School of Basic Sciences

Bachelor of Science Honours in Physics
Semester End Examination - Jun 2024

Duration : 180 Minutes
Max Marks : 100

Sem IV - C1UD402T - Condensed Matter Physics

General Instructions
Answer to the specific question asked
Draw neat, labelled diagrams wherever necessary
Approved data hand books are allowed subject to verification by the Invigilator

1) Define the Miller indices and demonstrate the procedure for finding the Miller indices. — K1(3)

2) Distinguish between the diamagnetism, paramagnetism, ferromagnetism and antiferromagnetism with suitable examples. Comment on the temperature variation of susceptibility for all types of materials. — K2(4)

3) Explain superconductivity giving its main characteristics. — K2(6)

4) Solve for the characteristics Einstein temperature for copper if Einstein frequency =4.8 x 1012 Hz. Given $K_B = 1.38 \times 10^{-23}$ 〚JK〛$^{-1}$ and $h = 6.6 \times 10^{-34}$ J sec — K3(6)

5) Use Einstein's theory of specific heat of solids, to solve for the frequency of Einstein's Oscillator for Einstein's temperature of 236 K. — K3(6)

6) Describe the powder diffraction method for X-ray diffraction. Interpret the formation of diffraction pattern on photographic plate. — K3(9)

7) Analyse the polarizability of atoms. Derive the Classius Mossoti equation between polarizability and dielectric constant of a solid — K3(9)

8) Discuss the importance of the first Brillouin Zone. — K4(8)

9) Analyse the Debye theory to show its contribution to our understanding of thermal properties in condensed matter physics, and what insights does it provide into the behaviour of solids at low temperatures? — K4(12)

10) Justify the statement that overall charge neutrality is maintained for extrinsic semiconductors on addition of impurities. — K5(10)

11) Discuss the superconductivity and describe the phenomenon's key characteristics, including zero electrical resistance and the expulsion of magnetic fields (the Meissner effect). Explain the significance of the critical temperature (Tc) in superconductors and how it relates to the transition between the normal and superconducting states. K5(15)

OR

Discuss the factors that influence the electrical conductivity of conductors, semiconductors, and insulators. Explain the role of carrier concentration, mobility, and temperature in determining the conductivity of each type of material. K5(15)

12) Prove that in determining lattice parameters, the greater the diffraction angle, the greater is the accuracy. K6(12)

OR

Starting with solution of Schrodinger equation for one dimensional lattice $\dfrac{P\,Sin\,\alpha a}{\alpha a} + \cos \alpha a = \cos ka \; with \; \alpha = \left(\dfrac{2mE}{\hbar^2}\right)^{\frac{1}{2}}$ discuss the formation of energy bands in solids. K6(12)