M.Sc. Physics SemesterII Paper X

Solid State Physics 22PHY22D1

Theory Marks: 80

Internal Assessment Marks: 20

Time: 3 Hours

COURSE OUTCOMES

The student will be expected to be able to:

CO1 Differentiate between different lattice types and explain the concept of reciprocal lattice and crystal diffraction using X-rays

CO2 Explain motion of electron in periodic lattice of solids under different binding conditions, concept of energy band and effect of same on electrical properties.

CO3 Lattice vibrations in solids and identity different types of defects in crystals

CO4 Explain various types of magnetic phenomena, superconductivity, Physics behind them and their possible applications.

Unit I

Crystalline solids, Lattice, The basis, Lattice translation vectors, Direct lattice, Two and three dimensional Bravais lattice, Conventional units cells of FCC, BCC, NaCl, CsCl, Diamond and cubic ZnS, Primitive lattice cell of FCC, BCC and HCP, Packing fraction: Simple Cubic, BCC, FCC, HCP and diamond structures, Interaction of x-rays with matter, Absorption of x-rays, elastic scattering from a perfect lattice, The reciprocal lattice and its application to diffraction techniques, Ewald's construction, The Laue, Powder and rotating crystal methods, Atomic form factor, Crystal structure factor and intensity of diffraction maxima, Crystal structure factors of BCC, FCC, monatomic diamond lattice, polyatomic CuZn.

Unit II

Vibration of one-dimensional mono and diatomic chains, Phonon momentum, Density of normal modes in one and three dimensions, Quantization of lattice vibrations, Measurement of phonon dispersion using inelastic neutron scattering, Point defects, Line defects and planer (stacking) faults, Fundamental ideas of the role of dislocation in plastic deformation and crystal growth, Observation of imperfection in crystals, X-rays and electron microscopic techniques.

Unit III

Electron in periodic lattice, Block theorem,Kronig-Penny model and band theory, Classification of solids, Effective mass, Weak-binding method and its application to linear lattice, Tight-binding method and its application to Simple cubic, BCC and FCC crystals, Concepts of holes, Fermi surface: Construction of Fermi surface in two-dimension, de Hass van Alfen effect, Cyclotron resonance, Magneto-resistance.

Unit IV

Weiss Theory of Ferromagnetism Heisenberg model and molecular field theory of ferromagnetism of spin waves and magnons, Curie-Weiss law for susceptibility. Ferriand Anti Ferro-magnetic order, Domains and Block wall energy, Occurrence of superconductivity, Meissner effect, Type-I and Type-II superconductors, Heat capacity, Energy gap, Isotope effect, London equation, Coherence length, Postulates of BCS theory of superconductivity, BCS ground state, Persistent current. High temperature oxide super conductors (introduction and discovery).

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. A student has to attempt five questions in all.

Text and Reference Books:

[1] Verma and Srivastava: Crystallography for Solid State Physics
[2] Azaroff: Introduction to Solids
[3] Omar: Elementary Solid State Physics
[4] Ashcroft&Mermin : Solid State Physics
[5] Kittel: Solid State Physics
[6] Chaikin and Lubensky: Principles of Condensed Matter Physics
[7] H. M. Rosenberg: The solid State.