LESSON PLAN

Subject code: **EP-202** Course title: **Condensed Matter Physics**

Unit	Detailed Syllabus to be covered for Mid and End Semester Examinations
1.	**Crystal structure and bonding:** ➢ Crystalline and Amorphous solids ➢ Lattice points and Space lattice ➢ Basis and Crystal structure ➢ Unit cell, Primitive and non-primitive cell, Wigner-Seitz cell ➢ Crystal systems and Bravais lattices ➢ Symmetry operations ➢ Point and Space groups ➢ Crystallographic points, Directions and Planes ➢ Miller indices, Interplanar spacings ➢ Simple crystal structures: Simple Cubic, BCC, FCC ➢ Relation between the density of crystal material and lattice constant in a cubic crystal ➢ Crystal structures: NaCl and CsCl ➢ Diffraction conditions, Bragg's law, Correction for Bragg's equation ➢ X-ray diffraction methods: Powder Method, Rotating Crystal Method, Laue's Method ➢ Review of Reciprocal Lattice ➢ Vector algebraic discussion- Relation between fundamental reciprocal lattice vectors (a*, b* and c*) and primitive translation vectors of the direct lattice (a, b and c), ➢ Properties of reciprocal lattice vector (i.e. $\sigma_{hkl} \perp (h\ k\ l)$; $\lvert\sigma_{hkl}\rvert = 1/d_{hkl}$) ➢ Reciprocal Lattice to SC, BCC and FCC lattice ➢ Properties of Reciprocal lattice and proofs ➢ Construction of Brillouin Zones for simple square lattice, BCC and FCC lattices ➢ Types of bonding: ionic, covalent, metallic, van der waals and hydrogen bond ➢ Bond dissociation energy of NaCl molecule ➢ Calculation of lattice and Cohesive energy of Ionic crystals ➢ Calculation of Madelung constant of Ionic crystals ➢ Point defects: Interstitial, Vacancy, Schottky defect, Frenkel defect, Impurities ➢ To determine the concentration of Schottky, Frenkel defects ➢ Expression to calculate the number of vacancies at a given temperature ➢ Line defects: Edge dislocation and Screw dislocation, Burger's vector and circuit
2.	**Free Electron Theory:** ➢ Drude-Lorentz's theory, Main drawbacks of this theory, Review of Sommerfeld theory ➢ Electronic motion in one- and three-dimensional box, quantum state and degeneracy ➢ Brief Review of Fermi-Dirac statistics, Effect of temperature on Fermi distribution function, Fermi level ➢ Conduction by free electrons: Electrical conductivity of Metals ➢ Density of states, Fermi Energy, Total energy, Mean or Average energy ➢ Bloch's theorem ➢ Kronig-Penny model ➢ Origin of Energy bands, Construction of Brillouin Zones ➢ Energy Band formation in solids ➢ Bands in solids and classification of solids on the basis of band theory, ➢ Distinction between metal, semiconductor and insulators.

3.	**Dielectrics:** ➢ Dielectric Polarization, Polarizability, Dielectric Constant ➢ Different types of polarization: Electronic, Ionic, Orientation and Space charge polarization ➢ Local Field, Clausius-Mossoti equation ➢ Ferroelectric materials ➢ Piezoelectric and pyroelectric materials ➢ Applications of Dielectric Materials
4.	**Magnetism:** ➢ Concept of Magnetism, Permeability and susceptibility ➢ Classification of dia, para, ferro, antiferro and ferrimagnetism, Ferrites, ➢ Hysteresis, Soft and Hard Magnetic Materials ➢ Langevin's theory of Diamagnetism & Paramagnetism ➢ Weiss theory of Paramagnetism & Ferromagnetism (Weiss molecular field theory) ➢ Ferromagnetic Materials, Origin of internal field and exchange interaction ➢ Domain theory and Bloch wall (Exchange, Magnetostatic, Anisotropy, Domain wall/ Bloch wall and Magnetostrictive energy) ➢ GMR and other Applications of Magnetic materials
5.	**Superconductivity:** ➢ Introduction, Zero resistance 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 (Entropy, Specific heat), Origin of Energy gap ➢ Isotope effect ➢ London equations, Penetration depth and Coherence length ➢ BCS theory, Cooper Pair, Ground state ➢ Josephson effect and tunneling, Flux quantization ➢ High T_c- superconductors ➢ Applications of Superconductors

S. No.	Name of Books/ Authors	Year of publication/Reprint
1.	Introduction to Solid State Physics by C. Kittel	1996/ John Wiley
2.	Elements of Solid State Physics by J.P. Srivastava	2015/PHI
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.	Materials Science and Engineering by V. Raghavan	2009/PHI Learning
6.	Material Science and engineering: An Introduction by W. D. Callister Junior	2003/ John Wiley & Sons, Inc
7.	Solid State Physics by S.O. Pillai	Wiley Eastern Ltd, 1994