(iv) Liquid drop model–semi empirical mass formula, nuclear fission.

(v) Qualitative discussion of extreme single particle model, quantitative treatment of single particle orbitals, explanation of spins and parities of nuclei. Introduction of spin orbit tern and reproduction of magic numbers and spins parities.

(vi) Collective model :– Simple discussion of rotational and vibrational states.

2. Two body problem and nuclear forces

(i) Ground state of deuteron (using central force) qualitative and quantitative discussion.

(ii) Neutron proton scattering below 10 Mev, elementary discussion of quantum mechanical theory of scattering, effective range theory, comparision of theoretical results with the experimental values and explanation of spin dependence of nuclear forces.

(iii) Existence of non–contral (tensor) forces, general form of non central forces aad their properties, qualitative and quantitative discussion of ground states of deuteron and its magnetic moment using non central forces.

(iv) Exchange forces–qualitetive discussion and formal definitions. Isospin formalism and general form of the nucleon–nucl.on interaction.

3. Nuclear Transformations

(i) Alpha–decay : Measurenent of alpha-particle energies, experimental decay constant & Geiger–Nutal Law, Gammonstheory of alfa–decay Nuclear energy levels as deduced from alpha–decay data.

(ii) Beta–decay : Beta-decay processes, measurement of Betaray energies, Neutrinohypothesis and simple theory of Beta-decay, curil plots, allowed and forbidden transitions, selection rules parity violation in Beta-decay.

(iii) Gamma Transitions : Gamma rays and measurement of Gamma ray energies—Bent crystal spectrometer, pair spectrometer, measurement of life time of excited states, internal conversion, angular correlation, assignment of spin and parity of nuclear Coefficients.

4. Accelerators and Nuclear reactions :

(i) Accelerating machines; Betatron, Synchro Cyclotron, Bevatron. Particle detector – G. M. counter, scaling circuit, scintillation counter, semi conductor, radiation detectors. Neutron detection techniques,

(ii) Description of nuclear reactions, Reaction kinematics—Q—Value equation, reaction cross-section, nuclear reaction, theories-resonance. Breit-Wigns dispersion relation for the compound nucleus theory-stripping & pick-up reaction, connection with shell models,

5. Classification of elementary particles. Nishijima Scheme, Mass formula, Symmetries & Conservation Laws, external and internal symmetries.

Books recommended :

1. Theoretical Nuclear Physics : Blatt and Weiskoff
2. Nuclear Physics : Roy and Nigam
3. —do— : Enge
4. —do— : M. A. Preston
5. —do— : Halliday
6. —do— : Elton
7. Theory of elementary particles : Keon

Paper III

ADVANCED ELECTRONICS

Note : There shall be no sections in the paper.

1. Transmissisn Lines :

Transmission line equation, line characteristics, line distortion and attenuation, line termination, impedance matching, standing wave ratio, transmission line as a circuit element. Transmission line charts (Smith Chart)

2. Antenna :

Radiation from linear antenna in space, effect of ground, field at a point above surface of the earth due to vertical antenna, power radiated from antenna and radiation resistance, quarter and half wave antenna antenna arrays, TV Antenna.

3. Propagation of Radio Waves :

Factors involving in propagation of radio waves, ground wave, space and sky waves, Appleton Hartree formula, nature of ionosphere and and its stratification, refraction and reflection of waves, skip distance, critical frequency, exploration of ionosphere.

4. Modulation & Detection :

(i) Amplitude modulation principle, modulation circuits, simple AM transmitter circuit (ii) Frequency modulation principle, Armstrong FM system, frequency discriminators.

Diode detectors, A-V-C frequency conversion; mixer, Intermediate frequency amplifier, AM Transistor Receiver.

5. T. V. and Radar :

Scanning, T. V. Camera (Videocon and Orthicon), Kinescope, Block diagram of B/W and Colour TV receiver, TV receiver and transmitter, elementary idea of radar.

