

**GSQ/M-21****1748****SOLID STATE AND NANO PHYSICS****Paper–XI**

Time Allowed : 3 Hours]

[Maximum Marks : 40

**Note** : Attempt **five** questions in all, selecting **one** question from each Unit. Question No. **1** is compulsory. Use of Scientific (Non-Programmable) calculator is allowed.

**Compulsory Question**

1. (a) Which type of lattice does diamond has? How many atoms are in a primitive cell and conventional cube of diamond ? 2
- (b) A two dimensional lattice has the basis vector  $\vec{a} = 2\hat{x}$ ,  $\vec{b} = \hat{x} + 2\hat{y}$ . Find the reciprocal lattice vectors. 2
- (c) Discuss the concept of flux quantization. 2
- (d) What is single wall carbon nanotube? 2

**UNIT–I**

2. (a) What do you mean by Miller indices? How do the Miller indices of a plane are determined? What are the important features of Miller indices? 6
- (b) Discuss in brief the Crystal structure of Zinc sulphide. 2
3. (a) Explain the concepts of Atomic radius and Atomic packing fraction. Calculate the values of atomic radius and atomic packing fraction for : 6
  - (i) simple cube
  - (ii) body centered cube
  - (iii) face centered cube structure.
- (b) A substance with fcc lattice has molecular weight 60.2 and density 6250 kg/m<sup>3</sup>. Calculate lattice constant  $\alpha$ . 2

## UNIT-II

4. (a) Derive Laue's equations of diffraction for X-rays. Show that these lead to Bragg's law for X-ray diffraction. 5
- (b) Discuss the rotating crystal method for X-ray diffraction. 3
5. (a) Discuss the concept of Reciprocal lattice. Show that the fcc lattice is reciprocal of the bcc lattice and vice versa. 5
- (b) Derive expression for Brillouin zone for fcc lattice. 3

## UNIT-III

6. (a) Explain the concept of Perfect diamagnetism. Prove that the coherence length is reduced due to the presence of impurities in a Superconductor. 5
- (b) The critical temperature for Mercury with isotopic mass 199.5 is 4.185 Kelvin. Calculate its critical temperature when its isotopic mass changes to 203.4. 3
7. (a) Discuss BCS theory of Superconductor. How does it account for the superconducting state? 5
- (b) Describe the applications and limitations of Superconductors. 3

## UNIT-IV

8. (a) Explain the Molecular assembler concept. 4
- (b) Explain the construction and working of Transmission electron Microscope. 4
9. (a) Explain the Carbon fullerene. Describe the synthesis and purification of fullerenes. 4
- (b) Explain the vision and the objectives of Nanotechnology. 4