Roll Number:

Thapar Institute of Engineering & Technology, Patiala

School of Physics & Materials Science

BE/BTech (Semester 3) MST, Sep. 2018

UES012: Materials Science & Engineering

Time: 02 hrs; MM: 50

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Note: i. Attempt all questions in a **sequence**.
ii. Assume any missing data suitably.

Q.1 Differentiate the following: **(3x2)**

(i) Alloys – Composite
(ii) Substructure – Microstructure
(iii) Resilience – Modulus

Q.2 (a) Draw one tetrahedral and octahedral void each in FCC and HCP unit cell. **(4, 3, 3)**

(b) Show (002) plane and [211] direction in a unit cell. Calculate their planar and linear density for FCC Cu. Given 'a' = 3.61 Å.

(c) What are the indices of the directions of the form <111> that lie in the $(\bar{1}01)$ plane of a cubic cell? Show them in a labeled figure.

Q.3 Define the following terms. **(4x2)**

(i) Passivation (ii) Hydrogen embrittlement (iii) Cathodic protection (iv) Stress corrosion cracking

Q.4 (a) For each of the following elements, use the Hume-Rothery rules to determine whether, on mixing with zinc (Zn), the resulting binary alloy will be a solid solution with i) substantial solubility, ii) limited solubility, or iii) essentially no solubility. Explain your answer. **(3, 3, 3)**

Element	Atomic Size [pm]	Electronegativity	Crystal Structure	Valence
Zn	133	1.6	HCP	2
Cu	128	1.9	FCC	2
Co	125	1.8	HCP	2
Cr	125	1.6	BCC	1

(b) Calculate the c/a ratio for hexagonal closed packed (HCP) structure.

(c) Differentiate between edge and screw dislocations. Provide neat diagrams for both cases.

Q.5 (a) Determine the expected diffraction angle for the first-order reflection from the (113) set of planes for FCC platinum when monochromatic radiation of wavelength 0.1542 nm is used. Atomic radius is 0.1387 nm. **(3, 2, 2)**

(b) What are the burgers vector for monoatomic FCC and BCC structure?

(c) Explain, with an example, why dislocations tend to have a smallest possible Burger vector.

Q.6 Explain why? **Limit your answer to 30-40 words.** **(2x5)**

(a) There is no end-centred cubic space lattice.

(b) Diffraction technique with a Laser cannot be used for crystal structure determination.

(c) Although both Si and Pb belong to group IVA of the periodic table, there is a significant difference in their melting points (Si: 1410 °C and Pb: 328 °C).

(d) Despite increase in the number of atoms in the unit cell in comparison to the FCC structure, diamond shows far less packing efficiency.

(e) Dislocations are not observed in amorphous materials.