Roll No. ..... **Total Pages : 03**

GSQ/M-20 1748

PHYSICS

Paper XI

Solid State and Nano-Physics

Time : Three Hours] [Maximum Marks : 40

Note : Q. No. **1** is compulsory. From Unit I to Unit IV, attempt *one* question out of two questions set from each Unit. Use of Scientific (Non-programmable) calculator is allowed.

1. (a) What do you understand by packing fraction ? **2**

(b) The primitive translation vectors of the hexagonal space lattice are $\vec{a} = 2\hat{i} + \hat{j}, \vec{b} = 2\hat{j}, \vec{c} = c\hat{k}$. Find the volume of the primitive cell. **2**

(c) Show that the material gets cooled when its conductivity is destroyed by a magnetic field. **2**

(d) What is a Nanotube ? **2**

Unit I

2. (a) What do you understand by Bravais lattices ? Explain different types of Bravais lattices in two and three dimensions. **5**

(b) A plane makes intercepts of 1, 2 and 3 Å on the crystallographic axes of an orthorhombic crystal with $a : b : c = 3 : 2 : 1$. Determine the Miller indices of this plane. **3**

3. (a) Discuss in brief the crystal structure of :

(i) Sodium chloride

(ii) Zinc sulphide. **4**

(b) What do you understand by symmetry operations in crystals ? Explain the concept of rotation axis of symmetry. **4**

Unit II

4. (a) Explain the powder method for X-ray diffraction. Discuss the formation of diffraction pattern on the photographic plate. **3**

(b) Derive Laue's equations of diffraction for X-rays. Show that these lead to Bragg's law for X-ray diffraction. **5**

5. (a) Explain the concept of Brillouin zones. Derive expression for simple cubic lattice Brillouin zone. **5**

(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. **3**

Unit III

6. (a) Explain Meissner effect. Show, how London equation lead to Meissner effect. **5**

(b) State and explain Josephson effect (A.C. and D.C.). **3**

7. (a) Write notes on the following :

(i) Persistant current in a superconductor

(ii) Type I and Type II superconductors. **4**

(b) Explain the concept of flux quantization. **2**

(c) Lead in a superconducting state has critical temperature of 6.2 kelvin at zero magnetic field and critical field $H_C(O) = 0.064$ mA m^{-1} at 0 kelvin. Calculate the critical field at 4 kelvin. **2**

Unit IV

8. (a) What do you undertand by sputtering ? Explain D. C. sputtering and RF sputtering. **4**

(b) What is scanning tunneling microscope (STM) ? Explain its principle, construction and working. **4**

9. (a) Explain, in detail, the size dependence of properties of particles. **4**

(b) Explain the different fields in which nanotechnology is used. **4**