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Total No. of Questions : 11 ]

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# **BFMS-454**

**M.Sc. (Final) Examination, 2023**

**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) Prove analytically that a five fold rotation symmetry is not possible in crystals.
- (ii) Derive Laue equations for x-ray diffraction by crystals.

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- (iii) What is point defects in crystals ?
- (iv) Write the statement of Bloch Theorem.
- (v) What is quantum hall effect ?
- (vi) Write Curie-Weiss law for susceptibility.
- (vii) Explain Meissner effect in short.
- (viii) Define critical temperature in superconductors.
- (ix) Give *two* examples of high temperature superconductor.
- (x) Write the statement of a.c. Josephson effect.

### Section-B

2. Define coordination number and packing fraction. Show that the maximum proportion of space which may be filled by hard spheres arranged in various lattices is for the S.C.  $-\frac{\pi}{6}$ ; b.c.c.  $-\frac{\sqrt{3}}{8}\pi$  and f.c.c.  $-\frac{\sqrt{2}}{6}\pi$ .

*Or*

Define a reciprocal lattice and prove the following :

- (i) The length of the reciprocal lattice vector  $\vec{r}^*$  is proportional to  $1/d_{hkl}$ .
  - (ii) The b.c.c. lattice is the reciprocal of f.c.c. lattice.
3. Write short note on x-ray and electron microscopic techniques to observe the imperfections in crystals.

*Or*

Obtain an expression for effective mass of an electron in a metal and use the energy spectrum of electrons to discuss whether the effective mass of an electron can be negative.

4. Give an account of a de-Haas-Van Alphen effect. Explain why is it considered to be the most powerful method for the study of Fermi surface.

*Or*

Explain Wein field theory of ferromagnetism and derive the Curie-Weiss law of susceptibility.

5. Write short notes on the following :

(a) Meissner effect

(b) Cooper Pair

*Or*

Using London equations show that the magnetic field decays exponentially with distance.

6. Give the basic idea of BCS theory.

*Or*

Write a short note on high temperature superconductivity.

### **Section–C**

7. Derive the expression for the atomic and geometrical structure factor.

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

9. Give an account of classical Langevin theory of paramagnetism. A material with molecular density  $4.14 \times 10^{28} \text{ m}^{-3}$  obeys Curie law. If the volume susceptibility of that substance at 300 K is found to be  $12.568 \times 10^{-3}$ , calculate the magnetic moment of a molecular dipole. [ $k_B = 1.38 \times 10^{-23} \text{ Jk}^{-1}$ ]

10. Discuss the following in superconductors :

(i) Critical temperature

(ii) Critical magnetic field

(iii) Type–I and Type–II superconductors

(iv) Coherence length

11. What do you understand by Josephson tunneling ? Explain D.C. and A.C. Josephson effect.