

[This question paper contains 2 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5870

J

Unique Paper Code : 2222513601

Name of the Paper : Solid State Physics (DSC paper)

Name of the Course : B.Sc. Prog. -Physical sciences with Physics_NEP:
UGCF-2022

Semester : VI

Duration : 2 Hours

Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Answer any **four** questions. **Q1** is compulsory.
3. **All** questions carry equal marks.
4. Use of scientific calculator is allowed.

Q1 Answer any *five* questions:

- (i) The primitive translation vectors of the hexagonal space lattice are $\mathbf{a}_1 = (3^{1/2}a/2)\hat{x}$; $\mathbf{a}_2 = (3^{1/2}a/2)\hat{y}$; $\mathbf{a}_3 = c\hat{z}$
Show that the volume of the primitive cell is $V = 3^{1/2}a^2c$
- (ii) Define primitive and non-primitive unit cell of a 2D oblique lattice.
- (iii) Explain the concept of local electric field in a dielectric material.
- (iv) In a hexagonal plane lattice the translation vector is $\mathbf{T} = 2\mathbf{a} + 3\mathbf{b}$ where $\mathbf{a} = \mathbf{b} = 3 \text{ \AA}$ and angle is 120° . Determine magnitude and direction of $\mathbf{T}$.
- (v) How Hall effect can be used to identify n-type and p-type semiconductors?
- (vi) What are ferromagnetic domains? Give examples of ferromagnetic materials.

[5 x 3=15]

Q2

- (a) Show that reciprocal of BCC lattice is a FCC lattice in real space.
- (b) If $\mathbf{k}$ is the wavevector and $\mathbf{G}$ is reciprocal lattice vector, write the Bragg's condition of crystal diffraction using Ewald's construction.
- (c) Copper has fcc structure and the atomic radius is $1.278 \text{ \AA}$. Determine its density (Atomic weight of Cu = 63.54, Avogadro number = 6.023×10^{23}).

[6,6,3]

P.T.O.

Q3

- (a) Draw the labelled periodic potential diagram of a Kronig-Penney model and explain the salient features of the model. Explain conductors, semiconductors and insulators based on energy bands.
- (b) Obtain the mathematical relation for effective mass of electron in solids.
- (c) What is superconductivity? Give an example of a superconductor. [6,6,3]

Q4

- (a) Explain lattice vibrations for a linear diatomic chain of atoms. Derive the dispersion relation and draw the diagram showing optical and acoustic branches.
- (b) Derive Dulong and Petit's law for specific heat of solids. Explain the conditions suggested by Einstein and Debye for further improvement. [8,7]

Q5

- (a) Derive Langevin's theory of diamagnetism and show that diamagnetic susceptibility is negative and independent of temperature.
- (b) Draw B-H hysteresis loop for a ferromagnetic material. Explain the B-H loop with the help of domain theory.
- (c) Define electronic, ionic and orientational dipolar polarizability for dielectric materials. [6,6,3]