6. High frequency Amplifier :

Common emitter short circuit current frequency response, Alpha cut off frequency, hybrid-pi-common alpha emitter model. CE short circuit gain with hybrid-pi-model.

7. Microwaves :

High frequency limitation in conventional tubes, velocity modulation theory of bunching and power deliverd by reflex klystron, types of magnetrons, modes of operation, tuning and output pewer of a multicavity magnetron, Basic principle of travelling wave tube.

Gunn Effect, and Gunn characteristic and modes, IMPATT and TRAPATT diode and its operation under small signal conditions, Rectangular and circular wave guides, TM, TM modes, Attenuation factor and Q of wave guides.

PAPER IV

Operational Amplifier Microprocessor and Digital Electronics :

Note : There shall be no sections in the paper

1. Operational amplifier

Difference amplifier circuit, details of op – Amp. 741, Inverting configuration and non-inverting configuration, Measurement of op – Amp parameters, frequency response of op-Amp, active filter, op-Amp application-Mathematical operation, solution of differential equations,high resistance voltmeter.

2. Microprocessor

Organization of micro-computer, progrmming of microprocessor, DATA representation, organization and programming of a microprocessor, interfacing memory & I/O Device, Application of Microprocessor.

3. Digital

TTL NAND operation,TTL open Collector NAND gate, Boolean function and truth table, 2, 3, 4 variable Karnaugh map, Karnaugh simplificatien, Don't-care conditions.

4. Flip-Flop

R-S latch, D-latch, D-Flop-flop, J-K Flip-flop, J-K Master-slave Flip-Flop Timer 555, T-Flip-Flop.

5. Register and Counter

Buffer Register, Control Register, Shift Register, Control Shift Register, Ripple Counter, Ring Counter, Synchronous counter, TTL Counter, Organization of Computer.

6. Memories

ROM, PROM and EPROM, RAM, A small TTL memory, Hexadecimal addresses, D to A and A to D converter.

Books Recommended

1. Antenna Theory & Practice by Chatterjee
2. Modern Digital Electronics by Jain
3. Electronics Devices & Circuits by Allen Mottershead
4. Integrated Electronics by Millman & Halkias
5. Digital Electronics by Malvino
6. Digital Electronics by Radha Krishnan
7. Digital Electronics by Gothmann
8. Microprocessor by A.P. Mathur

List of experiments of M.Sc. (F) Physics for those offering Group B (Advance solid state Physics)

1. Study of solid state power supply
2. Study of multivibrator
3. Hall effect
4. Energy gap measurements
5. Electron spin resonance studies
6. Elastic constant of cubic crystals
7. Thermal conductivity of a crystal and its temperature variation
8. Photo conductivity of CdS
9. Conductivity of semiconductors by four probe method
10. Electrical conductivity measurements of thin films
11. Study of conduction in ionic crystal (Ionic conductivity of NaCl)
12. Production of study of colour centres.
13. Lave perotographs
14. Powder photographs
15. Fleurescence intensity determination by photomultipliers
16. Transistor amplifier and its study
17. Mossbauer effects studies

18. Growing of metal crystal and their studies
19. Study of Hysterisis and transit on temperature of ferro electric crystal
20. Diffusion length of current carrier in semi conductors
21. Study of characteristics of FET
22. Study of phase and frequency response of FET

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Physics

M. Sc. (Prev.)

PAPER I

Mathematical Physics and Classical Mechanics

1. The Elements of the Theory of the complex variable.

Introduction -- General Functions of a complex variable. The Derivative and Cauchy-Rieman Differential Equations, Line Integrals of complex Functions, Cauchy's Integral Theorem — Cauchy's Integral Formula— Taylor's series — Lawrent's series — Residues — Cauchy 's Residue Theorem—Singular points of an analytic Function — The point at Infinity—Evaluation of Residues – Evaluation of Definite Integrals Jordon Lemma — Integrals Involving Multiple — valued functions — Simple exercises.

