B.Sc. Semester V (Honours) Examination, 2020 (CBCS)
Subject: Physics
Paper: CC-XII (Solid State Physics)

Full marks: 40   **Time: 2 hours**

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

Answer any **eight** of the following questions (All questions carry equal marks):   **5×8=40**

1.   (a) Prove that in determining the lattice parameter, the greater the diffraction angle, greater is the accuracy.
(b) Calculate the maximum radius of the sphere that can just fit into the void at the body centre of the *fcc* structure coordinated by facial atoms.

2.   (a) Two dimensional lattice has the basis vector **a = 2x** and **b** = **x** + 2**y**. Determine the reciprocal lattice vectors.
(b) Write down the geometrical structure factor for *bcc* crystal and account for the missing reflections for this crystal.

3.   (a) How does the electrical conductivity of an intrinsic semiconductor vary with temperature?
(b) The resistivity of an intrinsic semiconductor is 4.5 Ω-m at 20^0 C and 2.0 Ω-m at 32^0C. Find the energy band gap of the semiconductor.

4.   (a) Dy^{3+} has outer electronic configuration of $4f^9$ $6s^0$. Calculate the magnetic susceptibility for a salt containing 1 kg-mole of Dy^{3+} ions at 300K.
(b) Discuss the origin of diamagnetism and hence explain why diamagnetic materials have negative susceptibility?

5.   Show that in the Debye approximation, the total zero point energy per gm-mole of a solid is given by $\frac{9}{8} R\theta_D$.

6.   Obtain the dispersion relation for one-dimensional monoatomic crystal. Hence show that the group velocity vanishes at zone boundary.

7.   What is meant by "Orientational Polarizability" in dielectrics? The relative permittivity and square of refractive index of a dielectric material are 4.94 and 2.69 respectively. Find the ratio between electronic and ionic polarizabilities of the material.

8.   What are the essential properties of ferroelectric crystals? Derive the relation showing the variation of static dielectric constant of these materials with temperature.

9.   Give physical significance of effective mass of an electron and prove that it is given by
$m^* = h^2 /(d^2E/dK^2)$
        Plot the variation of effective mass of an electron with K.

10.   Explain the origin of superconductivity. What are the predictions of BCS theory? What is Meissner effect?