MINOR COURSE-MN1C	Solid State Physics	(Theory Credit -03) (Total Marks=60+15)

Course Objective:

1. To introduce the basic concepts of solid-state physics, including the different types of materials, their structures, and properties.
2. To develop an understanding of crystal structures, including unit cells, Miller indices, and the diffraction of X-rays.
3. To introduce elementary band theory and its application to conductors, semiconductors, and insulators.
4. To study the magnetic properties of materials, with an emphasis on the classical and quantum mechanical treatment of paramagnetism and ferromagnetism.
5. To explore the dielectric properties of materials and their relationship with electric fields, polarization, and susceptibility.
6. To understand the phenomena of superconductivity, including critical temperatures, magnetic fields, and the Meissner effect, along with an introduction to the BCS theory.

Course Outcomes:

Upon successful completion of the course, students will be able to:

1. Identify and describe the different types of crystal structures and lattices, and apply Miller indices and Bragg's Law to analyze diffraction patterns.
2. Understand and explain the principles of elementary band theory and distinguish between conductors, semiconductors, and insulators.
3. Analyze the electrical properties of semiconductors, including the Hall effect and conductivity, and relate them to material properties.
4. Explain the magnetic behavior of materials, distinguishing between dia-, para-, ferri-, and ferromagnetic materials, and understand the classical and quantum treatments of magnetism.
5. Apply the concepts of dielectric properties to solve problems related to electric polarization, susceptibility, and the Clausius-Mossotti equation.
6. Understand and explain the phenomenon of superconductivity, including the Meissner effect, type I and type II superconductors, and an introduction to BCS theory.

Course Contents:

Crystal Structure (12 HRS): Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.

Elementary band theory (08 HRS): Periodic potential and Bloch theorem. Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient.

Magnetic Properties of Matter (10 HRS): Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

Dielectric Properties of Materials (10 HRS): Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant.

Superconductivity (05 HRS): Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Super-conductorsIdea of BCS theory (No derivation).

Reference Books:

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. Introduction to Solid State Physics, Arun Kumar, PHI
3. Elements of Solid State Physics, J.P. Srivastava, 4th Edition, 2015, Prentice-Hall of India
4. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
5. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
6. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
7. Solid State Physics, Rita John, 2014, McGraw Hill
8. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
9. Solid State Physics, M.A. Wahab, 2011, Narosa Publications

MINOR COURSE-MN1C	Solid State Physics	(Practical Credit-01) (Total Marks=25)

1. Measurement of resistivity using linear four probe and Van der Paw method.
2. Calibration of Lock-in- Amplifier and Measurement of small resistance using Lock – in Amplifier.
3. Measurement of magnetic susceptibility of a solid using phase sensitive detection.
4. Measurement of Dielectric Constant of a dielectric Materials with frequency
5. Determination of the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6. Determination of refractive index of a dielectric layer using SPR
7. Study of PE Hysteresis loop of a Ferroelectric Crystal.
8. BH curve of Fe using Solenoid determine energy loss from Hysteresis
9. Measurement of resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 o C) and to determine its band gap.
10. Determination of Hall coefficient of a semiconductor sample.

Reference books

1. Practical Physics – G.L. Squires
2. Advanced Practical Physics for Students – B.L. Worsnop & H.T. Flint
3. Experimental Solid State Physics – R. Srivastava