[This question paper contains 2 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7184 **L**

Unique Paper Code : DSE- 2173540023

Name of the Paper : Crystalline Solids: Properties and Methods of Analysis

Name of the Course : **B.Sc. (Prog.)**

Semester : VIII

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. Attempt any **four** QUESTIONS in all.
3. All Questions carry equal marks.

1. (a) Discuss various types of symmetry elements present in the crystal?
(b) What is meant by stacking sequence in close-packed structures? Explain the stacking sequences in hexagonal closed packing (HCP) and cubic closed packing (CCP) with suitable diagrams.
(c) Define Miller indices. Calculate the Miller indices of crystal plane which cuts through crystal axes at (2a, -3b, -3c).

(5, 5, 5)

2. (a) How does Bragg's Law explain the lines obtained in the X-ray diffraction powder method?
(b) Explain electrical conductivity of an intrinsic semiconductor based on band theory.
(c) What do you mean by extrinsic semiconductors? Explain the semiconducting behaviour of extrinsic semiconductors by clearly drawing their energy level diagrams.

(5, 5, 5)

3. (a) Differentiate between crystalline and amorphous solids with respect to structure, properties, and examples.
(b) Explain the Williamson-Hall method for determining the crystallite size and lattice strain from X-ray diffraction data. Also write the corresponding equation explaining the meaning of each term used in this method.
(c) Derive Bragg's Law used in X-ray diffraction analysis, and explain the meaning of each term used in the Bragg's equation

(5, 5, 5)

P.T.O.

4. (a) Explain the formation of tetrahedral and octahedral voids in close-packed structures. How many such voids are present per atom?

(b) Compare the X-ray diffraction patterns of NaCl and CsCl highlighting the differences in their crystal structures and reflection conditions.

(c) Explain the term Spin Magnetic Moment. Calculate spin magnetic moments of Mn^{2-} and Fe^{2+} ions. (Atomic number of Mn = 25, Fe = 26)

(5, 5, 5)

5. (a) Sketch the (100) and (110) Miller planes within a cubic unit cell, clearly indicating the planes with shaded regions.

(b) Write a note on magnetic ordering and anisotropy.

(c) An X-ray diffraction (XRD) peak for a crystalline material appears at a Bragg angle $2\theta=36.5^0$. The full width at half maximum (FWHM) of the peak is $\beta=0.25^0$. The X-ray wavelength used is $\lambda=1.54$ Å. Calculate the crystallite size (D) of the material in nanometres using Debye-Scherrer formula. (K= 0.9, shape factor)

(5, 5, 5)

6. (a) Write a detailed note on Thermogravimetric Analysis (TGA). Discuss its principle, instrumentation, and applications.

(b) Explain the concept of electronic structure in solids. How does it lead to the formation of energy bands?

(c) Explain the concept of exchange interaction and its role in magnetism.

(5, 5, 5)