Final Assessment Test – November 2019

VIT® Vellore Institute of Technology

Course: MEE1005 - Materials Engineering and Technology

Class NBR(s): 1411 / 1836 / 1961 Slot: B2+TB2

Time: Three Hours Max. Marks: 100

KEEPING MOBILE PHONE/SMART WATCH, EVEN IN 'OFF' POSITION, IS EXAM MALPRACTICE

Answer ALL Questions

(10 X 10 = 100 Marks)

1. a) Check the validity of statement with proper justification, "Slip in a single is independent of its crystal structure". [5]

   b) Consider a metal single crystal oriented such that the normal to the slip plane and the slip direction are at angles of 60° and 35°, respectively, with the tensile axis. If the critical resolved shear stress is 5.4 MPa, will an applied stress of 14 MPa cause the single crystal to yield? If not, what stress will be necessary? [5]

2. Elaborate the growth mechanism of pure metals and alloys. Calculate the size of the critical radius and the number of atoms in the critical nucleus when solid iron (Fe) forms by homogeneous nucleation. Given freezing temperature, heat of fusion, solid-liquid interfacial energy and undercooling as 1538 °C, 1737 J/cm^3, 204 x 10^{-7} J/cm^2 and 420 °C. Also given lattice parameter of Fe is 0.28 nm.

3. Draw Fe-Fe$_3$C Cementite (Fe$_3$C). Also define the phases present in it and invariant reactions.

4. Draw the continuous-cooling transformation diagram for a 0.35 wt% C iron-carbon alloy. Indicate and specify heat treatment strategies (with cooling rates) in continuous-cooling curves to yield the following microstructures:

   a) Fine pearlite and proeutectoid ferrite
   b) Martensite
   c) Martensite and proeutectoid ferrite
   d) Coarse pearlite and proeutectoid ferrite
   e) Martensite, fine pearlite and proeutectoid ferrite

5. Elaborate the hardening technique of medium carbon steel for automotive shaft and gear. Elaborate on the case hardening techniques of low carbon steel for industries with the help of schematic sketches.

6. Elaborate on composition, microstructure, properties and application of different cast iron. Give three benefits of cast iron over steel?

7. a) Discuss the types of commercial Aluminium based alloys used in aerospace structures.

   b) Why titanium based alloys are widely used in biomedical implants compared to stainless steel?

8. Draw the stress strain curve of brass and indicate various regions in it. For a brass, the stress at which plastic deformation begins is 345 MPa and the modulus of elasticity is 103 GPa.

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

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

9. Discuss the strengthening mechanism of single phase materials and alloys with the help of schematic. Give the specific strengthening of aluminium alloys used in aerospace structures.

10. a) Classify polymers based on their thermal behaviour. Give examples of each. Also define glass transition temperature in polymers. [5]

    b) Elaborate the powder metallurgical route involved in preparation and processing of ceramic materials with the help of schematic? [5]

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