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

$$a/2\,[0\text{-}11] \longrightarrow a/6\,[1\text{-}21] + a/6\,[1\text{-}12]$$

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

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 Griifith'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