2. The Wave Equation and the Poisson's Equation

Introduction—The Transverse vibrations of a stretched string, D'Alembert's solution — Waves on Strings – Harmonic Waves — Fourier series solution – Orthogonal Functions— The Oscillations of a hanging Chain — The Vibrations of a Rectangular Membrane — The vibrations of a circular Membrane— The Telegraphists, or Transmission line, Equations – Tidal waves in a canal – Sound Waves in a Gas —The Magnetic Vector Potential — The Inhomogeneous Wave Equation — The Theory of wave Guides — Green's Function — Solution of Poisson's Equation using Greens's Function.

3. Group Theory

Concepts of a group – Abelian Group— The generators of a Finite Groups— The cyclic group—The group Multiplication Table—The Rearrangement Theorem — Subgroups—Cosets— Conjugate Elements and classes—

The product of classes – complexes – Conjugate subgroups-Normal subgroups and Factor groups. Isomorphism and Homomorphism – Permutation groups – The group of symmetry of an equilateral Triangle – group of symmetry of a square—Representation of groups – Reducible and Irreducible Representations – The orthogonality Theorem – The character of a Representation – Character Tables – The Unitary group – Point groups – Simple Problems.

4— Variational Principles and Lagrange's Equations

Hamilton's principle — Techniques of the calculus of variations — Derivation of Lagrange's Equations from Hamilton's principle — Extension of Hamilton's. principle to non – holonomic systems Advantages of a variational principle formulation – Conservation Theorems and symmetry properties.

5— The Hamilton Equations of motion - Canonical Transformations and Hamilton-Jacobi Theory

Legendre's Transformations and the Hamiltons equations of motion – Hamiltonian in the canonical equations of motion — The equations of canonical Transformation— Examples of canonical transformations – Poisson's Brackets-Equations of motion, canonical transformations and conservation theorems in the poisson's Bracket Formulation. The Hamilton jacobi equation for Hamilton's principle function. The harmonic oscillator problem as an example of the Hamilton — Jacobi method.

Books Recommended

1— Applied Mathematics for Engineers and Physicists by Louis A. Pipes, Ph. D. ; Mc – graw – Hill Book Company Inc. , New York, Toronto, London.

2— Mathematical Physics (Including classical Mechanics) by Satya Prakash, Sultan Chand & sons, Daryaganj, New Delhi –110002.

3— Classical Mechanics by Herbert Goldstein, Narosa Publishing House, 6 Community Centre, Panchsheel part, New Delhi—110017.

PAPER II :

Spectroscopy and Quantum Mechanics

Spectroscopy (60%)

Atomic Spec ra

Different modes of coupling. Spectra of alkaline earth and carbon group of elements.

Elementary ideas of hypofine structure, quantum number F, Examples of hyperfine structure, Back & Goudsmit Effect .

Weak Field and Strong Field. Stark effect in Hydrogen.

Dopple width, Natural width. Collision and pressure induced width. Width due to stark effect,

MOLECULAR SPECTRA

Observed Molecular spectra and their representation by Empirical

Formulae : Spectra in the visible and ultraviolet regions, spectra in the infra red region, Radio Frequency spectra, Raman spectra.

Interpretation of Infra red and Raman Spectra ; Interpretation of the Principal features of Infra red and Raman spectra by means of the models of the Rigid Rotator and of the harmonic oscillator, Interpretation of the fine details of Infra red and Raman spectra by means of the models of an harmonic oscillator, Non rigid Rotator vibrating rotator and symmetric top, Intensities in Rotation-Vibration spectra, Symmetry properties of Rotational levels.

Electronic states and Electronic transitions : Electronic Energy and total energy, Vibrational structure of Electronic transtions, Rotational structure of Electronic bands, Intensity distribution in the vibrational structure, Frank–Condon principle.

