Course 6: Condensed Matter Physics
Course code: MSCPH506 Credit: 3

BLOCK 1 CRYSTAL STRUCTURE

Unit –1: **Crystal Structure:** Unit and primitive cells, Wigner-Seitz cell, symmetry operations, Bravais lattices, basis,crystal class, two dimensional and three dimensional lattice, NaCl and CsCl structure, crystals of alkali and noble metals, close-packed structure, diamond structure, cubic ZnS structure, occurrence of non ideal crystals.

Unit –2: **Crystal diffraction**: Bragg law, experimental diffraction methods, Laue, rotating crystal and powder method, Reciprocal lattice vectors, diffraction conditions, Brillouin zone, Reciprocal lattice of sc, bcc, fcc

Unit –3: **Crystal binding**: Crystal binding, crystal of inert gases, Van der Waals interaction, repulsive interaction, cohesive energy, ionic bonding, Madelung constant, covalent crystal, metallic bonding

Unit –4: **Imperfection in crystals:** Lattice vacancies, Frenkel defects, Schotty vacancies, colour centers, F-center, other centers in alkali halides, Dislocations, grain boundaries

BLOCK 2 CRYSTAL VIBRATIONS AND BAND THEORY

Unit –5: **Crystal vibrations:** Mono-atomic and diatomic linear chain vibrations, Phonon dispersion relations, elastic and inelastic scattering by phonon, phonon momentum, quantisation of elastic waves

Unit –6: **Thermal properties of Solids:** Thermal properties, phonon heat capacity, density of states, Einstein theory of specific heat, Debye theory, Anharmonic crystal interactions, thermal conductivity. Thermal resistivity of phonon gas.

Unit –7: **Free electron theory**: Free electron theory, Fermi-Dirac distributions and effect of temperature, heat capacity of electron gas, electrical and thermal conductivity of metals, Hall effect.

Unit –8: **Band Theory of Solids:** Energy bands, nearly free electron model, Bloch function, Kronig-penny model, wave equation of electron in a periodic potential, metals and insulators.

Unit –9: **Semiconductor Solids**: Semiconductor crystal, band gap, equation of motion, effective mass, intrinsic carrier concentration, intrinsic mobility, thermoelectric effects, Peltier coefficient.

BLOCK 3 DIELECTRICS, MAGNETISM & SUPERCONDUCTIVITY

Unit –10: **Dielectrics:** Polarisation, macroscopic electric field, dielectric susceptibility, polarizability, Clausius-Mossotti relation, feroelectrics Antiferroelectricity, Piezoelectricity

Unit –11: **Plasma optics:** Dielectric function of electron gas, plasma optics and plasma frequency, Plasmons, electrostatic screening, polaritons and LST relation, electron- electron interaction, Polarons

Unit –12: **Diamagnetism and Paramagnetism:** quantum theory of Paramagnetism,
Magnetic susceptibility, Langevin Diamagnetism equation, quantum theory of Diamagnetism, Paramagnetism, quantum theory of Paramagnetism,

Unit– 13: **Ferromagnetism:** Ferromagnetism, Curie- Weiss law, Magnons, quantisation of spin wave, Ferromagnetic domains, nuclear magnetic resonance, electron paramagnetic resonance

Unit –14: **Superconductivity:** Occurrence, Meissner Effect, heat capacity, energy gap, Type 1and Type 2 Superconductors, London Equation, London penetration depth, BCS theory of superconductivity, Josephson tunnelling.

Reference Books:

1. C. Kittel, Introduction to Solid State Physics, 7th Edition, Wiley, New York.
2. M. Ali Omar, Elementary Solid State Physics-Principles and Applications, Addison-Wesley, London.
3. H.P. Myers, Introductory Solid State Physics, 2nd Edition, Viva Book, New Delhi.
4. S.O. Pillai, Solid State Physics, New Age International, New Delhi