

B.Sc. 5th Semester (Honours) Examination, 2020-21

PHYSICS

Course ID: 52412

SH/PHS/502/C-12

Course Title: Solid State Physics

Time 1 Hour 15 Minutes

Full marks:- 25

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Section – I

1. Answer any five of the following questions: (1×5=5)

- a) What is the number of nearest neighbor (s) in a BCC crystal?
- b) What is relative permeability?
- c) What is Hall effect?
- d) What is the average number of atoms in an FCC unit cell?
- e) Consider two ferromagnets: one having a hysteresis with broad area and another with a narrow area. Which one can be used as permanent magnet?
- f) Define the momentum of phonons.
- g) Why zeroth order diffraction is not considered in x-ray diffraction?
- h) Distinguish between a metal, semiconductor and insulator on the basis of their energy band structure.
- i) With a spacing $\alpha = 2.0 \text{ \AA}$, what is the range of electron wavelengths in the first Brillouin zone?

Section – II

2. Answer any two of the following questions: (5×2=10)

- a) What are the Miller indices? Derive an expression for the inter-planar separation of the (h, k, l) planes of a simple cubic lattice.

(1+4)

- b) Explain what do you mean by lattice and lattice constant? Using proper formula show that the ratio of the inter-planar spacing of (100), (110), (111) planes is $\sqrt{6}:\sqrt{3}:\sqrt{2}$. NaCl is a cubic crystal having density $3.13 \times 10^3 \text{ Kg/m}^3$. Find the length of a side of unit cell. (Atomic weight of $\text{Na} = 23, \text{Cl} = 35.5$) (1+2+2)
- c) What are type-I and type-II super conductor? 'When a super conductor is placed in an external magnetic field, the field must penetrate up to a certain depth inside the super conductor'- justify. (3+2=5)
- d) What is meant by induced and orientation polarizability? Derive an expression of Hall coefficient of a material. (1+4)

Section – III

Answer any one of the following questions: (10×1=10)

3. Answer the following questions:

- a) Derive the number of vibrational modes of a crystalline solid in the frequency range γ and $\gamma + d\gamma$. Hence obtain an expression for Debye temperature and explain the significance of the cut-off Debye frequency. 3+1

- b) What is spontaneous magnetization? Describe Weiss theory of ferromagnetism. (1+5)

4. Answer the following:

- a) Draw $E-K$ graphs for free electrons and electrons in solids.
- b) Explain the different types of bindings in solids.
- c) Show that the effective number of carriers is maximum when the band is half-filled and zero when filled or empty (Using effective mass).

(2+4+4)
