VIT
Vellore Institute of Technology

Final Assessment Test – April 2019

Course: MEE1005 - Materials Engineering and Technology
Slot: B2+TB2
Class NBR(s): 2068 / 2124 / 2278
Max. Marks: 100
Time: Three Hours

Answer any TEN Questions
(10 X 10 = 100 Marks)

1. a) Calculate the planar density of (100) and (110) plane and linear density of [111] and [110] direction in FCC metal (a = 0.5 nm). [6]

   b) Calculate the volume change from fcc γ-iron to bcc α-iron. The atom radius is R. [4]

2. a) A ceramic is suspected to have oxygen anions (O^{2-}) at locations (0 ½ ½), (½ 0 ½), (½ ½ 0), barium cations (Ba^{2+}) at locations all (000) and titanium cation (Ti^{4+}) at (½ ½ ½). Draw and label the contents of a unit cell of this material. What is the chemical formula? [5]

   b) If there are 400 grains per square inch in a photomicrograph of a ceramic material at 200X, what is the ASTM grain size number and grain size (mm) of the material. [5]

3. a) A hypothetical A-B alloy of composition 55 wt% B-45 wt% A at some temperature is found to consist of weight fractions of 0.5 for both α and β phases. If the composition of the β phase is 90 wt% B-10wt% A, what is the composition of α phase? [5]

   b) Explain the factors governing the formation of substitutional solid solutions. [5]

4. Differentiate between martensite and bainite structures and explain why neither of these phases appear on the equilibrium phase diagram.

5. Compare precipitation hardening and the hardening of steel by quenching and tempering with regard to (i) the total heat treatment procedure (ii) The microstructures that develop.

6. Explain the process and objectives of heat treatment. Explain about the Austempering and Martempering processes with neat sketches.

7. Describe the microstructures of gray, white, malleable, and ductile cast irons. Discuss how each is formed in terms of solidification behavior, composition, and heat treatment.

8. Discuss different types of titanium alloys and their properties and applications.

9. The following data were collected from a 12-mm-diameter test specimen of magnesium (l_o = 30.00 mm):

   After fracture, the gage length is 32.61 mm and the diameter is 11.74 mm. Plot the data and calculate

   (i) the 0.2% offset yield strength

   (ii) the tensile strength

   (iii) the modulus of elasticity

   (iv) the % Elongation

Possession of Mobile Phone in the exam hall even in switched off condition is a malpractice.

(v) the % Reduction in area

(vi) the modulus of resilience

Load (N)	Gage Length (mm)	Stress (MPa)	Strain (mm/mm)
0	30.0000	0	0
5,000	30.0296	44.2	0.000987
10,000	30.0592	88.4	0.001973
15,000	30.0888	132.6	0.00296
20,000	30.15	176.8	0.005
25,000	30.51	221.0	0.017
26,500	30.90	234.3	0.030
27,000	31.50 **(max. load)**	238.7	0.050
26,500	32.10	234.3	0.070
25,000	32.79 **(fracture)**	221.0	0.093

10. a) Difference between ductile and brittle material fracture surface. Discuss the ductile-to-brittle transition temperature (DBTT) with the help of diagram. **[7]**

b) In a Brinell hardness test, a 1500 kg load is pressed into a specimen using a 10 mm diameter hardened steel ball. The resulting indentation has a diameter = 3.2 mm. Determine the BHN for the metal. **[3]**

11. a) Discuss classification of composite materials based on reinforcements. Give examples of each class of composite materials. **[5]**

b) A continuous and aligned glass fiber reinforced polyester matrix composite consists of 40 vol% of glass fibers having a modulus of elasticity of 69 GPa and 60 vol% of a polyester resin that, when hardened, displays a modulus of 3.4 GPa. **[5]**

(i) Compute the modulus of elasticity of this composite in the longitudinal direction.

(ii) If the cross-sectional area is 250 mm^2 and a stress of 50 MPa is applied in this longitudinal direction, compute the magnitude of the load carried by each of the fiber and matrix phases.

12. a) Discuss the properties and applications of ceramic materials in industries. **[5]**

b) Define sintering. State and describe various stages of sintering process. **[5]**

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