Question bank on Solid State Physics (Condensed Matter Physics)
Sixth Semester

Objective and short answer type questions:

1. Distinguish between crystalline and amorphous solids.
2. What do you mean by crystal lattice?
3. What is a unit cell?
4. Write down the difference between a primitive cell and unit cell.
5. What are Bravais lattice?
6. What do you mean by Miller indices? Explain with examples.
7. Why X-rays are used for the analysis of crystal structure?
8. What do you mean by reciprocal lattice?
9. Define atomic scattering factor.
10. State Bragg's law of X-ray diffraction.
11. What do you mean by a phonon?
12. Distinguish between metal, semiconductor and insulator in view of the band theory of solids.
13. Explain the concept of 'effective mass' of electron.
14. What are Brillouin zones?
15. What is Hall effect?
16. What is intrinsic semiconductor?
17. What is superconductivity?
18. Distinguish between type I and type II superconductors.
19. What do you mean by Meissner effect?
20. What are polar and non-polar dielectrics?
21. Write down the Clausius-Mosotti relation.
22. Give some comparative study of dia, para and ferromagnetic materials. Give some examples of each kind.
23. What is Bohr magneton?
24. What do you mean by hysteresis?
25. Define Curie temperature.
26. Explain the differences between hard and soft magnetic materials.

Broad answer type questions:

1. What do you mean by packing fraction? Calculate the packing fraction of a BCC and FCC lattice.
2. Explain how Miller indices can be determined.
3. Show that reciprocal lattice corresponding to an FCC lattice is a BCC lattice.
4. Derive Laue's equations of diffraction of X-rays and obtain Bragg's law from them.
5. Derive Bragg's law of X-ray diffraction in crystals.
6. What are N-process and U-process as applied to lattice vibrations?
7. (a) Obtain the dispersion relation for one-dimensional atomic crystal and discuss the nature of acoustic and optical models.
   (b) Show that group velocity vanishes at the zone-boundary. Give physical interpretation of the result.

8. (a) Derive an expression for lattice specific heat capacity following Einstein model clearly explaining the underlying assumptions.
   (b) Discuss the temperature dependence of lattice heat capacity and compare with experimental observations.

9. (a) Write down the assumptions of Debye model of lattice specific heat of solid.
(b) Discuss the Debye model of lattice specific heat capacity.

10. (a) Using the Kronig-Penny model, show that the energy spectrum of an electron consists of a number of allowed energy bands separated by forbidden regions.

(b) Discuss the nature of energy spectrum in the limiting cases of very weak and very strong potentials.

11. How does the resistivity of a metal and a semiconductor vary with temperature? Explain qualitatively the temperature variation of resistivity in the two cases.

12. (a) Explain the Hall effect. Derive the expression for the Hall co-efficient of semiconductor on two band model of carriers in semiconductors.

(b) Mention two applications of Hall effect.

13. (a) Deduce Clausius-Mossotti relation for non-polar dielectrics. How is the relation modified if the dielectric is polar.

(b) Explain electronic polarizability and oriental polarization in a dielectric.

14. (a) Deduce Langevin's formula for the molar diamagnetic susceptibility.

(b) Show that the diamagnetic susceptibility increases with number of atoms per unit volume but is independent of temperature.

15. Give an account of the quantum theory of paramagnetism and explain how it removes the shortcomings of Langevin's theory.

16. What is ferromagnetism? Discuss the Weiss field theory of ferromagnetism and explain how magnetic susceptibility varies with temperature.