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Final Assessment Test – November/December 2023

Course: **BMEE209L - Materials Science and Engineering**

Class NBR(s): **1661/ 1663/ 1665/ 1869/ 1870** Slot: **B2+TB2**

Time: **Three Hours** Max. Marks: **100**

KEEPING MOBILE PHONE/SMART WATCH, EVEN IN "OFF" POSITION, IS TREATED AS EXAM MALPRACTICE

Answer any TEN Questions

(10 X 10 = 100 Marks)

1. a) Describe the enabling materials property of each of the following (i) aluminium for airplane bodies; (ii) glass for laboratory ware and (iii) polyethylene terephthalate for water bottles (iv) tungsten carbide for ball mill media. **[5]**

   b) Define a slip system. Do all metals have the same slip system? Why or why not? Write down the slip plane and slip direction of Al. How many slip systems are there in Al? **[5]**

2. a) The average grain diameter of an aluminium alloy is 14 μm with strength of 185 MPa. The same alloy with an average grain diameter of 50 μm has a strength of 140 MPa. (i) Determine the constants for the Hall-Petch equation for this alloy? (ii) How much more should you reduce the grain size if you desire a strength of 220 MPa? **[5]**

   b) The unit cell of a metal has an edge length of 2.8 Å and density 7.88 g/cm^3. Determine the crystal structure of metal? The atomic mass of the metal is 56 g/mol. **[5]**

3. a) Explain the factors that govern solubility of one metal in another. Using the data provided below, predict the relative degree of solubility of zinc and lead in copper. **[5]**

Element	Atom radius (nm)	Crystal Structure	Electronegativity	Valence
Cu	0.128	FCC	1.8	+2
Zn	0.133	HCP	1.7	+2
Pb	0.175	FCC	1.6	+2

   b) Draw the cooling curve of copper and red brass, given the melting temperature of copper and zinc are 1085 °C and 419.5 °C, respectively. Also, calculate the degree of freedom in single phase and two phase region of copper – zinc alloy? **[5]**

4. a) An iron-iron carbide alloy has proeutectoid phase and eutectoid phase at room temperature. The fraction of total ferrite and total cementite is 0.7 and 0.3, respectively. Find the nature of alloy and its composition. Also draw the microstructure of the alloy at room temperature. [5]

b) Draw the time temperature transformation (TTT) diagram of eutectoid steel and represent the phases present and corresponding transition temperatures and time. Also arrange the various phases in TTT diagram in the increasing order of hardness. [5]

5. a) Is it necessary to surface harden a high carbon steel component? What are the methods available? Explain hardening process using TTT diagrams. [5]

b) Nitridation of steels necessarily require few transition metal alloying elements. Explain the reason and process. What are the precautions to avoid white layer formation during nitriding? [5]

6. a) What is ausforming process? Describe microstructure of ausformed steel and explain its properties. [5]

b) How does spheroidizing improve machinability of steels? Explain Spheroidizing process and draw the microstructure of spheroidite. [5]

7. a) For a brass alloy, the stress at which plastic deformation begins is 345 MPa, and the modulus of elasticity is 103 GPa. [5]

(i) What is the maximum load that can be applied to a specimen with a cross-sectional area of 130 mm^2 without plastic deformation?

(ii) If the original specimen length is 76 mm, what is the maximum length to which it can be stretched without causing plastic deformation?

b) Discuss the significance of fatigue in metals and alloys. Draw the S-N curve and evaluate the variation in fatigue limit for ferrous and non-ferrous alloys. [5]

8. a) Elaborate two strengthening mechanism in metals and alloys with the help of schematic. Which strengthening mechanism is widely used in aluminium alloys for aircraft structures? [5]

b) You are given a plastic, a ceramic and a steel piece. Describe the chosen methods with which you would evaluate the hardness of the specimens with applicable formulae, loads and force time details. Typical hardness values with units must be listed. [5]

9. Compare the benefits and drawbacks of plain carbon steel and cast iron with respect to processing, structure, properties and application. Give the type of cast iron used in crush liners and pump impeller. [10]

10. Why is stainless steel stainless? Discuss the types of stainless steel with structure, properties and applications. [10]

11. a) Discuss a case study on the development of piston using aluminium alloy with the help of materials tetrahedron. [5]

b) Titanium is one of most explored metal in a wide range of diverse application. Justify the statement. Discuss the types of titianum alloys with the application areas. [5]

12. a) Evaluate the benefits of fibre reinforced polymer composites over conventional materials. What are the factors affecting the performance of composites? Elaborate with the help of examples and application. [5]

b) Discuss the simplest manufacturing strategies for ceramic components with the help of schematic. Give specific materials and applications areas. [5]

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