy: Solid State and Semi-conductor Physics.

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Paper – VIII

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 atleast two questions from each section.

Section-A

1. **Wave guides:** Introduction to microwaves and its frequency spectrum, microwaves.
 - (a) Rectangular wave guides: Wave Equation & its solutions, TE & TM modes, Dominant mode and choice of wave guide Dimensions Methods of excitation of wave: guide.
 - (b) Circular wave guide- wave equation & its solutions, TE, TM & TEM modes.
 - (c) Attenuation Cause of attenuation in wave guides, wall church & 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 Microstrip and Dielectric resonators, Frequency meter.
(b) Ferrites: 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:** Space charge spreading of an electron beam, Beam focusing. Klystrons: Velocity Modulation, Two Cavity Klystron, Reflex Klystron, Efficiency of Klystrons.
Electric & Magnetic Field of oscillations, Modes of oscillation & operating characteristics.
Travelling wave tubes: O & M type travelling wave tube.
4. **Microwave Measurement:**
 - (a) Power, Frequency, Attenuation, Impedance Using smith chart, VSWR.

Section B

1. **(a) Avalanche Transit Time Device:** Read Diode, Negative resistance of an avalanching P-n Junction diode IMPATT.
(b) Transferred Electron Device: Gunn Effect, two valley model, high field Domains Different Modes for Microwave generation.

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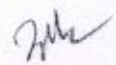
- (c) **Passive Devices:** E&H plane Tees, Hybrid Junctions. Directional coupler
2. **Parametric Amplifier:** Varactor, Equation of Capacitance in Linearly graded & abrupt p-n junction, Manely Rowe relations, parametric upconverter and Negative resistance parametric amplifier, use of circulator, Noise in parametric amplifiers.
3. (a) **Microwave Communication:** 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: Jorden & Balprijy.
2. Theory and application of microwaves by A.B. Brownwell 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.I. Sisodia and G.S. Raghuvanshi (New Age International, New Delhi)
6. Foundations of microwave engineering by R.E. 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-1 by A. Collateral. Zucker (McGraw Hill, New York)
10. Microstrip Antennas by Bahl & Bhartiya (Artech House, Massachusetts)
11. Antenna Theory Analysis by T.K. Sarkar & R. M. M. (New York).
12. Antenna Theory Analysis by E.A. W01 (J. Willey & Sons).
13. Antenna Theory & Design By R.S. Elliott (LPHI Ltd. New Delhi).
14. Microwave electronics by R.E. Soohoo (Addison Westey public company.).
15. Microwave Active Devices, Vacuum tubes 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. Vinderziel, (PHI, India).
18. Hand book of microwave measurement Vol-II by M. Sucher & J. Fox (polytechnic Press, New York).
19. Microwave devices & circuits by S.Y. Liao (PHI, India).

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20. Microwave Principles by H.J. Reich (CBS).
 21. Simple microwave techniques 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

Paper – VII
PLASMA 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 atleast two questions from each section.

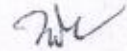
Section-A

1. **Basic properties and occurrence:** Definition of plasma, Criteria for plasma Behaviour. Plasma oscillation. Quasi neutrality and Debye Shielding. The plasma parameter, natural occurrence of plasma. Astrophysical plasmas. Plasma in Magnetosphere and ionosphere. Introduction to various theoretical approaches: Kinetic, Multi-Elude and single fluid.
2. **Charged particle motion and drifts:** Guiding centre motion of a charges particle. Motion in (i) uniform electric and magnetic field (ii) gravitational and magnetic fields. Motion in non-uniform magnetic field (1) grad B perpendicular to B, grad B drift and curvature drift (ii) grade B parallel to B and principle of magnetic mirror, Motion in non-uniform electric field for small Larmour radius, Time varying electric field and polarization drift, Time varying magnetic field adiabatic invariance romantic moment.
3. **Diffusion and Resistivity:** Collision and diffusion parameters. Decay of a plasma by diffusion, ambipolar diffusion. Diffusion across magnetic field. Collision in fully ionized plasma. Plasma resistivity: Diffusion in fully ionized plasmas. Solution of Diffusion equation, plasma production and diagnostics, Thermal ionization. Saha equation. Brief discussion of methods of laboratory plasma production; Steady stage glow discharge, microwave breakdown and induction discharge, Double Plasma machine, elementary ideas about plasma diagnostics Electrostatic and magnetic probes.
4. **MHD power generation:** basic principle and working of MID power generator, Conductivity of gascousty working lluid, Basic fluid equations, Generalized Ohm's law, Faraday and Hall generators performance characteristics and electrical efficiency of Faraday and hall generators.

