2022
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 <u>five</u> questions, taking <u>one</u> from each unit.

UNIT–I

1. (a) What is Bravais lattice? Explain the different Bravais lattices in two dimensions.   6
    (b) Sketch a set of planes having Miller indices (1 0 0) and (1 0 1). Also, calculate the Miller indices of crystal planes which cut through the axes at
     (i) (2a, 3b, c)   (ii) (2a, –3b, –3c)   4
    (c) Show that for simple cubic lattice

    $$d_{100} : d_{110} : d_{111} = \sqrt{6} : \sqrt{3} : \sqrt{2}$$ 6

2. (a) What is a reciprocal lattice? Prove that the BCC is the reciprocal lattice of FCC lattice.   6
    (b) BCC crystal is used to measure the wavelength of some X-rays. The Bragg angle for first order reflection from (2 1 2) planes is 30°. Calculate the wavelength and glancing angle for 2nd order diffraction? Given, the lattice parameter of the crystal is 6 Å.   4
    (c) Using Ewald construction, derive Bragg's diffraction condition in reciprocal lattice.   4

UNIT–II

3. What are phonons? Derive at the dispersion relation for a diatomic lattice chain and hence describe the characteristics of acoustical and optical phonons.   14

4. Discuss Einstein's theory of specific heat and explain how far it agrees with the experimental results in low and high temperature limits. How did Debye modify it?   14

UNIT–III

5. (a) Give the quantum theory of paramagnetism and explain how it overcomes the shortcomings of classical theory of Langevin's theory.
                                                                        10
    (b) What are the major differences between diamagnetic, paramagnetic and ferromagnetic substances? Give an example each.   4

6. (a) Derive London's theory of a superconductor and obtain an expression for the penetration depth.   8
    (b) The transition temperature of mercury with an average atomic mass of 200 amu is 4.153 K. Determine the transition temperature of one of its isotopes, $_{80}Hg^{204}$.   4
    (c) Mercury has critical temperature of $-269°C$ at zero magnetic field and a critical field of 0.33 MAm^{-1} at absolute zero. Find the critical field at $-266°C$.   2

UNIT–IV

7. (a) Derive Clausius-Mossotti relation. Also, obtain the frequency dependence of electronic polarizability.   10
    (b) The atomic weight and density of sulphur are 32 and 2.08 gm/cm^3 respectively. The electronic polarizability of the atom is 3.28×10^{-40} Fm^2. If sulphur solid has cubic symmetry, what will be its relative permittivity?   4

8. (a) Derive the mathematical expression to explain the dominance of imaginary dielectric constant at certain frequencies in dispersion of solids.   8
    (b) What are plasmons? Obtain an expression for plasma frequency.   6

UNIT–V

9. What are ferroelectricity, piezoelectricity and pyroelectricity? What are the different groups of ferroelectric crystals? Explain Curie-Weiss law of ferroelectricity. 14

10. (a) Discuss the Kronig-Penney model for the motion of an electron in a periodic potential. 10

    (b) How are the materials classified into conductors, semiconductors, and insulators on the basis of E vs K Diagram. 4

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