

**B.E Metallurgical Engineering, 3<sup>rd</sup> Year 1<sup>st</sup> Semester**  
**Supplementary Examination 2024**  
**Subject: Plastic Deformation of Metals**

Full Marks: 100

Time: Three hours

Answer Q. 1 and any four from the following Questions

1. Answer any five:

4x5 = 20

- a. "Crystal structure has a great role in determining the yield strength of metals/alloys" – Justify. [CO2]
- b. "Thin metal foils are made of aluminium in preference to copper" – Justify whether the statement is true or false. [CO2]
- c. "Springs are made of aluminium" – Justify whether the statement is true or false. [CO2]
- d. "Lomer-Cottrell barriers are formed in zinc" - Justify whether the statement is true or false. [CO2]
- e. Explain the reason for higher strength of single-phase polycrystalline materials in macroscale as compared to single crystal. [CO2]
- f. "Whether Justify that "yield strength is a material property?" – Justify your answer. [CO2]
- g. "Whether crystal structure is changed due to plastic deformation? – Justify your answer. [CO2]
- h. In polycrystalline single-phase materials how would you classify the grains as soft and hard? [CO2]
2. (a) Find the relationship for critical resolved shear stress for slip to occur in case of a single crystal. What important inferences can be drawn from this relationship? [CO3] 5 + 3 = 8
- (b) Discuss the factors that influence the strength of an alloy by second phase particles. Discuss the rule of mechanical mixture for predicting the strength of dispersed structure containing two phases. [CO3] 7 + 5 = 12
- 3 (a) If the  $\tau_{CRSS}$  for yielding in Aluminium is  $240 \times 10^3$  Pa, calculate the tensile stress required to cause yielding when the tensile axis is perpendicular to (001) plane. [CO3] 6
- (b) Discuss the effect of obstacles present on slip plane on the plastic deformation behaviour of metals and alloys. [CO3] 6
- (c) For a steel with ASTM grain size 3, what reduction in grain size would double the yield stress? Express both as average grain diameter and ASTM number. [CO3] 8
- 4 (a) Differentiate between Slip and Twinning. State the conditions conducive for formation of deformation twins. How does twinning help in the plastic deformation process? [CO3] 4+2+2= 8
- (b) Derive the relationship correlating shear strain rate, dislocation velocity and dislocation density. [CO3] 6
- (c) Give and account for dislocation climb phenomenon. [CO3] 6
- 5 (a) Find the relationship for theoretical fracture strength of a brittle material. Whether energy required for fracture of a brittle material is more than that of a ductile material? – Give reason in support of your answer. [CO4] 8 + 4 = 12
- (b) Draw a tensile stress-strain curve of a moderately ductile material and show how will you obtain different properties of the material. Explain the nature of the curve. [CO4] 8

[ Turn over

**6 (a)** In case of an infinitely wide thin plate with an edge crack of length 'a' loaded under tension below the yield strength what is the stress environment in the plate? What conclusions can be drawn if the stress environment is known. [CO5] 12

**(b)** Whether fracture toughness of a material will be different in neutral environment and corrosive environment? Give justification in support of your answer. [CO5] 4

**(c)** Find the relationship between specimen thickness and plastic zone size for obtaining valid plane strain fracture toughness. [CO5] 4

**7.** Write Short notes on the following:

**(a)** Cross-slip [CO2] 6

**(b)** Hall-Petch relationship [CO3] 6

**(c)** Precipitation strengthening [CO3] 8