BACHELORS WITH PHYSICS AS MAJOR
7th SEMESTER

PHY722J1 PHYSICS _ SOLID STATE PHYSICS

CREDITS: THEORY – 3, PRACTICAL: 1

THEORY (3 CREDITS: 45 HOURS)

COURSE LEARNING OUTCOMES:

The learning outcomes cover a wide range of topics related to crystal structures, electronic properties of materials, and the operation of semiconductor devices, providing a comprehensive understanding of the subject matter.

1. *Explain X-ray diffraction and Bragg's law.*
2. *Comprehend the concept of the reciprocal lattice.*
3. *Analyze specific heat using the Einstein and Debye models.*
4. *Explain lattice waves and the concept of phonons.*
5. *Understand the Drude model and the quantum mechanical free electron gas.*
6. *Examine thermal conductivity in metals.*
7. *Describe the heat capacity of conduction electrons.*
8. *Analyze electrons in a one-dimensional periodic potential using the Kronig-Penney model.*
9. *Distinguish between metals, insulators, and semiconductors based on energy band diagrams.*
10. *Understand the concept of the Fermi surface.*
11. *Analyze the temperature dependence of carrier concentration in semiconductors.*
12. *Analyze extrinsic semiconductors and their electrical conductivity, including temperature dependence.*
13. *Understand the effect of a magnetic field on a semiconductor, including the Hall effect.*
14. *Explain the working of a p-n junction based on energy band diagrams.*
15. *Analyze the rectification property of a p-n junction (Half-Wave rectification) and derive the rectification equation.*
16. *Describe the operation of a junction transistor based on energy band diagrams.*
17. *Understand the operation of a tunnel diode.*
18. *Introduce the concepts of nematic and hexatic phases in liquid crystals.*

UNIT-I (15 HOURS)

Bravais lattice and seven crystal systems; Xray Diffraction, Bragg's law, Reciprocal Lattice. Elastic waves, density of states of continuous medium. Specific heat: Einstein and Debye models; Lattice waves; One-dimensional monoatomic lattice; Density of states of a lattice; The concept of Phonons.

Drude model, Quantum mechanical free electron gas; Electrical conductivity; Electrical resistivity versus temperature; Thermal conductivity in metals. Heat capacity of conduction electrons.

UNIT-II (15 HOURS)

Electrons in one dimensional periodic potential; Kronig- Penney model; Concept of Brillouin zones; Explanation of energy bands on the basis of Brillouin zones; Metals, insulators and semiconductors. The Fermi surface; Electrical conductivity (effects of the Fermi surface); Band structure of Intrinsic semiconductors (Silicon only); Temperature dependence of carrier concentration; Impurity states (acceptor and donor).

UNIT-III (15 HOURS)

Extrinsic semiconductors: Electrical conductivity, Temperature dependence. The effect of magnetic field on a semiconductor: The Hall effect.

p-n junction: working (on the basis of energy band diagram); Rectification property (Half-Wave). Derivation of rectification equation. The junction transistor, Its working (on the basis of energy band diagram), Tunnel diode. Liquid Crystals- nematic and hexatic phases.

PRACTICAL (1 CREDIT: 30 HOURS)

1. To study Hall-effect in semiconductors.
2. Determination of Band Gap using Four Probe method.
3. To study Dielectric Constant of an insulator (BaTiO3/ PbTiO3) as a function of temperature.
4. Experimental determination of specific heat of a solid.
5. To study rectification properties of a Full wave rectifier.

TEXT BOOKS:

1. Elementary Solid-State Physics; Principles and Applications by Ali Omer, Pearson
2. Solid State Physics by S.O. Pillai, New Age International.
3. Physics of Materials: Essential Concepts of Solid-State Physics, Pratap Haridoss, Willey
4. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
5. B.Sc. Practical Physics by C.L. Arora
6. A Textbook of Advanced Practical Physics by S. Ghosh: New Central Book Agency.