Section-B

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5. **Waves in plasma:** Electron plasma waves. long Waves, Electrostatic electron oscillations perpendicular to B, upper hybrid oscillations. Electrostatic ion waves perpendicular to B. 10h cyclotron waves, Lower hybrid oscillations,



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Electromagnetic waves in field free plasma. Electromagnetic waves perpendicular to B. Cut offs and resonances Electromagnetic waves parallel to magnetic field, hydro magnetic waves. Magnetosonic waves.

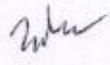
6. **Equilibrium and stability:** Hydromagnetic equilibrium. Diffusion of magnetic field into plasma, Classification instabilities. The gravitational instability. Kinetic treatment of plasma oscillations and Landau damping, physical explanation.
7. **Non-linear effects:** The Sagdeev potential, Derivation of KdV equation for ion acoustic waves. Soliton solution in one dimension. Elementary ideas about the ponderomotive force and parametric instability. Oscillating two stream instability.
8. **Controlled thermonuclear fusion:** Potentials and problems of controlled thermonuclear fusion, Ignition temperature and Lawson criteria, Magnetic confinement. Simple discussion of Tokamak, stellarators, multipoles and z pinch, Idea about inertial confinement and laser fusion, Methods of plasma heating and problems of fusion.

References:

1. F.F. Chen: An Introduction to Plasma Physics (Plenum Press) 1974
2. Boley; Plasmas: Laboratory and Cosmic.
3. W.B. Kunkel: Plasma Physics in Theory and Application
4. J.A. Bittencoms: Fundamentals of Plasma Physics (Pergamons Press 1986.
5. Huddlestone & Leonard: Plasma Diagnostic Technique.
6. R.C. Davidson: Methods in Non-linear Plasma Theory (Academy Press) 1972
7. Holt and Haskel. Foundations of plasma.

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LIST OF EXPERIMENTS FOR M.Sc PREVIOUS

19

Scheme:

The Examination will be conducted for two days, 6 hrs. each day. The distribution of the marks will be as follows:

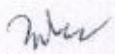
	Marks
Two experiments	120
Viva	40
Record	40
Total	200
Minimum Pass Marks 72	

LIST OF EXPERIMENTS (any eight for the session 20-21)

1. To determine half-life of a radio isotope using GM counter.
2. To study absorption of particles and determine range using at least two sources.
3. To study characteristics of a GM counter and also statistical nature of radioactive decay.
4. To study spectrum of β (Beta) particles using Gamma ray spectrometer.
5. To calibrate a scintillation spectrometer determine energy of γ -rays from an Source.
6. (a) To study variation of energy resolution for a Nai (T) detector.
(b) To determine attenuation coefficient (μ) for rays from a given source.
7. To study Compton scattering of Gamma-rays and verify the energy shift formula
8. To study temperature variation of resistivity of a semi-conductor and to obtain band gap using four probe method.
9. To study Hall Effect to determine hall coefficient.
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 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 given Klystron and calculate the mode number, E.T.S. and transit time.
15. Study the simulated L.C.R. transmission line (audio frequency) and to find out the value for Z_0 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.

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
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17. Find the dielectric constant of a given solid (Teflon) for three slotted section. different lengths by using slotted section.
18. Find the dielectric constant of a given liquid (organic) using slotted section of K-band.
19. Verification of Braggs 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.

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