Details of Course

Course Title	Course Structure			Pre-Requisite
Condensed Matter Physics - B.Tech. (EP), 4th Sem Lesson Plan	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objective:
The course provides a valuable theoretical introduction, principles, techniques and an overview of the fundamental applications of the physics of solids/materials.

Course Outcomes (CO)

Students will be able to

1. Understand the significance and value of condensed matter physics scientifically and the underlying physics of solid-state materials
2. Enable students with knowledge of lattices and describe the crystallographic structural properties of materials and their analysis for engineering and technological applications.
3. Describe various electronic theories of the electronic structure of materials with the knowledge of energy band structures of solids.
4. Equip the students with fundamentals, theory and analysis of dielectric and magnetic materials in engineering and technology for social applications.
5. Impart theoretical knowledge, principles and applications of advanced materials in science, engineering and technology, which are useful to contribute for materials innovation.

S. No.	Content	Contact Hours
Unit 1	**Crystal Structure and bonding:** Introduction to crystal physics, Bravais lattices, Simple crystal structures, Miller indices, Interplanar spacing, Symmetry operations, X-ray diffraction, Reciprocal lattice, Brillouin zones, Ionic bonding, Bond dissociation energy, Madelung constant of ionic crystals, Covalent, Metallic and Intermolecular bonds, Defects in crystals: Point and line defects.	10
Unit 2	**Lattice Vibrations:** Vibration of one-dimensional monoatomic and diatomic lattices, Acoustic and optical modes; Dispersion relation, Thermal properties of solids: Einstein and Debye models; Phonons and quantization; thermal conductivity of metals and insulators.	6
Unit 3	**Free Electron Theory:** Free electron theory of metals; Drude-Lorenz's theory, Electronic motion in a one and three-dimensional potential well; Brief review of Fermi-Dirac statistics, Effect of temperature on Fermi distribution function, Fermi level, Electrical conductivity of metals, Density of states, Total energy, Wave equation in a periodic potential and Bloch theorem; Kronig-Penny model; Construction of Brillouin zones, Band theory, Distinction between metal, semiconductor and insulators.	8

Unit 4	**Dielectrics & Magnetism:** Dielectric polarization, Dielectric constant, Polarization mechanism and types: Electronic, Ionic, Orientation/ dipolar and Space charge polarizations, Local Field, Clausius Mossoti equation, Ferroelectric, Piezoelectric and Pyroelectric materials, Applications of dielectric materials. The concept of magnetism, Permeability and susceptibility, Classification of dia-, para-, ferro-, antiferro and ferrimagnetism (Ferrites), Hysteresis, Soft and Hard magnetic materials, Ferromagnetic materials, Applications of magnetic materials.	8
Unit 5	**Superconductivity:** Introduction and historical developments; Meissner effect and its contradiction to the Maxwell's equation; Effect of magnetic field, Type-I and Type-II superconductors, Critical parameters, Thermal properties, energy gap, Isotope effect, London equations, Penetration depth, Coherence length, BCS theory, Cooper pair, ground state, Josephson effect and tunnelling, Applications of superconductors.	10
	Total	**42**

Suggested Books:

S. No.	Name of Books/ Authors	Year of publication/ Reprint
1.	Elementary Solid State Physics, by M. A. Omar	2002/ Pearson India
2.	Introduction to Solid State Physics, 8th edition, by C. Kittel	2012/ Wiley
3.	Solid State Physics, by A. J. Dekker	1986/ Macmillan
4.	Solid State Physics, N. W. Ashcroft and N. D. Mermin	1976/ HBC Publication
5.	Solid State Physics, 10th Edition, by S. O. Pillai	2023/ New Age International (P) Ltd., Publishers
6.	Material Science and Engineering: An Introduction By W. D. Callister Junior, David G. Rethwisch	2018/ John Wiley & Sons, Inc

List of Experiments for Condensed Matter Physics Lab

1. To demonstrate the I-V and P-V characteristics of series and parallel combination of PV modules.
2. To show the effect of variation in tilt angle on PV module power.
3. To determine the Curie temperature of the ferrite core and find out the loss in energy.
4. To determine the dielectric constant of three dices of plywood, glass and PZT samples.
5. To determine the coercively and retentivity of ferroelectric material using a PE loop Tracer.
6. To determine the heat capacity of solids.
7. To investigate the Lattice dynamic for mono-atomic and diatomic chains.
8. To determine the conductivity of glass by the method of Lees and Charlton.
9. To determine the coefficient of thermal conductivity of copper by using Searle's apparatus.
10. To determine the value of Mechanical Equivalent of heat with Callender and Barne's Continuous flow Calorimeter.