

M.Sc. PHYSICS (EVENING) SECOND YEAR SECOND SEMESTER- 2022

Subject : SOLID STATE PHYSICS

Time : 2 Hours

Full marks : 40

Answer any FOUR Questions

1. (a) Explain why crystals cannot possess a long range five-fold symmetry.

(b) Why only fourteen Bravais lattice exist? Which of the seven crystal systems has the maximum number of Bravais lattice? Prove using a diagram the equivalence of a base centered tetragonal with primitive tetragonal.

(c) Assuming hard incompressible spheres, draw the projection of (111) plane of an fcc unit cell, and hence calculate the packing fraction of that plane.

[3+4+3]

2. (a) Prove that parallel crystal planes have the same Miller indices.

(b) Assuming the primitive translation vectors, show that the reciprocal lattice of a simple cubic lattice is also a simple cubic lattice.

(c) What is the limitation of Bragg's law? Establish the equivalence of Laue's approach and Bragg's approach.

[3+3+4]

3. What is piezoelectric effect? Explain piezoelectric effect in Quartz crystal and its application in clock.

[3+7]

4. What is the source of permanent dipole moment in Barium Titanate? Explain temperature dependence of dielectric constant for Barium Titanate single crystal. How this dielectric constant varies with grain size?

[5+5]

5. (a) A specific atom has electronic configuration $[\text{Xe}]4f^6$. Examine what type of magnetic atom it is.

(b) Compare the properties of paramagnetic and ferromagnetic material.

(c) Derive the magnetic susceptibility of a ferromagnetic material as a function of temperature.

[2+4+4]

6. (a) What is Meissner Effect?

(b) Explain Josephson junction (JJ) and Josephson effect.

(c) In a circuit containing a JJ is applied a dc voltage. Find out the current in the circuit. What type of current is it?

[3+3+4]