

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27
M.Sc. PHYSICS – IV SEMESTER
SEMESTER EXAMINATION: APRIL 2017
PH 9215: Solid State Physics

Time-3 hrs

Max Marks-100

This paper contains 2 printed pages and 2 parts

PART A

Answer any FIVE of the following

[5 x 15=75]

1. a) What are Phonons? Derive dispersion relation for monoatomic chain. How is it different from continuous string?
b) Discuss the variation of group and phase velocity in first Brillouin zone. [10+5]
2. a) Obtain an expression for diamagnetic susceptibility using Langevin's theory. What is the significance of negative susceptibility?
b) Discuss the physical origin of ferro-magnetic domains in ferromagnetic materials. [10+5]
3. How are Cooper pairs formed? Explain the BCS theory of superconductivity and discuss the energy gap based on this theory.
4. a) Discuss with theory the characteristic features of ferrimagnetic substance and derive Curie temperature and its susceptibility.
b) Explain the classification of solids as metals, semiconductors and insulators based on band theory. [8+7]
5. Show that the set of reciprocal lattice vectors determines the possible x-ray reflections and hence deduce Bragg's and Laue's equations of X ray diffraction.
6. a) Discuss the results of Kronig-Penny model for the motion of an electron in a periodic potential. What is meant by density of energy states?
b) Explain Hall effect and derive an expression for Hall coefficient. [7+8]
7. a) Discuss the details of Landau's theory of first order phase transitions of ferroelectrics.
b) Derive the Lorentz relation for the field acting at an atom in a cubic site. [7+8]

PART B

Answer any FIVE of the following

[5 x 5=25]

8. Calculate the value of London penetration depth λ_0 at 0 K for lead whose density is $11.3 \times 10^3 \text{ kg/m}^3$ and the atomic weight is 207.19 ($T_c=7.22\text{K}$). Calculate the increase in λ at 3.61K from 0K.
9. Calculate the Debye temperature for diamond given Young's modulus= 10^{12} N/m^2 and density 3500 kg/m^3 .
10. Evaluate the carrier concentration and conductivity of intrinsic Ge at $T= 300\text{K}$. Given mass of electron= $9.1 \times 10^{-31} \text{ kg}$, $E_g=0.66\text{eV}$, mobility of electron= $0.38\text{m}^2/\text{V-s}$, mobility of holes= $0.18\text{m}^2/\text{V-s}$, $k_B=1.3/ \times 10^{-23}\text{J/K}$ and $h= 1.055 \times 10^{-34}\text{Js}$.
11. Lattice constant of unit cell "alpha iron" is 0.287nm. Find number of atoms per mm^2 of planes (100),(110) and (111), if structure of "alpha iron" is BCC.

12. Density of copper is 8.95 gm/cm^3 and electrical resistivity is $1.55 \times 10^{-8} \text{ } \Omega\text{m}$ at room temperature. Calculate mean free time, Fermi energy and Fermi velocity assuming the valency of copper as one.
13. A paramagnetic salt contains 10^{28} ions/m^3 with magnetic moment of 1 Bohr magneton. Calculate the paramagnetic susceptibility and the magnetization produced in a uniform magnetic field of 10^6 A/m at 300K.
14. a) An elemental dielectric material has $\epsilon_r = 12$ and contains $5 \times 10^{28} \text{ atoms/m}^3$. Calculate its electronic polarizability.
b) Calculate the energy of an electron below the fermi level at a temperature 200K for $f(E)=0.9$ and Fermi energy= 3eV .
[2+3]