U.G. 5th Semester Examination - 2022

PHYSICS

[HONOURS]

Course Code : PHY-H-CC-T-12

(Solid State Physics)

Full Marks : 40 Time : $2\frac{1}{2}$ Hours

The figures in the right-hand margin indicate 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

   a) Calculate the coordination number for SC, and BCC crystal.

   b) Discuss the construction of the first two Brillouin zones for a square lattice.

   c) Derive Bragg's relation from Laue's equations.

   d) Draw the susceptibility vs. temperature graph for dia, para and ferromagnetic materials.

   e) Define Hall coefficient. Why it is positive in metals?

   f) Why does dielectric loss occur?

g) What is the physical significance of the hysteresis loop in magnetic or dielectric materials?

GROUP-B

2. Answer any **two** questions: 5×2=10

a) Derive an expression for the electronic polarizability of an atom on the basis of classical theory. 5

b) Show that the diamagnetic susceptibility of an element is independent of temperature. 5

c) Obtain the dispersion relation for one-dimensional diatomic lattice. Hence, explain the concept of optical branches. 3+2

d) i) The conductivity of a metal decreases with rise of temperature, whereas the conductivity of a semiconductor increases with increase of temperature. Explain both the cases clearly giving appropriate examples.

ii) Write the domain hypothesis of Weiss and explain the physical origin of domain formation from the general thermodynamic principle. 2+1+2

GROUP-C

Answer any two questions: 10×2=20

3. a) Write down Laue's condition for constructive interference in a crystal. Derive Bragg's law from it for a simple cubic lattice. Show that the Bragg's diffraction condition in the reciprocal lattice is $2\mathbf{k}.\mathbf{G} + G^2 = 0$ (where **G** is the reciprocal lattice vector and **k** is the incident wave vector).

   b) Show that the reciprocal lattice corresponding to an FCC lattice is a BCC lattice.

(1+2+4)+3

4. a) Consider the local field at an atomic site in a cubic structure in terms of the polarization ***P*** produced by the applied electric field ***E***. Hence, arrive at the Clausius-Mossotti relation for non-polar dielectric medium.

   b) What is meant by complex dielectric constant?

   c) Derive Curie-Weiss law from Weiss's Molecular theory of magnetism. Sketch the variation of the magnetic susceptibility with temperature above the Curie point.

(1+3)+2+(3+1)

5. a) What is Meissner Effect? The perfect diamagnetism and Zero resistivity of a superconductor are the two mutually exclusive properties.— Explain. Discuss the difference between type-I and type-II superconductors.

b) Briefly explain how BCS theory accounts for the superconducting state.

c) What is critical temperature of superconductor? Discuss the isotope effect on critical temperature of superconductor.

(1+2+2)+2+(1+2)

6. a) State Bloch's theorem and explain its significance.

b) How does Kronig Penny model lead to the concept of allowed and forbidden energy bands in solid?

c) Derive the expression conductivity for an intrinsic semiconductor. 2+4+4
