2072
B.E. (Biotechnology) Second Semester
ASP-X03: Physics of Materials
(Common with IT,CSE and MEC)

Time allowed: 3 Hours

Max. Marks: 50

NOTE: *Attempt* <u>*five*</u> *questions in all, including Question No. I which is compulsory and selecting two questions from each Part.*

x-x-x

1 (a) Offer an explanation as to why covalently bonded materials are generally less dense than ionically or metallically bonded ones. (2)

(b) What is the difference between a lattice and a crystal? (2)

(c) Rank the magnitudes of the diffusion coefficients from greatest to least for the following systems: (i) N in Fe at 700C (ii) Cr in Fe at 700C (iii) N in Fe at 900C (iv) Cr in Fe at 900C. Also justify this ranking. (2)

(d) Explain the difference between resolved shear stress and critical resolved shear stress. (2)

(e) Cite two major differences between martensitic and pearlitic transformations. (2)

Part A

2 (a) Niobium has an atomic radius of 0.1430nm and a density of $8.57 g/cm^3$. Determine whether it has an FCC or BCC crystal structure. (4)

(b) Draw an orthorhombic unit cell, and within that cell a $[2\bar{1}1]$ direction. (3)

(c) Derive planar density expressions for FCC (100) and FCC (111) planes in terms of the atomic radius R. (3)

3 (a) What are dislocations? Differentiate between edge and screw dislocations. (4)

(b) For which set of crystallographic planes will a first-order diffraction peak occur at a diffraction angle of 44.53° for FCC nickel when a monochromatic radiation having a wavelength of 0.1542 nm is used? (3)

(c) For a steel alloy it has been determined that a carburizing heat treatment of 15 h duration will raise the carbon concentration to 0.35 wt% at a point 2.0 mm from the surface. Estimate the time necessary to achieve the same concentration at a 6.0 mm position for an identical steel and at the same carburizing temperature. (3)

4 (a) Show that the void in a simple cube can be filled by sphere having radius not larger than $0.732R$, where R is the radius of the larger sphere involved in the packing of these spheres. (4)

(b) Cite the primary differences between elastic, anelastic, and plastic deformation behaviors. (3)

(c) A steel bar and an aluminium bar are each under a load of 5000N. If the cross-sectional area of the steel bar is 100 mm^2, what must be the area of aluminium for the same elastic deformation. Given the young's moduli $E_{Al} = 71\,GN/m^2$, $E_{steel} = 210\,GN/m^2$. (3)

Part B

5 (a) What is a slip system. Do all metals have the same slip system? Why or why not? (3)

(b) Explain the differences in grain structure for a metal that has been cold worked and one that has been cold worked and then recrystallized. (3)

(c) Distinguish between (i)stable and unstable crack (ii) intergranular and transgranular fracture. (4)

6 (a) With reference to the Fatigue failure, What information does an SN plot convey? (4)

(b) Discuss the typical creep curve for a material subjected to a constant load creep test, while maintaining the temperature constant. (4)

(c) Briefly explain why a proeutectoid phase (ferrite or cementite) forms along austenite grain boundaries. (2)

7 (a) Discuss the development of microstructure in Pb-Sn alloy of eutectic composition as it is cooled from a temperature above the eutectic temperature to a temperature below the eutectic temperature. (4)

(b) Briefly discuss the differences between (i)congruent and incongruent transformations (ii) TTT and CCT transformations. (4)

(c) What is Temper Embrittlement? (2)

x-x-x