# NIMS UNIVERSITY, JAIPUR

## SYLLABUS

# M. Sc. PHYSICS FINAL

# M. Sc PHYSICS FINAL

- **Paper-I** Advanced Quantum Mechanics and Introductory Quantum Field Theory
- **Paper II.** Nuclear Physics
- **Paper III** Statistical and Solid State Physics
- **Paper-IV** (A) Microwave Electronics.

  **OR**
- **Paper-V** (B) Condensed Matter Physics

- **List of Experiments for M.Sc. Final**

**LIST OF EXPERIMENTS FOR M.Sc. PREVIOUS**

**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 | 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 cut of 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 amplifies 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 frequency and study its wave shape
7. To Study the Characteristics of FET 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 of a UJT and use it to design a relaxation oscillator and measure its frequency.
10. To study the addition ,Integration and differentation properties of an operational amplifier.
11. Determine Plack constant and work function by a photo-cell.
12. To determine Plack constant and work function by a pjoto-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 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 to I.
21. Study of CH Bands

22. Salt Analysis/ Raman effect (Atomic)
23. Design and study of pass filters
24. Michelson Interferometer
25. Fabry patot Interferometer
26. Determination of velocity of Ultrasonic waves.
27. Study of Eliptically polarised light by babinet Compensator.
28. Verification of Cauchey's Dispersion relation.
29. Study of DC gate control Characteristics and Anode current characteristics of SCR

# PAPER -I

# ADVANCED QUANTUM MECHANICS AND INTRODUCTORY QUANTUM FIELD THEORY

**Max.Marks :100** **Duration: 3hrs.**

**Note:** Five questions are to be set taking one from each unit (each question will have an internal choice).Student will attempt all the five questions. 40% weightage will be given to problems and numericals.

**UNIT - I**

**Scattering (non-relativistic):** Differentialand 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 dependance and resonance scattering. Breit-Wigner 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, Coulombscatteringproblem under first Born approximation in elastic scattering.
**Relativistic Formulation and Dirac Equation:** Attempt for relativistic formulation of quantum theory, The Klein-Gordon equation, Probability density and probabilitycurrentdensity,solution of free particle KG equation in momentum representation, interpretation of negative probability density and negative energy solutions.

**UNIT - II**

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.
**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,Billinear covariants, and their transfonnations behaviour underLorentz transfonnation, 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, Zitter bewegung, Klain paradox.

**UNIT - III**

**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.

**UNIT - IV**

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

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

**UNIT - V**

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.
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. Merzbaker : Quantum Mechanics, Second Edition (John Wiley and sons)
3. Bjorken and Drell : Relativistic Quantum Mechanics (MGraw 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 Advance Quantum Theory, (Cambridge University Press).

# PAPER - II: NUCLEAR PHYSICS

**Max.Marks :100** **Duration: 3hrs.**

**Note:** Five questions are to be set taking one from each unit (each question will have an internal choice).Student will attempt all the five questions. 40% weightage will be given to problems and numericals.

**UNIT - I**

**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:Phenomemonological Hamada- Johnston hard core potential and Reid hard core and soft core potentials; Main features of the One boson Exchange Potentials (OBEP) no derivation.

**UNIT - II**

**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 deuteronusing a square wellpotential,range-depth relationship, excited states of deuteron, Discussion of the ground state of deutron under noncentral force, calculation of the electric quadrupole and magnetic dipole moments and the D-state admixture. **Experimental Techniques:** Gas filled counters; Scintillator counter, Cerenkov counters; Solid state detectors; Surface barrier detectors; Electronic circuits used with typical nuclear detectors; Multiwire proportion chambers; Nuclear emulsions, techniques of measurement and analysis of tracks; Proton synchrotron; Linear accelerations; Acceleration of heavy ions.

**UNIT - III**

**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. **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.

**UNIT - IV**

**Interaction of radiation and charged particle with matter (No derivation):** Law of absorptionand 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, Bremstrahlung; energy target and projectile dependence of all three processes, Range-energy curves; Straggling. .

**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) Short comings of PWBA nuclear structure studies with deutron stripping (d,p) reactions.

**UNIT - V**

**Nuclear gamma and beta decay:** Electric and magnetic multipole moments and gamma decay probabilities in nuclear system (no derivations), Reduced transition probability, Selection mles; fu.ternal 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 Gammaw-Teler) 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.

**ReferenceBooks :**

1.J. M Blatt and V.E. Weisskipf: 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 Structlire, Affiliated East-West Press, 1982).
6. RR Roy and B.P.Nigam, Nuclear Pbysics, 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 PeYsic~,Addition-Wesley, 1970
12. W.E.Burcham- Elementsof NuclearPhysics,ELBS, Longman, 1988
13. B.L. Cohen - Concpt 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:** Five question are to be set taking one from each unit(each question will have an internal choice).Student will attempt all the five questions. 40% weightage will be given to problems and numericals.