Books Recommended :

(1) Introduction to Atomic Spectra —H. E. White (Text Book)

(2) Spectra of Diatomic Molecules —G. Herzberg (Text Book)

(3) Atomic spectra and atomic structure G. Herzberg (Reference Book)

(4) Introduction to Molecular Spectra—R.C. Johnson (Reference book)

Quantum Mechanics (40%)

1– Matrix Formulation and angular momentum

Matrix Formulation of states and operators, Linear vector space Expansion theorem, Hilbert space. Diagonalization of operator matrix, projection operator. matrix formulation of H.O. problem—theory.

Elementary representation, theory Unitary transformation, pauli spin matrices, Matrix elements of J^2, Jz, J+ J-Operators, coupling of two angular momentra, Clebsch Gordon Coeff, and their matrices.

2— Approximation Methods

(a) Time independent perturbation theory— non-degenerate and degenerate cases with examples of Harmonic Oscillator, Ground state of He—atom, Zeeman Effect and Stark Effect.

(b) Variat onal methods – Ground state & excited states of He—atom.

(c) W.K.B. Method. its application to α - decay problem.

Books Recommended :

(1) Quantum mechanics—L. I. Schiff, IIIrd Edition, Mc-graw

(2) Quantum Mechanics. Ghatak and Leknathan—Mc-Millan.

(3) A Text book of Quantum Mechanics. Mathews and Venkatesan. Tata—Mc-graw Hill.

PAPER III

Advanced Solid State Physics

1. Crystal diffraction and Reciprocal Lattice

Diffraction of X-rays, electrons and neutrons from Crystals. Reciprocal lattice, Interplanar spacing. Reciprocal lattice to Sra. s. c. b. c. c. f. c. and hexagonal lattices; Diffraction conditions, Laue equations, Ewald construction, Brillouin zones; Atomic Scattering factor; Geometrical structure factor for bcc and fcc lattices and for SCI, KCI, KBr and diamond structures; Determination of crystal structures. Laue, rotating crystal and powder methods.

2. Crystal Binding and point defects in Crystals

Inert gas crystals, Lennard-zones potential, Cohesive energy and compressibility : Ionic crystals, Madelung energy, Evjen method for Madelung constant, cohesive energy and compressibility.

Frenkel and Schottky defects in ionic crystals, concentration of defects as a function of temperature. Ionic conductivity and diffusion in Ionic crystals, color centres in alkali halide crystals deBoer model for F-centres.

3. Elastic constants and Elastic Waves

Stress-Strain relations. Elastic compliance and stiffness constants, Elastic energy density; Elastic stiffness constants of cubic crystals, compressibility : Elastic waves in cubic crystals waves in (100), (110) and (111) directions; Experimental determination of elastic constants.

4. Phonons and lattice Vibrations

Quantization of lattice Vibrations. Inelastic scattering of photons and neutrons by phonons, Vibration of mono-atomic and diatomic linear lattices; optical and acoustical phonons, Dielectric function and Lyddane-

Sache-Teller relation, Local phonon modes; lattice thermal resistivity; Phonon-Phonon collisitions, crystal size effect.

5. Free electron Fermi Gas

Dielectric response of electron gas, transverse optical modes in a plasma, Transparency of alkali metals in ultraviolet. Longitudinal optical modes in a plasme.

Boltz mann transport equation, sommer field's theory of electrical conductivity of metals, motion of free electrons in magnetic field, cyclotron frequency, static magneto resistance and Hall effect in metals.

6. Energy Bands of Electrons in solids

Fermi surfaces; Electrons, Holes and open orbits, effective mass of electrons in crystals; Cyclotron resonance and Hall effect in semi-conductors : High field magneto resistance; The de Hass-Van Alphen effect.

