Roll No. : .....

Total No. of Questions : **11**] [Total No. of Printed Pages : **4**

BPF–2231

M.Sc. (Final) Examination, 2022

PHYSICS

Paper - V

(Condensed Matter Physics)

*Time : **3** Hours*] [*Maximum Marks : **75***

Section–A **(Marks : 2 × 10 = 20)**

Note :– Answer all *ten* questions (Answer limit **50** words). Each question carries **2** marks.

Section–B **(Marks : 5 × 5 = 25)**

Note :– Answer all *five* questions. Each question has internal choice (Answer limit **200** words). Each question carries **5** marks.

Section–C **(Marks : 10 × 3 = 30)**

Note :– Answer any *three* questions out of five (Answer limit **500** words). Each question carries **10** marks.

Section–A

1. (i) Calculate lattice constant and packing fraction of body centered cubic structure.

   (ii) A certain orthorhombic crystal has a ratio of a : b : c of 0.429 : 1 : 0.377. Find the Miller indices of faces whose intercepts are 0.214 : 1 : 0.188.

(iii) Define the 'color center' defect in crystal.

(iv) Define the term 'pseudo-potential'.

(v) Draw Fermi surface of copper. Write the few applications of Fermi surface.

(vi) Write Curie-Weiss law for susceptibility.

(vii) Explain Meissner effect briefly.

(viii) Write London equation and show that it leads to Meissner effect.

(ix) Give *two* examples of high temperature superconductor.

(x) Write the statement of d.c. Josephson effect.

Section–B

2. Define the following terms :

(i) Lattice translation vectors and primitive translation vectors.

(ii) Space lattice and basis

(iii) Unit cell and primitive cell

(iv) Wigner-Seitz cell

(v) Bravais lattice 1+1+1+1+1

Or

Define Reciprocal lattice. Prove that volume of reciprocal lattice is inverse of the volume of its corresponding direct lattice. Also prove that reciprocal lattice of bcc is fcc and vice versa. 1+2+2

3. Write short note on X-ray and electron microscopic techniques to observe the imperfection in crystals.

Or

Explain the formation of energy bands in solids. Classify the solids on the base of energy bands.

4. Explain how magneto resistance method is used to determine the Fermi surface.

Or

Write short note on spin wave and magnon.

5. Define the following terms in superconductors :

   (i) Critical temperature

   (ii) Critical magnetic field

   (iii) Type-I and Type-II superconductors

   (iv) Coherence length

   (v) Cooper pair 1+1+1+1+1

Or

Calculate the :

(i) Critical current that can flow through superconducting wire of diameter 10^{-3} m. The critical magnetic field for wire is 7.9×10^3 amp./meter.

(ii) Critical temperature of mercury when its isotopic mass change from 199.5 to 203.4. Critical temperature at 199.5 is 4.185 K. 2½+2½

6. Explain Macroscopic quantum interference.

Or

Prove that total magnetic flux passing through a superconducting ring is quantized.

Section–C

7. Write short notes on the following :

   (i) Powder and rotating crystal method

   (ii) Crystal structure factor and atomic form factor

8. Explain tight binding method for calculation of energy band.

9. Discuss the following :

   (i) Langavin theory of paramagnetism

   (ii) Heisenberg model and molecular field theory

10. Derive London equation. Estimate London penetration depth from the following data :

Critical temperature = 3.7 K, Density = 7.3×10^3 kg/m^3

Atomic weight = 118.7, Effective mass = 1.9 m

Explain the physical significance of penetration depth. 5+3+2

11. Discuss the following in detail :

(i) Ginzburg-Landau theory

(ii) BCS theory of superconductivity 5+5