2023
B.A./B.Sc.
Fifth Semester
CORE – 12
PHYSICS
Course Code: PHC 5.21
(Solid State Physics)

Total Mark: 70 *Pass Mark: 28*
Time: 3 hours

Answer five *questions, taking* one *from each unit.*

UNIT–I

1. (a) The primitive translation vectors of a two dimensional lattice are $\vec{a} = 2\hat{i} + \hat{j}$ and $\vec{b} = 2\hat{j}$. Calculate the primitive translation vectors of its reciprocal lattice. 6

   (b) Using Ewald construction, prove that Bragg's diffraction condition in reciprocal lattice is equal to Bragg's diffraction condition in the direct lattice. 6

   (c) Sketch $(\bar{1} \quad 0 \quad 0)$ in simple cubic cell. 2

2. (a) Define interplanar spacing. Derive the general expression of interplanar spacing. 1+5=6

   (b) What is reciprocal lattice? Show that the reciprocal of the reciprocal lattice vector is a direct vector. 1+3= 4

   (c) With a neat diagram, explain the crystal structure of sodium chloride. 4

UNIT –II

3. (a) The angular frequency of a wave propagating inside a wave guide is given by $\omega = 2ck^2$. Find the phase and group velocity of the wave. 4

   (b) Discuss the low temperature behaviour of specific heat in Debye's model. 4

(c) Derive the dispersion relation for a monoatomic lattice vibration . 6

4. (a) Explain, with neat diagram, the acoustic and optical branches using the dispersion relation for a linear diatomic lattice chain. 6
   (b) Why does Einstein's theory of specific heat of solids work well at high temperatures but fail at low temperatures? 8

UNIT–III

5. (a) Explain Meissner effect in superconductivity. Differentiate between type-I and type-II superconductors. 2+2=4
   (b) Explain the origin of domains in ferromagnetic materials. 4
   (c) Discuss the Langevin's quantum theory of paramagnetism. 6

6. (a) In an iron bar magnet of cross-section 2 mm^2, a magnetic intensity of 1.2 Am^{-1} produces a magnetic flux of 3.2×10^{-5} weber. Calculate the permeability and susceptibility of the iron. 4
   (b) $_{80}Hg^{200}$ in the superconducting state has critical temperature of 6.2 K at zero magnetic field and a critical field of 0.064 MAm^{-1} at 0 K. Determine the critical field at 4 K and also, determine the transition temperature of one of its isotopes $_{80}Hg^{204}$. 4
   (c) In B-H loop, show that the energy loss is the area under the B-H loop. 6

UNIT–IV

7. (a) Derive Lorentz relation for a local electric field in a dielectric material. 4
   (b) What are plasma? Write a short note on plasma oscillations. 1+3=4
   (c) Define dipolar polarizability. Show that dipolar polarizability per molecule is given by $\alpha_d = \frac{p^2}{3k_B T}$ 1+5=6

8. Explain normal and anomalous dispersion, clearly stating the underlying assumptions. 14

UNIT–V

9. Discuss the formation of allowed and forbidden energy bands on the basis of the Kronig-Penney model. Give schematic representation of period, extended and reduced zone of E-K relationship. 14

10. (a) Write a note on piezoelectric effect. 4
    (b) Calculate the Hall coefficient of sodium based on free electron model. Sodium has BCC structure, and the side of the cube is 4.2 Å. 4
    (c) Explain Curie-Weiss law for ferroelectricity. 6
