

Course Name : Condensed Matter Physics

Course Number : PH 523

Credits : 3-0-0-3

Prerequisites : Quantum Mechanics-I and faculty consent.

Intended for : I-Ph.D., M.Sc., B.Tech 3rd and 4th Year

Distribution : Core for I-PhD (Physics) and Elective for others

Semester : Even

Preamble: A basic understanding of solids is important for practicing physicists as well as for many other related disciplines. The course is an introduction to the physics of the solid state matter.

Course Outline: The course emphasizes the large-scale properties of solid materials resulting from their atomic-scale properties. This course provides a basic understanding of what makes solids behave the way they do, how they are studied, and the basic interactions which are important.

Modules:

1. **Introduction:** Crystal Structures, Reciprocal Lattice, Brillouin Zones, X-ray diffraction and Structure factor, Defects in Crystal structures [5]
2. **Lattice Vibrations and Phonons:** Monoatomic and Diatomic basis, Quantization of elastic waves, Phonon momentum and Phonon density of states, Einstein and Debye model of heat capacity, Thermal properties of solids. [6]
3. **Electrons in Solids:** Drude and Sommerfeld theories, Fermi momentum and energy, Fermi surface, Density of states, Electrical conductivity, Ohm's law, Motion in a magnetic field, Hall Effect, Bloch Theorem and crystal momentum, Electron motion in Solids, Kronig-Penning Model, Formation of band, Effective mass [8]
4. **Semiconductors:** Intrinsic and extrinsic semiconductors, Acceptor and donor level, Bound State and optical transitions in semiconductors. Degenerate and non-degenerate semiconductor, Optical properties of solids. [6]
5. **Magnetism:** Introduction, Origin of magnetism, Bohr-Van Leeuwen theorem, Types of magnetism: Diamagnetism, Paramagnetism, Ferro and Anti-ferro magnetism [7]

6. **Superconductivity:** Basic phenomena, Meissner effect, Types of superconductors, London equation, Idea of Cooper pair, Flux quantization, Josephson's tunneling [8]

Textbooks:

1. Introduction to Solid State Physics by C. Kittel, 8th Edition, John Wiley & Sons, Inc, 2005.
2. Solid State Physics by N. W. Ashcroft and N. D. Mermin.
3. Condensed Matter Physics by M. P. Marder, (John Wiley & Sons, 2010)

References:

1. Advanced Solid State Physics by Phillips. (Cambridge University Press, 2012).
2. Solid State Physics, Hook and Hall, Wiley Science
3. Physics of Semiconductor Devices, S. M. Sze.