



Registration Number:

Date & Session

**ST. JOSEPH'S COLLEGE (AUTONOMOUS), BENGALURU -27**

**B.Sc. (PHYSICS) – VI SEMESTER**

**SEMESTER EXAMINATION: APRIL 2024**

(Examination conducted in May/June 2024)

**PH 6223: Elements of Condensed Matter Physics and Devices**

**(For current batch students only)**

**Time: 2 Hours**

**Max Marks: 60**

**This paper contains 2 printed pages and 3 parts**

**PART-A**

Answer any **FOUR** questions:

[4X8=32]

1. a) What is meant by symmetry operations in crystals? Explain the different symmetry elements in a crystal lattice. (4)  
b) Deduce the reciprocal lattice vectors of a SC lattice. (4)
2. a) Obtain Bragg's condition of X-ray diffraction. Mention its limitations. (6)  
b) Explain the term Fermi velocity. (2)
3. a) Based on assumptions of classical free electron theory obtain an expression for electrical conductivity of a metal and show that it is inversely proportional to the square root of temperature. (6)  
b) Explain the concept of effective mass of an electron. (2)
4. a) Derive an expression for the density of holes in the valence band of an intrinsic semiconductor. (6)  
b) What are the properties of Bloch Function. (2)
5. a) Develop the Clausius-Mossotti relation for elemental dielectric systems. Give its significance. (6)  
b) Write a note on high temperature superconductor. (2)
6. Derive an expression for the specific heat of solids following Einstein's model. To what extent does this model agree with the experimental results?

**PART-B**

Answer any **FOUR** questions:

[4X5=20]

7. Silver crystallizes as FCC structure with edge of the unit cell being 409 pm. Find the radius of the silver atom, length of the face diagonal and the cube diagonal.
8. When X-rays of wavelength  $1.54\text{\AA}$  is diffracted from (111) plane of a crystal having FCC structure the first order diffraction is obtained for an angle of incidence  $70.8^\circ$ . If the atomic weight of the crystal is 26.98 g/mol, calculate the density of the crystal.

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9. The density of copper is  $8940 \text{ kg/m}^3$ , calculate the number of electrons per unit volume, the Fermi energy, the average kinetic energy and the Fermi velocity of the free electrons. Assume one electron per Cu atom. At. Wt. of copper 63.5.
10. Find the temperature at which there is 1% probability that a state with an energy of 0.5 eV above Fermi energy will be occupied by an electron.
11. For mercury with isotopic mass 199.5 the critical temperature is 4.185 K. If its isotopic mass changes to 203.4, calculate its critical temperature.
12. A solid contains  $5 \times 10^{28}$  atoms  $\text{m}^{-3}$  each with a polarizability of  $2 \times 10^{-40} \text{ F m}^2$ . Calculate the ratio of the Lorentz field to the external electric field. Given  $\epsilon_0 = 8.854 \times 10^{-12} \text{ F/m}$ .

### PART – C

Answer any **FIVE** of the following:

(5 x 2 = 10)

13. Is Wiegner Sietz cell a primitive cell or non-primitive? Explain.
14. How do you change the quality and quantity of X-ray produced in a Coolidge tube?
15. How are liquid crystals different from solid crystals?
16. Where does the Fermi level lie in an intrinsic semiconductor? Justify.
17. How is LDR used in automatic street lights?
18. How does the temperature and frequency affect polarization?