### UNIT - I

**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 thermodyanic 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.

### UNIT - II

**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 fimction 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 ofhannonic oscillator and creation and annihilation of Phonon operators, quantization of fermion operators.

### UNIT - III

**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.

**Semiconductors:** law of mass action, calculation of impurity conductivity,ellipsoidal energy surfaces in Si and Ge, Hall effect, recombination mechanism, optical transitions and Schockely-Read theory excitons, photoconductivity, photo-Luminescence.Points line, planar and bulk defects, colour centres, F-centre and aggregate centresin alkali halides.

### UNIT - IV

**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 thennal conductivity and electrical conductivity,

Widemann -Franz ratio, susceptibility, width of conduction band, Drude theory of light, absorption in metals.

**Lattice Vibratuibs and Thermal Properties:** Interrelations between elastic constants C11, C12 and C44 wave propagation and exparimental determination of elastic constant of cubic crystal, vibrations of linearmono and diatomic lattices, Detennipation of phonon dispersion by inelastic scattering of neutrons.

**UNIT - V**

**Magnetism:** Larmor diamagnetism.Paramagnetism,Curie Langevin and Quantum theories. Susceptibility of rare earth and transition metals. Ferromagnetism: Domain theory, Veiss 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.

**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 Thermodynamical 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 Semi-conductor Physics.

## PAPER-VIII: (A) MICROWAVE ELECTRONICS

Max.Marks :100 Duration: 3hrs.

**Note:** Five question are to be set taking one from each unit(each question will have an internal choice).Student will attempt all the five questions. 40% weightage will be given to problems and numericals.

**UNIT - I**

1. Introduction to microwaves and its frequency spectrum, Application of microwaves.
**Wave guides:** (a) Rectangular wave guides: Wave Equation & its solutions,TE&TM modes.Dominan tmode 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 current & derivation of attenuation constant, Q of the wave guide.
**2. Resonators:** Resonant Modes of rectangular and cylindrical cavity resonators, Q of the cavity resonators, Excitation techniques, Introduction to Microstrip and Dielectric resonators, Frequency meter.

**UNIT - II**

**3. 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.
**4. Microwave Measurement:**
(a) Microwave Detectors: Power, Frequency, Attenuation, Impedance Using smith chart, VSWR, Reflectometer, Directivity, coupling using direction coupler.
(b) Complex permittivity of material & its measurement: definition of complex of Solids, liquids and powders using shift of minima method.

**UNIT - III**

**3. Microwave tubes:** Spacecharge spreadingof an electronbeam, 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.

**UNIT - IV**

**6.** (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 velley, 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.
**7.Parametric Amplifier:** Varactor, Equation of Capacitance in Linearly graded & abrupt p-njun.ction, Manely Rowe relations, parametric upconvertor and Negative resistance parametric amplifier,-use of circulator, Noise in parametric amplifiers.

**UNIT - V**

**8. Microwave Antennas:** Introduction to antenna parameters, Magnetic Currents, Electric and magne* current sheet, Field of Huygen's source, Radiation from a slot antenna, open end of a wave guide and Electromagnetic Horns. Prabolic reflectors, Lens antennas.
Radiation fields of Microstrip wave guide, Microstrip wave guide, Microstrip antenna calculations, Microstrip design formulas.

**9. 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, Ductpropagation.
(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 & 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 (Mc Graw 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, New York)
10.Microstrip Antennas by Bahl & Bhartiya (Artech House, Messachausetts)
11. Antenna Theory Analysis by C.A. Balanis Harper & Row. Pub. & Inc. New York.
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 (Addisen Westey pubblic company,).
15.Microwave Active Devices, Vacuoums by M.L. Sisodia new Age International New Delhi.
16. Semiconductors & Electronics device by A. BarIe vs (PHI, India).
17. Solid State physical electronics by A.Vanderziel, (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).
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.

## PAPER -VIII : CONDENSED MATTER PHYSICS

Max.Marks :100 Duration : 3hrs.

**Note: Note:** Five question are to be set taking one from each unit(each question will have an internal choice).Student will attempt all the five questions. 40% weightage will be given to problems and numericals.

### UNIT - I

**Simple liquids :** order-disorder theory, Lindemann theory of melting, cell and hole theories of liquids, communal entropy and free volume concept; molecular distribution function, two praticle distribution function and its relation with pair correlation function g(r); derivation of internal energy of liquid and equation of state.
**Structure factor** static struvture factor and its relation with the pair correlation function. Determination of structure factor by X-ray and neutron scattering, Inelastic neutron scattering and dynamic structure factor, spacetime correlation function and its relation with dynamic structure factor properties of space time correlation function. Langevin equation for Brownina motion and its modification. velocity autocorrelation function mean square displacement. Relation between velocity autocorrelation function and diffusion coefficient.

