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DS-544

January 2022

M. Sc. III Semester Examination

PHYSICS

First Paper : Condensed Matter Physics – I

Time 3 Hours]

[Max. Marks : Regular 85 / Private 100
[Min. Marks : Regular 28 / Private 33

Note : This question paper is meant for all Regular and Private students. Answer all five questions. All questions carry equal marks. The blind candidates will be given 60 minutes extra time.

1. (a) Explain what is meant by atomic packing factor in cubic lattices.

   (b) Describe the face centred cubic (fcc) and hexagonal packed (hcp) Structures. Show the atomic packing factor for fcc and hcp metals are the same.

   OR

   (a) Calculate the volume of Zinc crystal structure unit cell by using following data : 00.4947 nm.

   (b) What do you understand by Miller indices of a crystal plane ? Show that in cubic crystal the spacing between consecutive parallel planes of Miller indices (h, k, l) is given by :

$$d_{hkl} = \frac{a}{\sqrt{h^2 + k^2 + l^2}}.$$

2. (a) Explain how x-ray are used for determining the crystal structure.

   (b) Outline construction of reciprocal lattice vector. Explain Ewald construction for X-ray diffraction and hence prove Bragg's Law $G^2 - 2K = 0$ in vector form.

   OR

   (a) If the angle between the direction of incident x-rays and the diffracted one is 16°, what is angle of incident ?

   (b) (i) Show that the every reciprocal lattice vector G is normal to the plane of the crystal lattice.

   (ii) Show that the reciprocal lattice of a bcc is fcc.

3. (a) Write short note on reduction of number of elastic constants.

   (b) Show that the number of independent stiffness constants is three in a cubic crystal.

   OR

   (a) Define Stress and Strain Components.

   (b) Show that the velocity of the transverse wave in the [1 0 0] direction of a cubic crystal is given by :

$$V_S = \left(\frac{C_{44}}{\rho}\right)^{1/2}.$$

4. (a) Show that the energy of a lattice vibration is quantized.

   (b) The unit cell parameter of NaCl crystal is 5.6 Å and the modulus of elasticity along [1 0 0] direction is 5×10^{10} N/m^2. Estimate the wavelength at which an electromagnetic radiation is strongly reflected by crystal. (At. Wt. of Na = 23 and Cl = 37).

   OR

Analyze the vibrational motion of a diatomic periodic linear chain and obtain expression for the vibration frequencies (w) as a function of the wave number (k). Show that dw/dk must vanish at the zone boundary.