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BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR
B. E. (Met. E.) 4th Semester Examination, April/May 2013

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) State *Hall-Petch* relationship and define its all parameters.

(b) Derive *Hall-Petch* relationship on the basis of dislocation pile-up theory.

(c) What is *inverse Hall-Petch effect*?

[2+5+3]

2. (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 *strain-ageing*?

[2+(3+3)+2]

3. (a) With the help of schematic diagrams, discuss the dislocation mechanisms of precipitation hardening. State the criteria for transition of one mechanism to another.

(b) Find out the yield stress of an Al-4.5%Cu alloy, if the average spacing of $CuAl_2$ particles is 10 nm. Given G = 27.6 GPa, b = 0.25 nm.

[(4+3)+3]

4. (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) Calculate the elastic moduli of WC-Co composite in the longitudinal and transverse direction. Given E_{Co} = 207 GPa, E_{WC} = 690 GPa and V_{Co} = 30%

[3+4+3]

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

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

(c) Discuss the role of *staking fault energy* on plastic deformation of materials with examples?

[4+3+3]

6. (a) Explain the importance of yield criteria.

(b) Find out the relationship between σ_0 and τ_0 following *Tresca* and *von Mises'* yield criteria.

(c) What is yield locus? Discuss its utility.

[3+4+3]

7. (a) Define plane-strain and plane-stress condition with relevant equations.

(b) Prove that both *Tresca* and *von Mises'* yield criteria are equivalent in *plane-strain* condition.

[5+5]

8. (a) Prove that the following reaction is vectorically correct and spontaneous in nature.

$$\frac{a}{2}[10\bar{1}] \rightarrow \frac{a}{6}[2\bar{1}\,\bar{1}] + \frac{a}{6}[11\bar{2}]$$ (a is lattice parameter)

(b) State the dislocation reaction proposed by *W.H. Lomer* in FCC crystal and comment on the mobility of the product dislocation.

(c) Discuss how the *Lomer dislocation reaction* has been modified by *A.H. Cottrell* and state its significance in strain-hardening.

[4+3+3]

9. (a) Explain why {001} planes are cleavage planes in BCC crystal.

(b) Discuss the mechanism of *Frank-Read source* of dislocation multiplication.

(c) Calculate the length of *Burgers vector* in copper. Copper is FCC with lattice parameter of 3.6151 A^0.

[4+3+3]

10. Write short technical note on:

(a) Polygonization

(b) Dislocation climb

(c) Mohr's circle

[3+3+4]