Indian Institute of Engineering Science and Technology, Shibpur

B. E. (Met. E.) 4th Semester Examination, May 2014

Deformation Behavior of Materials
(MT 403)

Full Marks: 70 **Time: 3 hrs**

Answer *any* SEVEN questions.

Use *single answer-script* for answering of all questions. Answer must be brief and to the point. Figures on the right-hand side indicate full marks.

1. (a) What is *yield-point phenomenon?*

   (b) Discuss the generalized theory of *yield drop*. Explain how this theory also validates the '*dislocation locking by interstitial atoms*' theory for *yield-point phenomenon* observed in annealed mild steel.

   (c) What is *stretch strain?* How can it be eliminated?

   [2+5+3]

2. (a) Draw and level a typical stress-strain curve of continuous fiber reinforced composite materials with relevant expressions of elastic modulus.

   (b) States the philosophy of minimum and critical volume fractions of fibers in a continuous fiber reinforced composite material and also derive the concerned expressions.

   (c) Differentiate between *iso-stress* and *iso-strain* conditions.

   [3+5+2]

3. (a) Discuss the dislocation mechanisms of precipitation strengthening. State the criteria for transition of one mechanism to another.

   (b) Find the yield stress of a duralumin, if the average spacing of $CuAl_2$ particles is 10 nm. Given G = 27.6 GPa, b = 0.25 nm.

   (c) Differentiate between dispersion hardening and precipitation hardening.

   [(4+1)+2+3]

4. (a) State *Hall-Petch* relationship, and drive the same on the basis of dislocation pile-up theory.

   (b) Discuss the applicability of *Hall-Petch* relationship for nanostructured materials.

   [6+4]

5. (a) Explain why *martensite* in Fe-C system is hard.

   (b) Discuss the *Ashby's* concept of *geometrically necessary dislocations.*

   (c) State and justify the minimum number of slip system require for any material to undergo arbitrary change of shape.

   [3+4+3]

6. (a) State and explain the cleavage planes in BCC crystal.
   (b) Discuss the mechanism of *Frank-Read source* of dislocation multiplication.
   (c) Explain why rate of strengthening by interstitial elements is much higher than substitutional elements.

[3+3+4]

7. Write short technical note on the following (any TWO):
   (a) Yield locus
   (b) Lomer-Cottrell barrier
   (c) Cross slip

[5x2]

8. (a) Explain the importance of yield criteria.
   (b) State *Tresca* and *von Mises'* yield criteria.
   (c) Find out the relationship between σ_0 and τ_0 following *Tresca* and *von Mises'* yield criteria.

[2+4+4]

9. (a) Define plane-stress and plane-strain conditions with relevant stress-strain relationships.
   (b) Prove that both *Tresca* and *von Mises'* yield criteria are equivalent in *plane-strain* condition.

[5+5]

10. (a) Prove that Poisson's ratio for ideal plastic materials is 0.5.
    (b) Prove that general state-of-stress in plane-strain condition is summation hydrostatic stress plus pure shear.

[5+5]

11. (a) Classify crystal imperfections with examples.
    (b) Define the followings with units: Elastic limit, Proportional limit; Yield strength, Ultimate tensile strength, Uniform elongation, Total elongation, Resilience and Tensile toughness.

[2+8]