

**B.E. METALLURGICAL AND MATERIAL ENGINEERING**  
**THIRD YEAR FIRST SEMESTER – 2019**

**Subject: DEFORMATION AND FRACTURE BEHAVIOUR OF MATERIALS**

**Time: Three Hours**

**Full Marks: 100**

**Answer Question No. 1 and any four from the rest:**

**1. Answer any five -**

- (a) What is the reason for anisotropic nature of elastic modulus of a metallic crystal.
- (b) Whether springs can be made of aluminium? Justify. Suggest two materials for making springs.
- (c) Suggest two methods by which excess vacancy can be retained at room temperature.
- (d) Which type of crystalline material is suitable for studying Bauschinger phenomenon? – Justify.
- (e) What is the reason for increased brittleness of a material at continuously decreasing temperature?
- (f) What parameter controls the dynamic recovery? Explain.
- (g) "tacking faults have positive energy, but still deformation of FCC metals occurs through formation of stacking faults." – Justify.
- (h) Interstitial elements are responsible for strain ageing, but substitutional elements – Justify.
- (i) Between two materials of different yield strength in which case fracture toughness will be more? - Justify

**2 (a).** Draw and label the engineering stress-strain curves of two metals, one showing continuous yielding and the other with discontinuous yielding. Explain the discontinuous yielding behaviour.

Find the relationship between true strain and engineering strain. 5+7++3 = 15

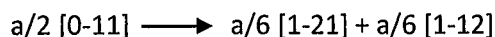
(b) Explain the effect of strain rate on the flow stress in terms of dislocation theory. 5

**3 (a)** What is the difference between precipitation hardening alloy and dispersion hardening? What is the advantage of dispersion hardening over precipitation hardening? Give an account for precipitation hardening of an alloy. 3+ 2 + 8 = 13

(c) Discuss the parameters control the strength properties of dispersion hardened system. 7 parameters control the strength properties

**4 (a)** What is Schmid's law? Show that strain hardening of polycrystalline materials is more than single crystal and comment on your finding. 2 + 6 = 8

(b) Whether the following reaction is feasible? 4



(c) Derive the Hall-Petch relationship on the basis of dislocation theory. What is the limitation of Hall-Petch relationship? 6 + 2 = 8

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- 5 (a). Discuss the strain hardening behaviour and the underlying mechanisms for FCC single crystal. 8
- (b) What is Lomer-Cottrell barrier? Discuss the formation of such barrier. 7
- (c) Find the line energy of dislocations in BCC iron. Given: Lattice parameter of BCC iron = 2.87 angstrom and Shear Modulus = 80 GPa. 5
- 6(a) What is the limitation of Griffith's Theory and how the limitations are accounted for wide acceptability of Griffith's theory. Discuss the effect of notch in case of a ductile material loaded in plane strain condition. 8
- (b) Discuss the fracture behaviour of a ductile material under tensile loading. 8
- (c) The length of a dislocation line between two pinning points is on the average equal to the reciprocal of the square root of the dislocation density in a crystal. Find the dislocation density in copper, work hardened to a stage where slip occurs at a shear stress of 35 MPa. Given: lattice parameter of Copper = 3.61 angstrom and shear modulus of Copper = 44 GPa.
7. (a) By deriving all necessary steps show the equivalence between Griffith's brittle fracture stress and fracture stress value obtained on stress concentration point of view. 12
- (b) Find the relationship for plastic zone size in case of a thin plate contacting an edge crack 'a'. 8