7. Magnetism

Ferro, antiferro and ferri magnetism, Wiess molecular field theory, Hei-senberg exchange interaction, spin waves and magnon. dispersion relation for one dimensional and simple cubic crystals, Bloch $T^{3/2}$ law, Ferromagnetic domains, Bloch wall.

8. Exciton, Photoconductivity. Luminescence, Laser and maser

Weakly and tightly bound excitons; photo–conductivity and a simple model of a photo conductor, influence of traps, space charge effects; Luminescence, thallium–activated alkali halide phosphors.

Principle of Laser and Maser, stimulated emission. Ruby laser and semi conductor junction laser, three lavel Ruby Maser, applications of Lasers and Masers.

NMR ESR and Mossbauer effect

NMR, Bloch equations, power absorption, line width, experimental method and applications; ESR, experimental study and applications.

Mossbauer effect, recoilless transition, fraction of recoilless events, Lamb-Mossbauer factor Experimental study and applications of Mossbauer effect.

10. Supper Conductivity

Properties in super conducting state, Meissner-effect, type I and II super conductors thermodynamics of super conducting transition, Rutger's formula, London equations, penetration depth, coherence length, basic ideas of BCs theory.

Books Recommended

1. C. Kittel — Introduction to solid state Physics
2. A. J. Dekker — Solid state Physics
3. R. L. Shinghal — Solid state Physics

PAPER IV :

Electronics 60% and Electrodynamics 40% Electronics

1. Network Theorems : Thevenin, Norton, Millman, Compensation and superposition theorems, Decible notation, Impedance matching.
2. Semi-Conducting Devices : Shottky Diode, Tunnel-Diode, Varactor Diode, LED, Liquid Crystal Diode, Diac, Triac and S. C. R., Thermistors and L. D. R. and their use in A. C. Voltage regulators.
3. Electronically regulated power supply : Shunt ragulator, series regulator (using emitter follower and Darlington pair) short circuit overload protection, parameters of a regulated power supply, block diagram of a mono-lithic regulator, power control using SCR and triac, SMPS power supply.

4. Power Amplifiers : Class A power amplifier, Push pull class AB power amplifier, complimentary Symmetry, Tone Control and frequency compensation, Class C-amplifier.
5. Wave Shaping and Pulse Technique : Differentiating. integrating and summation circuits, Generation of a voltage step from cramp, square wave from a triangular wave. Narrow pulses from rectangular wave form, A stable, monostable, bistable multivibrator, Schmidt trigger circuit.
6. JFET and MOSFET : Operation of an N-Channel JFET, Transfer and output characteristics of a JFET, parameters of JFET, JFET as an amplifier, biasing of JFET, Principle and operation of MOSFET in Depletion and Enhancement mode.

Books Recommended

1 Electronic Devices & Circuits by Allen Mottershead,
2 Integrated Electronics Fundamental by Milman-Halkias
3 Hand Book of Eiectronics by Kumar & Gupta
4 Electronic Devices & Circuits by Mathur, Chaddha & Kulshrestha
5 Electronic Devices By A. Singh

Electro-dynamics

Electromagnetic Field equation :

Electric field and potential in terms of charge distribution Multiple expansion, electric field in di-electric media, theory of polarisation, field energy in free space and di-electrics, Maxwell stress tensor.

Electromagnetic field equation :

Displacement current, Maxwell's equations, propagation of plane waves in non-conducting and conducting media, Poynting vector boundary conditions at interfaces, laws of reflection at the inter face of non-conducting media, reflection from a conducting plane: electromagnetic scalar and vector potential, radiation from an oscillating dipole, scattering of electromagnetic waves and dispersion.

Electrodynamics of moving charge:

Lienard-wichert potentials, field of a charge in uniform motion, radiation from an accelerated charge.

Electrical neutrality in a plasma, equation of motion of charge in constant uniform electric and magnetic field, particle orbits and drift motion in a plasma, hydromagnetic equation, pinch effect, plasma oscillations and wave equation.

