

Roll Number

Thapar University

School of Physics and Material Science

B. Tech. (III Semester) MST, September 2016

UES012: Engineering Materials

Time: 02 Hours, MM: 50

Name of faculty: KUS, PNS, CBN, BCM, LKB, DBD, RBP

- Note: 1. Attempt all questions in **sequence**. Attempt all parts of questions together.  
2. Answers should be precise and to the point.  
3. Assume any missing data suitably.

- Q.1 (a) Differentiate between
- (i) Substructure and microstructure.
  - (ii) Alloys and composites.
- (b) Discuss the structure-processing-properties relationship in materials engineering.
- (c) Discuss the dependence of the following properties on the bonding character with proper reasoning.  
(a) Modulus (b) Mechanical strength (c) Melting point (d) Resistivity.
- (d) List two each of structure-sensitive and structure-insensitive properties of materials.

(6+2+4+2)

- Q.2 (a) Show the atomic configuration in (111) plane and [111] direction for Fe (BCC) and Cu (FCC). Also calculate their planar and linear density. The lattice parameter for Fe and Cu is 2.87 Å and 3.63 Å, respectively.
- (b) Draw (1100), ( $\bar{1}2\bar{1}2$ ) planes and  $[2\bar{1}\bar{1}1]$ , [0001] directions in a hexagonal unit cell.
- (c) Derive Bragg's condition for X-ray diffraction from a monoatomic crystal.  
An X-ray diffractometer record diffraction peaks at following  $2\theta$  angle:  $36.191^\circ$ ,  $51.974^\circ$ ,  $64.982^\circ$ , and  $76.663^\circ$ . If the wavelength of radiation was 1.54 Å, then determine:
- i. The crystal structure of the element.
  - ii. The Miller indices of diffracting planes.
  - iii. The lattice constant of element.
- (d) Draw the common direction in (111) and (110) planes.

(6+4+6+2)

- Q.3 (a) Explain why? Limit your answers within 30-40 words.
- i. Water molecule is covalently bonded, but remains in liquid state at room temperature.
  - ii. Ionic radii of  $\text{Fe}^{2+}$  is larger than  $\text{Fe}^{3+}$ .
  - iii. Inert gases form bonds at low temperature.
  - iv.  $K_\beta$  radiation is not used for crystal structure determination.
  - v. (100) reflection does not exist in X-ray diffraction pattern of the BCC crystal.
  - vi. FCT does not exist in Bravais lattice.
- (b) Draw potential energy vs distance curve for covalently bonded and metallic bonded atoms and discuss their distinct feature(s).
- (c) The Coulomb attractive force between the  $\text{Mg}^{+2}$  and  $\text{S}^{-2}$  that just touch each other is  $1.49 \times 10^{-8}$  N. Determine the radius of the  $\text{Mg}^{+2}$  ion. (Radius of  $\text{S}^{-2}$  is 0.184 nm).

((2x6)+3+3)