Ref. No.: Ex/Met/PC/B/T/313/2025

B.E Metallurgical Engineering, 3rd Year 1st Semester Examination, 2025

Subject: Plastic Deformation of Metals

Full Marks: 100 **Time:** Three hours

Answer five questions (Q. 3 is compulsory)

Q1. (a) A 24 mm thick plate is decreased in thickness according to the following schedule: 12, 6, 3 mm. Compute the total strain on the basis of initial and final dimensions and summation of the incremental strains, using both **(i)** conventional strain, and **(ii)** true strain. [CO1] **8 x 2 = 16**

(b) In which kind of material does fracture occurs at a lower load than maximum load during tensile loading? [CO1] **4**

OR

Q2. (a) Determine the engineering strain ***e***, the true strain ε, and the reduction in area ***q*** for each of the following situations: [CO1] **4 x 4 = 16**

(i) Extension from L to 1.1 L
(ii) Compression from h to 0.9 h
(iii) Extension from L to 2 L
(iv) Compression from h to 0.5 h

(b) Which tensile properties are not influenced by the specimen geometry and why? [CO1] **4**

Q3. Answer any five: **5 x 4 = 20**

a. "Whether crystal structure is changed due to plastic deformation? – Justify your answer. [CO2]

b. Explain the reason for higher strength of single-phase polycrystalline materials in macroscale as compared to single crystal. [CO2]

c. "Thin metal foils are made of aluminium in preference to copper" – Justify whether the statement is true or false. [CO2]

d. Between 'slip' and 'cross-slip' which one is easier and why? [CO2]

e. In polycrystalline single-phase materials how would you classify the grains as soft and hard? [CO2]

f. Why does "pure" gold not used for making ornaments and what is done in making gold ornaments and why? [CO2]

g. Whether dislocations are thermodynamically stable? Give justification in support of your answer. [CO2]

Q4. a. What are different partial dislocations in FCC system? How do they form? Discuss the role of different partial dislocations in relation to plastic deformation process? [CO3] **2+7+6 = 14**

b. Justify the role of crystal structure in governing the yield strength of metallic systems. [CO3] **5**

OR

Q5. a. Discuss the formation of Lomer-Cottrell barrier and its role in plastic deformation process. By drawing two adjacent FCC unit cells show the plane and direction on which Lomer-Cottrell barrier are formed. How can such barriers be overcome during plastic deformation process? [CO3] **6+5+2 = 15**

b. Give an account for dislocation climb phenomenon. [CO3] **7**

Q6. a. What type of alloys are amenable to precipitation hardening? By giving an example of a precipitation hardenable alloy state the processing stages for strengthening the alloy. What is the reason for strengthening achieved in such alloy? [CO3] **2+4+3 = 9**

b. How can the kinetics of precipitation hardening process be experimentally studied? Draw and explain the nature of shear stress – shear strain curve of the precipitation hardenable alloy under solution annealed, peak aged and overaged conditions. [CO3] **4+7 = 11**

OR

Q7. a. Show that the strain hardening rate of single polycrystalline materials are many times higher than that of single crystal. What is the fundamental reason for higher strain hardening in case of polycrystalline materials? [CO3] **5+2 = 7**

b. Give an example of ordered structure. What is the reason for very high strength achievable in such ordered structure? [CO3] **2+4 = 6**

c. Discuss the role of different microstructural parameters in controlling the strength of a two-phase aggregate structure. [CO3] **7**

Q8. a. State and explain Griffith's theory for brittle fracture? What is the shortcoming of Griffith's theory and how is it overcome? [CO4] **4+3 = 7**

b. By deriving all the necessary relationship find the equivalence between fracture stress of a brittle material obtained on consideration of stress concentration point of view and that in accordance with Griffith's theory. [CO4] **13**

OR

Q9. a. What is meant by "critical crack extension force?" – Explain. Find an analytical relationship for the "critical crack extension force" under fixed displacement loading condition. [CO5] **4+6 = 10**

b. What is K_{ISCC}? How is it obtained? Is it a material property? Give justification in support of your answer. [CO5] **2+5+3 = 10**