Roll Number

Thapar University

School of Physics and Material Science

End Semester Examination, December 2016

B. Tech. (III Semester)	**UES012: Engineering Materials**
Time: 03 Hours, MM: 100	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 Differentiate between edge and screw dislocations. Draw diagram of both to show Burger and dislocation line vector.

(6)

Q.2 (a) i. Prove that the shear stress required to initiate plastic deformation in perfect crystals is $\mu/6$ (μ is shear modulus).

ii. Explain why a real crystal deforms at much lower shear stress than $\mu/6$.

(b) i. Draw labelled tensile load - elongation curve and true strain - true stress curve for a ductile material.

ii. Compute the strain hardening exponent '*n*' for an alloy in which a true stress of 520 MPa produces a true strain of 0.20; assume strength coefficient K = 1050 MPa.

(c) A low carbon steel cylindrical specimen has an initial diameter of 12.5 mm. It reduces to 12.0 mm when 75 kN load is applied. Calculate the engineering stress and engineering strain. Also calculate true stress and true strain. Assume that the volume of the specimen remains the same.

((6+2)+(5+2)+4)

Q.3 Calculate the density and packing efficiency of the NaCl crystal. Given the ionic radius corresponding to Na^+ and Cl^- are 0.97 Å and 1.81 Å, respectively. Atomic masses of Na and Cl is 23 and 35.5 g/mol, respectively.

(7)

Q.4 (a) Draw a labelled hypothetical binary phase diagram of a system with two components A and B from the following data:

i. Melting point of A and B is 1000 and 800 °C, respectively.

ii. The system undergoes a eutectic reaction at 600 °C and composition with 40 wt% B.

iii. The maximum solubility of A in B and B in A is 15 % and 10 %, respectively, at 600 °C.

iv. The solubility of A in B and B in A drops to 2.5 % and 0% at room temperature, respectively.

Calculate the amount of α and β phases at 700 °C and 80 % A composition.

(b) Briefly explain why,

i. upon solidification, an alloy of eutectic composition forms a microstructure consisting of alternating layers of the two solid phases.

ii. a two component system cannot have more than four phases in equilibrium.

(c) Draw a labelled representative isomorphous phase diagram of a two component system.

(10+(2x2)+4)

Q.5 (a) Sketch atomic positions in the (100), (110), and (111) planes for FCC Nickel. Determine the planar density in each of these planes. Which, if any, of these planes is close-packed? Given that lattice parameter a is 3.5167 Å.

(b) In an ionic compound of AB with cubic close packing, the radius of B^- ion is 1.95 Å. Calculate the radius of the A^+ ion that just fits into the tetrahedral void. Can a cation A^+ with a radius of 0.82 Å be slipped into an octahedral void?

(4+4)

Q.6 (a) Differentiate between

i. Hard and soft magnetic materials (with examples)
ii. Type I and Type II superconductors (with examples)
iii. Ionic and electronic polarization

(b) A p-type Ge semiconductor, with dimensions 10 mm long and 1 mm diameter, has impurity concentration 4.19×10^{21} /m^3. Calculate the resistance offered by the material. The mobility of holes in Ge is 0.19 m^2/Vs.

(c) Calculate the relaxation time of electrons in Al at room temperature, if conductivity of Al is $3.57 \times 10^7 (\Omega\ m)^{-1}$, Density of Al is 2.7 g cm^{-3}. Atomic mass is 26.98 g mol^{-1}. Also compute current density when electric field of 3 V/cm is applied.

((3x3)+4+4)

Q.7 Define the following corrosion and corresponding mechanism associated with it. Explain the preventive method to control them.

(a) Crevice corrosion (b) Stress corrosion cracking
(c) Hydrogen Embrittlement (d) Erosion Corrosion

(2.5x4)

Q.8 (a) Draw $(\bar{1}01)$ plane in a cubic unit cell. Show in the diagram and list the directions of type <111> which lie on this plane.

(b) Explain why? Limit your answers to 30 words.

i. Fe and Cu both are metallic solids, but Cu forms closed packed structure.
ii. Polycrystalline materials are stronger than single crystalline materials.
iii. $BaTiO_3$ is ferroelectric only below Curie temperature.
iv. Mn is antiferromagnetic but Cu_2MnAl is ferromagnetic.
v. It is easier to move wide dislocations compared to narrow dislocation.
vi. Copper shows low resistivity than copper alloys at 0K.

(3+(2x6))