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DS-544

January 2015

M. Sc. IIIrd Semester Examination

PHYSICS

First Paper : Condensed Matter Physics – I

Time 3 Hours] [Max. Marks : Regular 85 / Private 100 / ATKT 35

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

1. (a) Explain with examples, the characteristics exhibited by bcc and fcc.
   (b) What is a Bravais Lattice ? What are the different space lattices in the cubic system ?

   OR

   (a) What are the various symmetry operations that are present in a crystal ?
   (b) Discuss hexagonal closed packed (hcp) structure. Show that the atomic packing factor for the face centered cubic (fcc) and hcp metals are the same.

2. (a) Draw reciprocal lattice vectors for bcc and fcc lattices.
   (b) Obtain the following condition of X-ray diffraction :

   $$2K.G + G^2 = 0$$

   where K – wave vector, G – reciprocal lattice vector.

   OR

   (a) If the angle between the direction of the incident X-rays and the diffracted one is 16°, what is the angle of incident ?
   (b) Explain the concept of reciprocal lattice. Write steps of its geometrical construction.

3. (a) Define Stress and Strain Components.
   (b) Show that the velocity of transverse wave in [100] direction of a cubic crystal is given by:

   $$v_s = \left[\frac{C_{44}}{\rho} \right]^{1/2}.$$

   OR

   (a) Write short note on reduction of number of elastic constants.
   (b) Explain in detail the method for experimental determination of elastic constants.

4. (a) Define acoustic and optical branches of diatomic molecules.
   (b) Show that the physical momentum of a phonon is zero.

   OR

   (a) If the velocity of sound in a solid is take to be 3×10^3 m/s and the inter atomic distance as 3×10^{-10} m, calculate the value of cut-off frequency assuming a linear lattice.
   (b) Describe with necessary theory and the method of neutron diffraction for the study of phonons in crystals.

5. (a) What are Normal and Umklapp Processes ?
   (b) Show that the effective mass of the electron is :

   $$m^* = \frac{h^2}{4\pi^2} \left(\frac{d^2 \in}{dk^2} \right)^{-1}.$$

   OR

   (a) Explain the term Fermi surface and construct it for square lattice.
   (b) How does the band theory of solids lead to the classification of solids into conductors, insulators and semiconductors ?

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