October 2025
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) Distinguish between crystalline solid and amorphous solid. 5
   (b) Calculate the packing efficiency (packing fraction) of a body centred cubic crystal. 5
   (c) The spacing between principal planes of NaCl crystal is 2.82 Å. It is found that first order Bragg reflection occurs at an angle of 100. What is the wavelength of X-rays? (Given, sin 10° = 0.1736 rad) 4

2. (a) Prove that the reciprocal lattice of an FCC lattice is BCC lattice. 5
   (b) What are Brillouin zones? Explain Brillouin zones of body centred cubic crystal. 6
   (c) In a crystal a lattice plane cuts intercepts of $2a$, $3b$ and $6c$ along the three axes, where a, b and c are primitive vectors of the unit cell. Determine the Miller indices of the given plane. 3

UNIT–II

3. (a) Discuss Einstein's theory of specific heat and explain how far it agrees with the experimental results in low and high temperature limits. 9
   (b) Gold has same structure as copper. The velocity of sound in gold is 2100 m/s and that in copper is 3800 m/s. If the Debye temperature of the gold is 170 K, determine the Debye temperature of copper. (Density of gold = 1.93×10^4 kg m^{-3},

density of copper = 8.96×103 kg m^{-3}, atomic weight of gold = 197 a.m.u., atomic weight of copper = 63.54 a.m.u.) 5

4. (a) What are phonons? Derive the dispersion relation for a monoatomic lattice chain. 11
   (b) Calculate Einstein temperature, given Einstein frequency as 9×10^{11} Hz. 3

UNIT–III

5. (a) Discuss the Langevin's classical theory of paramagnetism. 7
   (b) Explain domain theory of ferromagnetism and hence calculate the susceptibility. 7

6. (a) Explain Meissner effect in superconductivity. Differentiate between type-I and type-II superconductors. 6
   (b) Derive London's 1^{st} and 2^{nd} equations in case of a superconductor. 8

UNIT–IV

7. (a) Obtain the Lorentz relation for the local electric field. 7
   (b) What are plasmons? Obtain an expression for plasma frequency. 4
   (c) A solid dielectric has electronic polarizability of 10^{-40} Fm^2, if the internal electric field be a Lorentz field, what is the dielectric constant of the material. (Given, number of atoms per unit volume = 3×10^{28} atoms/m^3) 3

8. (a) Derive Langevin Debye equation for polarization. 10
   (b) The crystal of sodium chloride has static dielectric constant of 5.6 and optical index of refraction 1.5. Calculate the percentage contribution of ionic polarizability. 4

UNIT–V

9. (a) Distinguish metal, semiconductor, and insulator in view of band theory of solids. 3
   (b) Find the expression of conductivity of a semiconductor. 5
   (c) Derive the Kronig-Penny equation for an electron moving in a one-dimensional periodic potential. 6

10. (a) Write a short note on piezoelectric effect. 3

(b) Set up Curie-Weiss law in reference to ferroelectric materials. 5

(c) Find the expression of concentration of electron in the conduction band of an intrinsic semiconductor. 6