23/3/17

DOON UNIVERSITY, DEHRADUN

Mid Semester Examination, Second Semester, 2016-17

School of Physical Sciences

M.Sc. Physics (Optoelectronics)

Course: PHC-453: Solid State Physics

Time Allowed: 2Hours *Maximum Marks: 30*

Note: Attempt All Questions from Sections A, B, C.

SECTION: A *(Marks: 2 X 3=6)*

1. Solve the following:
   (a) If a crystal plane makes intercepts of 2, 3,∞ units on crystallographic axis a, b and What will be the Miller indices of the plane?
   (b) For a cubic crystal lattice, what do the following represent?
   <101> (b) [110] (c) (101) (d) {100}
2. What do you understand by Madelung constant? Calculate the Madelung constant in a linear chain of ions.
3. (a)What is non directional bonding? Write down the lattice parameters for trigonal crystal structure.
   (b) Draw $[1, \frac{\bar{1}}{2}, 1]$ in (110), (101) and $[\bar{1}10]$

SECTION: B *(Marks: 4 X 3=12)*

4. A beam of X-rays incident on Na crystal. If the difference between the incident and scattered wave vectors is $K = h\hat{x} + k\hat{y} + l\hat{z}$, where $\hat{x}, \hat{y}, \hat{z}$ are the unit vectors of the associated cubic lattice:
   (a) Determine which X-ray reflections will be observed for Na.
   (b) Write down the extinction rule for the allowed reflections.
5. Consider a BCC crystal structure with lattice constant a. Determine
   (a) Miller indices of (100)
   (b) Number of atoms per unit area in (111).
6. The potential energy between the two adjacent atoms may be represented by $V = -\frac{A}{r} + \frac{B}{r^n}$. Calculate the binding energy at equilibrium. Explain the concept of attractive and repulsion energy with respect to that.

SECTION: C *(Marks: 6 X 2=12)*

7. (a) Define the term reciprocal lattice and explain its relation to Bragg reflection.
   (b) A FCC lattice is formed by atoms having radius r. Obtain an expression, in terms of r, for the areal density of atoms for (111) plane.
8. (a)What is Brillouin Zone (BZ). Explain in detail about Ist, IInd and IIIrd BZ.
   (b) The density and the molar mass of a bivalent sample of volume V= 4 x 10^{-6} m^3 are 1.7 x 10^3 kg/m^3 and 24.0 x 10^{-3} kg/mol, respectively. Calculate the number of conduction electrons in the sample (N= 6.023 x 10^{23}/ mol)