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PHYSICS

B.Sc.- THIRD YEAR

		Max. Marks
PAPER I	RELATIVITY AND STATISTICAL PHYSICS	75
PAPER II	SOLID STATE AND NUCLEAR PHYSICS	75
PAPER III	SOLID STATE ELECTRONICS	75
PRACTICAL	TWO PRACTICALS (50 MARKS) + VIVA (15 MARKS) + RECORD (10 MARKS)	75
TOTAL		300

Candidate must obtain minimum pass marks in Theory and Practical Examinations separately.

PAPER I - RELATIVITY AND STATISTICAL PHYSICS

UNIT-I

Relativity

Reference systems, inertial frames, Galilean invariance and conservation laws, propagation of light, Michelson-Morley experiment; search for ether.

Postulates for the special theory of relativity, Lorentz transformations, length contraction, time dilation, velocity addition theorem, variation of mass with velocity, mass-energy equivalence, particle with a zero rest mass.

UNIT -II

Statistical physics

The statistical basis of thermodynamics: Probability and thermodynamic probability, principle of equal a priori probabilities, probability distribution and its narrowing with increase in number of particles. The expressions for average properties. Constraints; accessible and inaccessible states, distribution of particles with a given total energy into a discrete set of energy states.

UNIT - III

Some universal laws: The  $ji$ -space representation, division of  $i$ -space into energy sheets and into phase cells of arbitrary size, applications to one-dimensional harmonic oscillator and free particles. Equilibrium between two systems in thermal contact, bridge with macroscopic physics. Probability and entropy, Boltzmann entropy relation. Statistical interpretation of second law of thermodynamics. Boltzmann canonical distribution law and its applications; rigorous form of equipartition of energy.

UNIT -IV

Maxwellian distribution of speeds in an ideal gas: Distribution of speeds and of velocities, experimental verification, distinction between mean, r.m.s. and most probable speed values. Doppler broadening of spectral lines.

Transition to quantum statistics: 'h' as a natural constant and its implications, cases of particle in a one-dimensional box and one-dimensional harmonic oscillator, Indistinguishability of particles and its consequences, Bose-Einstein, and Fermi-Dirac distributions, photons in black body chamber, free electrons in a metal, Fermi level and Fermi energy. ,

**Text and Reference Books**

- A. Beiser, "Concepts of Modern Physics" (McGraw-Hill).
- B B Laud, "Introduction to Statistical Mechanics" (Macmillan 1981).
- F Reif, "Statistical Physics" (McGraw-Hill 1988).
- K Haug, "Statistical Physics" (Wiley Eastern, 1988).

**PAPER II- SOLID STATE AND NUCLEAR PHYSICS**

**UNIT-I**

**Crystal Structure**

Lattice translation vectors and lattice, Symmetry operations, Basis and Crystal structure, Primitive Lattice cell, Two-dimensional lattice types, systems, Number of lattices, Point groups and plane groups, Three dimensional lattice types, Systems, Number of Lattices, Points groups and space groups. Index system for crystal planes Miller indices, Simple crystal structures, NaCl, hcp, diamond, Cubic ZnS; and hexagonal , Occurrence of Nonideal crystal structures, random stacking of polyprism, glasses.

**Crystal Diffraction and Reciprocal Lattice**

Incident beam, Bragg law, Experimental diffraction method, Laue method, Rotating crystal method, Powder method, Derivation of scattered 'wave amplitude, Fourier analysis, Reciprocal lattice vectors, Diffraction conditions, Ewald method, Brillion zones, Reciprocal lattice to sc, bcc and face lattices , Fourier analysis of the basis and atomic form factor.

## UNIT -II

### Crystal Bindings

Crystal of inert gases, Van der Waals-London interaction, repulsive interaction, Equilibrium lattice constants, Cohesive energy, compressibility and bulk modulus, ionic crystal, Madelung energy, evaluation of Madelung constant, Covalent crystals, Hydrogen-bonded crystals, Atomic radii.

### Lattice Vibrations

Lattice Heat capacity, Einstein model, Vibrations of monatomic lattice, derivation of dispersion relation, First Brillouin zone, group velocity, continuum limit, Force constants, Lattice with two atoms per primitive cell, derivation of dispersion relation, Acoustic and optical modes, Phonon momentum. Free electron theory, Fermi energy, density of states, Heat capacity of electron gas, Paramagnetic susceptibility of conduction electrons, Hall effect in metals. Origin of band theory, Qualitative idea of Bloch theorem, Kronig-Penney model, Number of orbitals in a band, conductor, Semi-conductor and insulators, Effective mass, Concept of holes.

## UNIT - III

### Nuclear Physics

#### 1. General Properties of Nucleus:

Brief survey of general Properties of the Nucleus, Mass defect and binding energy, charges, Size, Spin and Magnetic moment, Bainbridge mass spectrograph.

#### 2. Nuclear Forces:

Saturation phenomena and Exchange forces, Deuteron ground state properties.

#### 3. Nuclear Models:

Liquid drop model and Bethe Weiszacker mass formula, Single particle shell model (only the level scheme in the context of reproduction of magic numbers).

4 **Natural Radioactivity:**

Fundamental laws of radioactivity, Soddy-Fajan's displacement law and law of radioactive disintegration, Basic ideas about  $\alpha$ ,  $\beta$  and  $\gamma$  decay.

**UNIT-IV**

**1. Nuclear Reactions:**

Nuclear reactions and their conservation laws, Cross section of nuclear reactions, Theory of fission (Qualitative), Nuclear reactors and Nuclear fusion.

