Roll Number 101703801

Thapar Institute of Engineering and Technology

School of Physics and Materials Science

END Semester Examination, 10th December 2018

B. Tech. (*III* Semester)	**UES012: Engineering Materials**
Time: 03 Hours, MM: 100	Name of faculty: OPP, PNS, CBN, BCM

Note: Attempt all parts of a question **together.** Assume any missing data suitably.

Q.1 **(a)** Draw a labelled hypothetical two component (A & B) phase diagram from the following data: **(10)**

i. Melting point of A and B are 1100 °C and 900 °C respectively

ii. Maximum solid solubility of A in B is 12% and B in A is 8 % at invariant temperature i.e. 750°C, the solubility drop down to zero in both the cases at room temperature.

iii. The eutectic reaction takes place at 68% of B.

(b) From the above constructed phase diagram, for an overall composition of 75% A, determine **(2+4)**

i. the fraction of liquid and solid phases at 800°C.

ii. the fraction of primary α, fraction of eutectic α and fraction of eutectic β phases at 730 °C.

(c) Write (i) Peritectic reaction **(2+2)**

(ii) Eutectoid reaction

Q.2 **(a)** Draw the M-H curves for type I and type II superconductors *below their critical* temperature(s). ***(4)***

(b) Fe undergoes allotropic transformation from BCC to to FCC at 910 °C. Calculate the % volumetric change during the transformation. Given lattice parameters, a_{BCC} = 1.258 Å and a_{FCC} = 1.292 Å. ***(4)***

(c) Define uniform corrosion and list two prevention methods for it. **(4)**

(d) Write the equation and calculate the stress required to move a dislocation if the width of the dislocation is twice of the magnitude of the burgers vector. **(4)**

Q.3 **(a)** i. Explain how grain size of a polycrystalline material affects its yield strength. Also mention the mathematical relation between them. **(5+4)**

ii. Estimate the change in yield strength of a polycrystalline material when its ASTM grain size increased from 4 to 8. Assume yield strength at infinite grain size, σ_i = 80 MN/m² and Hall-Petch constant, k = 0.63 MN/m$^{3/2}$.

(b) Explain why Al is not suitable for light weight air borne structures while its composite with Boron is. Calculate the modulus of Al (70%)-B(30%) composite; Given: Young's modulus of Al=71 GPa; B=440 GPa. **(3+3)**

(c) A cylindrical specimen of steel having an original diameter of 14 mm is tensile-tested to fracture and found to have engineering fracture strength of 500 MPa. If its cross-sectional diameter at fracture is 12 mm, determine the true stress at fracture. **(5)**

Q.4 (a) Draw a planar view of diamond cubic structure and calculate its packing efficiency. (5)

(b) In an ideal HCP unit cell, draw $(01\bar{1}0)$ plane and calculate its planner density. Given, the atomic radius is 1.31 Å. (5)

(c) The Bragg angle (2θ) corresponding to a reflection for which $(h^2+k^2+l^2) = 8$ is observed at 14.35° for a cubic crystal. Determine the lattice parameter of the crystal if the X-ray wavelength is 0.71 Å. (4)

Q.5 (a) Draw a labeled polarization *vs.* frequency plot for $PbTiO_3$ in audio to optical frequency range. Which polarization mechanism, if any is absent in it? Justify your answer. (4+2)

(b) Draw labelled *M-H* loops for (i) AlNiCo and (ii) Ni-Zn ferrite. Which will have higher energy product and why? (6)

(c) Show that electrical conductivity of a metal is proportional to the average collision time of electrons. (4)

(d) Calculate the room temperature conductivity of pure Ge. The concentration of holes is $n_h = 1.01 \times 10^{14}\ cm^{-3}$ and mobility of electrons and holes is 0.39 $m^2/V.s$ and 0.19 $m^2/V.s$ respectively. (4)

Q.6 Briefly explain why (Limit your answer to 20-30 words) (10)

i. Glazing is done for ceramic insulators.
ii. Fe is ferromagnetic while Mn is not.
iii. Platinum is used in resistance thermometers.
iv. Graphite is used as a lubricant while diamond is not.
v. Ionic crystals have large burger vector.