### UNIT - II

**Liquid metals :** Metallic interaction- kinetic energy, electrostatic exchange and correlation, pseudopotential formalism, diffraction model,structure factor, form factor for local and non local potential, energy eigen states, dielectric screening. Energy-wave number characteristics, calculation of phonon dispersion in liquids metals. Band structure energy in momentum and direct space , Ziman's resistivity formula.
**Quantum liquids :** Distiniction between classical and quantum liquids, criteria for freezing, phase diagram for $He^4$,He I and He II, Tisza's two fluid model, Entropy filter, Fountain effect Super fluid film vehicle, Viscosity and specific heat of $He^4$, first sound, second sound, third sound and fourth sound. Landau theory: Rotons and Phonons.

### UNIT - III

**Exotic solids :** Structure and symmetries of liquids, liquid crystals and amorphous solids. Aperiodic solids and quasicrystals; Fibonaccy sequence and Penrose lattice, their extension to quasi-srystal, synthesis and properties. Speial Carbon solids: fullerence and tubules; formation and characterization of fullerences and tubules. Carbon nanotube based electronic devices; method of synthesis of nanostructured materials: sel-gel, co-precipitation, effect of temperature on particle size; special experimental techniques for characterization of nanostructured materials: x-ray diffraction and XANES.

### UNIT - IV

**Phase transformation and alloys:** Equilibrium transformation of first and second order. Equilibrium diagrams phase rule, interpretation of phase diagrams. Substitutional solid soluation. Vegards's law intermediate phase, HumeRothery rules, interstitial phase (carbides, nitrides, hydrides, bordides). Marternsitic transitions.

**2. Disodered systems:** Disorder in condensed matter, substitutional, positional and topographical disorder, short and long-range order.Spinning, sputtering and ion-implantation techniques, glass formation ability, glass transition, nucleation and growth process. Anderson model for random system and electron localization, mobility edge, qualitative application of the idea of amorphous semiconductors and hopping conduction Metglasses, model for structure of metglasses of glassy systems.

**UNIT - V**

**Structure determination / characterization :** Basic theory of X-ray diffraction. Indexing of Debye- Scherer patterns friom powder samples, examples from some cubic, non-cubic and non-cubic symmetries. Netutron differaction-basic interactions cross-sections, scattering lengh and structure factor Mossbaure effect, hyperfine parameters-Isomer shift, quadruple splitting and Zeeman splitting. Application- Valance and coordination , site symmetry magnetic behaviour Discussion in context of $^{57}$Fe. Electronic Structure Determation: Basic principles of X-ray, photoemission and positron annihilation techniques Qualitative discussion and positron annihilation techniques. Qualitative discussion of experimental arrangement and typical result for both simple as well as transition metals.
**References:**


1. Egelstaff- An introduction to the liquid state (hapters 2-8).
2. Mc Donald and Hansen- Theory of Simple liquid (Chapters 3,5,8 and 9).
3. Faber - Theory of Liquid Metals.
4. N.H. March- Liquid Metals
5. D. Pines and P. Nozier- Theory of Quantum Liquids
6. W.A. Harrison - Pseudopotentional in the theory of metals.
7. March, Young and Saupenthe - Many body problem
8. March and Tosi - Atomic Motions in liquids
9. March, Tosi and Street-Amorphous solids and the liquid State.
10. Dug dale- Electrical Properties of Metals and Alloys.
11. M.Shimoji - Liquid Metals
12. P.I. Taylor - A Quantum approach to the solid State Prentice hall
13. L. Azaroff - Introduction to Solid State.
14. Srinivasan - Physics of Engineering Materials
15. Lecture Notes in Physics No. 283,Electrnic Band structure and its applications (Editor M. Yusouf (1987) Springer- Verlag).


**LIST OF EXPERIMENTS FOR M.Sc. FINAL**

**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. Todetermine 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 GMcounter and to study statistical nature of radioactive decay.
4. To study spectrum of -◎ particles using Gamma ray-spectrometer.
5. To calibrate a scintillation spectrometer and determine energy of ◎-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 ◎-rays and verify the energy shift formula

8. To .stud y temperature variation of resistivity or a semi-conductor and to obtain band gap using four probe method.
9. To study hall effect a:nd to det,erminehall 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. Todetermine ultrasonic velocity and to obtain compressibility for agiven 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:5mission 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 constaD.tof a gi yen solid (Teflon) for three different lengths by using slotted section.
18. Find the dielectric const.ant 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.