**2. Accelerators and detectors:**

Vande Graff, Cyclotron and Synchrotron, Interaction of charged particles and gamma rays with matter (qualitative), GM counter, Scintillation counter and neutron detectors.

**3. Elementary Particles:**

Basic classification based on rest mass, Spin and half life, particle interactions (gravitational, Electromagnetic, weak and strong Interactions).

**Text and Reference Books**

Pun and Babbar, "Solid State Physics" (S. Chand).

C. Kittel, "Introduction to Solid State Physics"- Vth Edition (John Wiley & Sons). H.S. Mani and G.K. Mehta, "Introduction to Modern Physics" (Affiliated East-West Press— 1989).

A. Beiser, "Perspectives of Modern Physics".

T.A. Littlefield and N. Thoreley, "Atomic and Nuclear Physics" (Engineering Language Book Society). Eisenberg and Resnik, "Quantum Mechanics of Atoms, Molecules, Solids, Nuclei and Particles" (John Wiley).

Ghoshal S.N.- Nuclear Physics - S. Chand & Co.

## UNIT-I

Diffusion of minority carriers in semiconductor, work function in metals and semiconductors, Junctions between metal and semiconductors, <sup>Junction between</sup> Semiconductor and semiconductor, p.n. Junction, Depletion layer, Junction Potential Width of depletion layer, Field and Capacitance of depletion layer, Forward A.C. and D.C. resistance of junction, Reverse Breakdown.

Zener and Avalanche diodes, Tunnel diodes, Point contact diode, their importance at High frequencies, LED photodiodes, Effect of temperature on Junction diode Thermistors.

## UNIT -II

Transistor <sup>R, B</sup> parameters, base width modulation, transit time and life-time of minority carriers, Base- Emitter resistance, Collector conductance, Base spreading resistance, Diffusion capacitance, Reverse feedback ratio, Equivalent circuit for transistors, Basic model, hybrid model and Y parameter equivalent circuit, Input and output impedances.

## UNIT III

Current and Voltage gain, Biasing formulae for transistors, Base bias, emitter bias and mixed type bias and mixed type biasing for small and large signal operation. Transistor circuit application at <sup>low</sup> frequencies, their AC and DC equivalent for three different modes of operation, Large signal operation of transistors, Transistor Power amplifiers, Class A and B operation, Maximum power output Effect of temperature, heat sinks, thermal resistance Distorsion in amplifiers, cascading of stages, Frequency response, Negative and positive feedback in transistor amplifiers.

## UNIT -IV

Field effect transistors and their characteristics, biasing of FET, use in preamplifiers, MOSFET and their simple uses.

**Power Supplies:**

Electronically regulated low and high voltage power supplies, Inverters for battery operated equipments.

**Miscellaneous;**

Basic linear integrated circuits, phototransistors, Silicon Controlled rectifiers, Injunction transistor and their simple uses.

**Text and Reference Books**

B G Streetman; "Solid State Electronic Devices", UK Edition (Prentice-Hall of India. New Delhi, 1986).

W D Stanley; "Electronic Devices, Circuits and Applications" (Prentice-Hall, New Jersey, USA. 1988).

J D Ryder; "Electronics Fundamentals and Applications" 1<sup>st</sup> Edition (Prentice-Hall of India. New Delhi, 1986). I Miliman and A Grabel; "Microelectronics", International. Edition (McGraw-Hill Book Company, New York, 1988).

**NOTE:**

This is a suggested list. Every institution may add any experiment of same standard in the same subject area.

**Statistical Physics**

1. Data from n-option systems of several relative weightages to be examined and interpreted.
2. Plotting F-D distribution in the neighbourhood of Fermi energy for different temperature values.
3. Solar wind as a thermal expansion of solar corona at one million Kelvin.
4. Study of dilute gas for experimental verification of Maxwell-Boltzman statistics.
5. Number of microscopic states of perfect gas (Gibbs-paradox).

**Solid State Physics**

1. Goniometric study of crystal faces.
2. Determination of dielectric constant.
3. Hysteresis curve of transformer core.
4. Hall-probe method for measurement of magnetic field

**Solid State Devices**

1. Specific resistance and energy gap of a semiconductor
2. Characteristics of a transistor
3. Characteristics of a tunnel diode

**Electronics**

1. Study of voltage regulation system
2. Study of, a regulated power supply
3. Study of Lissajous figures using a CRO
4. Study of VTVM



5. Study of RC and TC coupled amplifiers  
6. Study of AF and RF oscillators

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### **Nuclear Physics**

1. Study of absorption of alpha and beta rays.
2. Study of statistics in radioactive measurement.

### **Text and Reference Books**

B.G. Strechman, "Solid State Electronic Devices". II Edition (Prentice-Hall of India, New Delhi, 1986).

W.D. Stanley, "Electronic Devices, Circuits and Applications" (Prentice-Hall, New Jersey, USA, 1988).

D.P. Khandelwal, "A Laboratory Manual for Undergraduate Classes (Vani Publishing House, New Delhi). S.P. Singh, "Advanced Practical Physics" (Pragati Prakashan, Meerut).

### **Instructions for Paper Setting**

All questions carry equal marks.

**Section A:** One compulsory question with four parts. One part (numerical or short answer type) from each unit.

**Section B:** Two questions (long answer or numerical type) from each unit but only one question from each unit is to be attempted.