LIST OF EXPERIMENTS FOR MSc. PREVIOUS

1. e/m by Thomson's method.
2. e/m by Magnetron valve method or Bush method.
3. Verification of Hartmann Formula.
4. Verification of Cauchy's formula.
5. Verificatlon of Fresnel's formula for reflection.
6. Study of elliptically polarised light by Babinet's compensator.
7. Michelson's Interferrometer.
8. Fabry Perot's elation.
9. Determination of Stephen constant.
10. Determination of planck's constant by Photo cell.
11. Determination of velocity of light.
12. B.H Curve.
13. Self Inductance by Anderson bridge.
14. Study of valve characteristics Triode, tetrode and pentode.
15. Study of transistor characteristics.
16. Study of C. R. O.
17. Study of H. W. and F. W. rectifiers.
18. Study of R. C. Amplifiers.
19. Study of ionisation and excitation potentials.
20. Ultra sonic velocity in liquids.
21. Study of Zeeman effect.
22. Measurement of Magnetic susceptibility.
23. Study of G. M. Counter.

Physics

M. Sc. (Final)

PAPER I

ADVANCED QUANTUM MECHANICS

Note : There shall be no sections in the paper

1. Time Dependent Perturbation Theory

Schrodinger, Heisenberg and Interaction representation, operator formalism of time dependent perturbation theory, Dyson chronological operator. Constant and harmonic perturbations, Transition probability per unit time, Radiative transitions in atoms, Dipole transitions and selection rules, Adiabatic and sudden approximations.

2. Scattering Theory

Scattering cross section Laboratory and centre of mass system, Normalization of incoming wave, method of partial waves. The Scattering amplitude, Integral equation of scattered wave, Born Approximation, Validity of Born Approximation for square well and screened coulomb potentials, Scattering between identical particles, Formal theory of scattering and Lippmann – Schwinger equation, The scattering amplitude and the transition matrix, the scattering of an electron by an atom (Neglecting exchang e) S—matrix, Rotational and Time reversal invariance of S – matrix.

3. Relativistic Wave Equations

The Klein – Gordan equation for frec—particle and electro – magnetic potential Inadequacy of Klein—Gordon Equation, The Dirac equation, free particle solution, Soluions for electro—magnetic potential and for central field, Energy levels of Hydrogen atom, Negative energy states.

4. Occupation number representation and Quantisation of fields

Second quantisation of Harmonic Oscillator, Creation, Annihilation and Number operators, Vaccum state, One-body and two-body operators in occupation number representation, Co-ordinates of the Schrodinger Field. The Klein – Gordan Field, The Dirac Field, and the Electromagnetic Field.

5. Interacting Fields and Fynman's diagrams

Feynman Diagrams, Normal products, Dyson & Wick's chronological products, contraction Wick's Theorem, S-Matrix and the scattering processes of various orders.

Books Recommended

1. Quantum Mechanics : VK. Thankappan, Wiley Eastern Limited, 1986.
2. Quantum Mechanics ; E. Merzbacher, John Wiley & Sons, 1970.
3. Many-body Problems : G.E. Brown, North Holland Publ. 1972.
4. Many-body Theory and Diagram techniques : S. Muttack
5. Quantum Mechanics : B.S. Rajput, Pragati Prakashan
6. Quantum Mechanics : Schiff 3rd Ed.
7. Quantum Mechanics : Mathews & Venkatesan, Tata Mc-Graw Hill

Paper II

NUCLEAR PHYSICS AND PARTICLE PHYSICS

Note :- There shall be no sections in the paper

1. Basic properties of Atomic nucleus and Nuclear models

(i) Nuclear size and charge distribution, High energy electron scattering (Hofstadter method).

(ii) Electromagnetic moments – electric dipole moment, electrical quadrupole moment, magnetic moment, experimental determination of magnetic moment and electric quadrupole moment.

(iii) Angular momentum, parity and statistics of the nucleus.