**PH 503: Condensed Matter Physics (3-1-0:4)**

**Crystal Structure**

Space lattice and unit cells, crystal system, symmetry operation, point groups and space groups, plane lattices and their symmetries. Miller Indices, representation of directions and planes, packing fractions, simple crystal structures. X-ray diffraction by crystals. Laue theory, interpretation of Laue equations, Bragg’s law, reciprocal lattice. Ewald construction, atomic scattering factor. Brief discussion on neutron and electron diffraction. **[6L+3T]**

**Phonon and Lattice Vibrations**

Vibrations of one-dimensional monatomic and diatomic lattices. Infrared absorption in ionic crystals (one-dimensional model). Normal modes and phonons. Frequency distribution function. Review of Debye’s theory of lattice specific heat. Anharmonic effects. **[6L+2T]**

**Free Electron Theory and Energy Bands**

Energy level in one dimension,free electron gas in three dimension, heat capacity of the electron gas, Drude model, electron transport, Hall effect, thermal conductivity of metals. Nearly free electron model, Bloch function, Kronig- Penney Model, wave equation of electron in a periodic potential, number of orbitals in a band. **[6L+2T]**

**Semiconductor**

Formation of bands, band gap, intrinsic carrier concentration, concept of a hole, impurity conductivity, Fermi level, direct and indirect band gap, p-n junction, drift current, diffusion current.

**[6L+2T]**

**Magnetic Properties of Solids**

Diamagnetism, Langevin equation. Quantum theory of paramagnetism. Curie law. Hund's rules. Paramagnetism in rare earth and iron group ions. Ferromagnetism. Curie-Weiss law. Heisenberg exchange interaction. Mean field theory. Nuclear magnetic resonance.   **[6L+2T]**

**Superconductivity**

Meissner effect, Flux quantization, London’s equation, Type I and Type II Superconductors, Outline of BCS theory, Josephson Junction, SQUIDS. **[6L+1T]**

**Textbooks and References**

1. N. W. Ashcroft and N. Mermin, “Solid State Physics”, Brooks.
2. C. Kittel, “Introduction to Solid State Physics”, Wiley.
3. A. J. Dekkar, “Solid State Physics” Macmillan & Co Ltd.
4. J. R. Christman, “Fundamentals of Solid State Physics”, John Wiley & Sons.
5. B. Di Bartolo and B. College, “Crystal Symmetry, Lattice Vibrations and Optical Spectroscopy of Solids: A Group Theoretical Approach”, World Scientific.
6. C. A. Wert and R. M. Thomson, “Physics of Solids”, McGraw-Hill Book Company.
7. J. P. Srivastava, “Elements of Solid State Physics”, Prentice Hall India.