4. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
5. Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer.
6. Introductory Quantum Mechanics, R. L. Liboff; 4th Ed., Addison Wesley, 2003.
7. Quantum Mechanics: Concepts and Applications, 2nd Edition, Nouredine Zettili, A John Wiley and Sons, Ltd., Publication

References for Laboratory Work:
1. Schaum's outline of Programming with C++. J. Hubbard, 2000, McGraw- Hill Publication
2. An introduction to computational Physics, T. Pang, 2nd Edn.,2006, Cambridge Univ. Press
3. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer.
4. Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co.
5. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press.

CC-XII: Solid State Physics (32221502)
Credit : 06 (Theory-04, Practical-02)
Theory : 60 Hours
Practical : 60 Hours

Course Objective

This course introduces the basic concepts and principles required to understand the various properties exhibited by condensed matter, especially solids. It enables the students to appreciate how the interesting and wonderful properties exhibited by matter depend upon its atomic and molecular constituents. The gained knowledge helps to solve problems in solid state physics using relevant mathematical tools. It also communicates the importance of solid state physics in modern society.

Course Learning Outcomes

On successful completion of the module students should be able to
- Elucidate the concept of lattice, crystals and symmetry operations.
- Understand the elementary lattice dynamics and its influence on the properties of materials.

- Describe the main features of the physics of electrons in solids: origin of energy bands, and their influence electronic behavior.
- Explain the origin of dia-, para-, and ferro-magnetic properties of solids.
- Explain the origin of the dielectric properties exhibited by solids and the concept of polarizability.
- Understand the basics of phase transitions and the preliminary concept and experiments related to superconductivity in solid.
- In the laboratory students will carry out experiments based on the theory that they have learned to measure the magnetic susceptibility, dielectric constant, trace hysteresis loop. They will also employ to four probe methods to measure electrical conductivity and the hall set up to determine the hall coefficient of a semiconductor.

Unit 1

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis. Types of Lattices. Unit Cell, Symmetry and Symmetry Elements. Miller Indices. Reciprocal Lattice. Brillouin Zones. Diffraction of X-rays: single crystal and powder method. Bragg's Law, Laue Condition. Ewalds' construction. Atomic and Geometrical Factor. Simple numerical problem on SC, BCC, FCC.

(14 Lectures)

Unit 2

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law.

(10 Lectures)

Unit 3

Electrons in Solids: Electrons in metals- Introduction to Drude Model, Density of states (1-D, 2-D, 3-D) (basic idea), Elementary band theory: Kronig Penney model. Band Gap, direct and indirect bandgap. Effective mass, mobility, Hall Effect (Metal and Semiconductor).

(10 Lectures)

Unit 4

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Para- magnetism. Hunds's rule. Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Curie's law. B-H Curve. soft and hard material and Energy Loss Hysteresis.

(9 Lectures)

Unit 5

Dielectric Properties of Materials: Polarization. Local Electric Field in solids. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mossotti Equation. Classical Theory of Electric Polarizability. AC polarizability, Normal and Anomalous Dispersion. Complex Dielectric Constant. Langevin-Debye equation.

(9 Lectures)

Unit 6

Introduction to basics of phase transitions: Landau theory for ferromagnetic materials (No derivation).

(3 Lectures)

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation).

(5 Lectures)

Practical : 60 Hours

Sessions on the construction and use of specific measurement instruments and experimental apparatuses used in the solid state physics lab, including necessary precautions.

Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors. Application to the specific experiments done in the lab.

At least 06 experiments from the following:

1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method).
2. To measure the Magnetic susceptibility of solids.
3. To determine the Coupling Coefficient of a piezoelectric crystal.
4. To study the dielectric response of materials with frequency.
5. To determine the complex dielectric constant and plasma frequency of a metal using Surface Plasmon Resonance (SPR) technique.
6. To determine the refractive index of a dielectric material using SPR technique.
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of Iron (Fe) using solenoid & determine the energy loss from Hysteresis loop.
9. To measure the resistivity of a semiconductor (Ge) with temperature (up to 150^0C) by four-probe method and determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.
11. Analysis of X-Ray diffraction data in terms of unit cell parameters and estimation of particle size.
12. Measurement of change in resistance of a semiconductor with magnetic field.

References for Theory:

Essential Readings:

1. Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.
3. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
4. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.
5. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer.

Additional Readings

1. Elementary Solid State Physics, M.Ali Omar, 2006, Pearson
2. Solid State Physics, Rita John, 2014, McGraw Hill

3. Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

References for Practical:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India
4. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press
5. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.

CC-XIII: Electromagnetic Theory (32221601)
Credit : 06 (Theory-04, Practical-02)
Theory : 60 Hours
Practical : 60 Hours

Course Objective

This core course develops further the concepts learnt in the electricity and magnetism course to understand the properties of electromagnetic waves in vacuum and different media.

Course Learning Outcomes

At the end of this course the student will be able to:

- Apply Maxwell's equations to deduce wave equation, electromagnetic field energy, momentum and angular momentum density.
- Understand electromagnetic wave propagation in unbounded media: Vacuum, dielectric medium, conducting medium, plasma.
- Understand electromagnetic wave propagation in bounded media: reflection and transmission coefficients at plane interface in bounded media.
- Understand polarization of Electromagnetic Waves: Linear, Circular and Elliptical Polarization. Production as well as detection of waves in laboratory.
- Learn the features of planar optical wave guide.
- Understand the fundamentals of propagation of electromagnetic waves through optical fibres.