PPH201 CONDENSED MATTER PHYSICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To study some of the basic properties of the condensed phase of matter especially solids.

Crystal Structure: Fundamental types of lattices-two and three dimensional lattice types, SC, BCC and FCC unit cells, Miller indices, Diffraction of x-rays by crystals, Scattered wave amplitude-Fourier analysis, Reciprocal lattice vectors, Diffraction conditions, Laue equations, Brillouin Interpretation, Structure factor and Atomic form factors.

Electrical Conductivity and Free Electron Fermi gas: Drude theory, DC conductivity, Hall effect and magneto-resistance, AC conductivity, thermal conductivity, Fermi-Dirac distribution, Free electron gas in three dimension, thermal properties of an electron gas, Wiedemann-Franz law.

Lattice Vibrations and Thermal Properties: Vibration of lattice with monoatomic and diatomic basis: Dispersion relation, optical and acoustical branches. Quantization of elastic waves: Phonon, Classical theory of Specific heat. Average energy of harmonic oscillator, Phonon Density of states. Einstein and Debye models of specific heat. Electronic contribution to specific heat. Anharmonic effect: thermal expansion, Phonon collision process, Thermal conductivity.

Concept of Energy Band: Nearly free electron model and origin of energy gap, magnitude of gap, Bloch function, Kronig-Penny model, Wave equation of electron in periodic potential, Bloch theorem and crystal momentum, Classification of metal, insulator and semiconductors.

Dielectrics: Dielectric properties of insulators, Types of polarizations, Local field, Claussius-Mossotti equation, Dielectric constant and loss.

Magnetism: Types of magnetism, Susceptibility, Permeability and their relation. Diamagnetism: Langevin Quantum theory of Diamagnetism. Paramagnetism: Quantum Theory, Paramagnetism of rare earth and iron group ions, Crystal field Splitting and quenching of orbital angular momentum. Paramagnetism of conduction electrons**.** Ferromagnetism, Ferrimagnetism and Antiferromagnetism: Curie point and exchange integral, saturation magnetization. Ferromagnetic Domains and their origin.

Superconductivity: Superconductivity, critical temperature, Meissner effect, Destruction of superconductivity by magnetic field, Type I and type II superconductors, Isotope effect, energy gap, London equation, London penetration depth, BCS theory of superconductivity, Coherence length.

Course learning outcomes: Students will have achieved the ability to:

1. differentiate between different Lattice types and explain the concepts of reciprocal lattice and crystal diffraction.
2. predict electrical and thermal properties of solids and explain their origin.
3. explain the concept of energy bands and effect of the same on electrical properties.
4. describe the dielectric properties of insulators.
5. explain various types of magnetic phenomenon, physics behind them, their

properties and applications.

6. explain superconductivity, its properties, important parameters related to possible applications.

Recommended Books

1. *Kittel, C., Introduction to Solid State Physics, John Willey, (2007).*
2. *Omar, M.A., ElementarySolid State Physics, Pearson Education, (1999).*
3. *Srivastava, J.P., Elements of Solid State Physics, Prentice Hall of India, (2008).*
4. *Ashcroft, N.W. and Mermin, N.D., Solid State Physics, Cengage Learning, (2008).*
5. *Dekker, A.J., Solid State Physics, Macmillan, (2003).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25