Solid State Physics

Course Contents:

1. **Types and Structure of Crystals**: 1.1 Crystalline types of solid, amorphous and glassy, liquid state, 1.2 Lattice and lattice translational vector, 1.3 symmetry operations and space groups, basis and crystal structure, 1.4 Primitive lattice cell, 1.5 Fundamental types of lattices - two and three dimensional lattices, 1.6 Simple crystal structures- (i) simple, body-centered and face-centered cubic (ii) sodium chloride, (iii) hexagonal close-packed, (v) diamond structures, 1.7 Primitive unit cell,1.8 Wigner-Seitz cell [12 hours]

2. **Crystal Structure from Diffraction**: 2.1 Neutron and X-ray diffraction techniques for studying crystal structure, 2.2 Braggs law, 2.3 Laue method, 2.4 Brillouin zone: First Brillouin zone of (i) simple cubic, (ii) body centered cubic and (iii) face centered cubic lattices, 2.5 Lattice Planes and Miller indices, 2.6 reciprocal lattice- reciprocal lattice vectors, reciprocal lattice to simple cubic, body centered cubic and face centered cubic lattices; 2.7 Geometrical Structure Factor, 2.8 Atomic Form Factor [12 hours]

3. **Bonding in Crystals**: 3.1 Equilibrium lattice constant, 3.2 Different types of bonding (ionic, covalent, metallic, hydrogen) in crystals and lattice energy, 3.3 Bonding in Crystals of Inert gases [5 hours]

4. **Defects in Crystals**: 4.1 Lattice vacancies, colour-centers, alloy, slip, types of dislocations, 4.2 Burgers vector, 4.3 Dislocation and crystal growth [6 hours]

5. **Lattice Dynamics**: 5.1 Lattice vibration, 5.2 phonon spectrum, 5.3 lattice specific heat Dulong and Petits relation, Einstein theory, Debyes theory, 5.4 Thermal conductivity Thermal resistivity of phonon gas, 5.5 Umklapp processes [8 hours]

6. **Free Electron Theory**: 6.1 Free electron theory of metals, 6.2 density of states, 6.3 Fermi energy, 6.4 electron specific heat, relaxation time, mean free path, mobility, thermal conductivity, electrical conductivity, 6.5 Wiedmann-Franz law, 6.6 Hall effect [7 hours]

7. **Band Structure of Crystals**: 7.1 Bloch Functions, 7.2 Concept of energy bands in solids, 7.3 Energy bands in one dimension, 7.4 Energy-wave vector curves in three dimensions, 7.5 The tight binding method Linear combination atomic orbitals, applications to bands from s-levels, 7.6 Valence and conduction band, 7.7 distinction between conductor, insulator and semiconductor on the basis of band theory, 7.8 Fermi surfaces, 7.9 Number of orbitals in a band [12 hours]

8. **Semiconductors**: 8.1 Types of semiconductors (extrinsic and intrinsic) and carrier concentration, 8.2 Impurity conductivity- donor states, acceptor states, 8.3 Thermal ionization of donors and acceptors; Mobility [4 hours]

9. **Superconductivity**: 9.1 General properties of superconductors, 9.2 zero resistivity, 9.3 Critical temperature, Critical magnetic field, 9.4 Meissner effect, 9.5 Type I and type II Superconductors [7 hours]

10. **Dielectric properties**: 10.1 Dielectric constant and polarizability, 10.2 Electronic, ionic and orientational polarizabilities, 10.3 Electric Susceptibility, 10.4 Clausius Mosotti Equation [4 hours]

11. **Magnetism**: 11.1 Dia-, Para-, Ferri-,Antiferro- and Ferromagnetic Materials, 11.2 Classical Langevin Theory of dia and Paramagnetic Domains, 11.3 Quantum Mechanical Treatment of Paramagnetism, 11.4 Curies law, 11.5 Weisss Theory of Ferromagnetism and Ferromagnetic Domains [7 hours]

Text Books:

1. Kittel C. Introduction to Solid State Physics, 8th ed., John Wiley & Sons Ltd, India (2005)
2. Ashkroft N. L. W. and Mermin- Solid State Physics, Holt Rinehart and Winston, New York (1976)

Reference Books:

1. Murugeshan R. and Sivaprasad K. - Modern Physics, S. Chand & Co. Ltd. New Delhi, (2007)
2. Elliot R. J. & Gibson A. F. An Introduction to Solid state Physics and its Application, ELBS, Macmilan (1974)
3. Harrison W. A. Solid State Theory, Tata McGraw Hill, India (1977)
4. Dekker A. J. Solid State Physics, Macmillan, Students Edition (1991)
5. Luth H. and Ibach H. Solid State Physics, Narosa Publishing House, New Delhi (1991)