

B.Sc. 5th Semester (Honours) Examination, 2019 (CBCS)

Subject : Physics

Paper : CC-XII

Time: 2 Hours

Full Marks: 40

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

Group-A

1. Answer *any five* questions:

2×5=10

- What are different crystal symmetries? How many rotational symmetries are there in a Simple Cubic System?
- Calculate packing fraction for BCC lattices.
- Silicon has the dielectric constant 12 and the edge length of the conventional cubic cell of Silicon lattice is 5.34\AA . Calculate the electronic polarisability of Silicon atoms.
- What are optical mode and accoustical mode of lattice vibration? Draw the two modes of vibration.
- What is Hall effect? What is the physical implication of Hall co-efficient?
- Which type of interaction and temperature favours the formation of Cooper-pair?
- Define magnetic susceptibility. State its dimension and unit in S.I. system.
- In a crystal whose primitives are 1.2\AA , 1.8\AA and 2\AA , a plane (231) cuts an intercept of 0.6\AA on the x -axis. Find the corresponding intercepts on the y and z -axes.

Group-B

2. Answer *any two* questions:

5×2=10

- Explain Bragg's law and Lane's equations for diffraction of X-rays in crystals. Show the equivalence of these two formulations. 2+2+1=5
- What do you understand by electronic polarization of an atom? An oxygen atom, on being polarized produces a dipole moment of $0.5 \times 10^{-22} \text{C-m}$. If the distance of the centre of $-ve$ charge cloud from the nucleus be $4 \times 10^{-17} \text{m}$, calculate the polarizability of the oxygen atom. ($e = 1.6 \times 10^{-19} \text{C}$, $\epsilon_0 = 8.85 \times 10^{-12} \text{farad/m}$). 2+3=5

- (c) Obtain an expression for the lattice specific heat on the basis of Einstein's theory. State the limitation of the theory. 4+1=5
- (d) (i) Explain hysteresis phenomenon for a ferromagnetic material.
 (ii) Why do the domains form in a ferromagnetic material? What is domain wall motion?
 (iii) Why a domain structure with multiple domain is favoured in a ferromagnetic material below Curie temperature? 2+(1+1)+1=5

Group-C

3. Answer any two questions:

10×2=20

- (a) (i) What is paramagnetism?
 (ii) Describe Langevin's classical theory of paramagnetism and obtain an expression for paramagnetic susceptibility. Discuss the limitations of the theory.
 (iii) When do we call a substance as ferromagnetic? 2+(6+1)+1=10
- (b) (i) What do you mean by plasma? What is plasma frequency? Prove that, dielectric constant is given by, $\epsilon(\omega) = \frac{\omega_p^2}{\omega^2}$.
 (ii) Write Bloch theorem. Determine the number of wave functions in a band considering one dimensional lattice. (1+2+2)+(2+3)=10
- (c) (i) What is superconductivity? Describe the effect of magnetic field on a super conductor. What are type-I and type-II superconductors?
 (ii) What is electrostrictive effect? How does it depend on electric field? (2+3+2)+(2+1)=10
- (d) (i) Deduce an expression for the Hall coefficient of a semiconductor with two types of carriers having different concentrations and mobilities.
 (ii) The Debye temperature for diamond is 2230 K. Find the highest possible vibrational frequency and the molar heat capacity of diamond at 10K. 7+3=10