Ref. No.: Ex/Met/PC/B/T/412/2025

B.E Metallurgical and Material Engineering 4th Year 1st Semester Exam 2025

Subject: Fabrication Processes

Time: 3 hours **Full Marks = 100**

(Answer All the Questions)	COs
1. Answer any two: (8 × 2 = 16) *a.* Derive the equation of stresses on an oblique plane in plane stress condition and prove that sum of the normal stresses on two perpendicular planes is an invariant quantity. **(8)** *b.* Define the Principal stress. Derive the Principal stresses in plane strain condition. **(2+6=8)** *c.* Write down the condition to represent the cylindrical state of stress. Explain whether hydrostatic stress causes yielding or not. Explain the concepts of normal shear and pure shear. **(2+3+3=8)**	CO1
2. Answer any three: (6 × 3) = 18) *a.* Principle stresses at a point in an isotropic body are 50, 15 and -20 MPa. Can this stress state produce plastic yielding if the tensile yield stress of the body is 75 MPa? **(6)** *b.* Describe why Tresca yield criteria is less accurate as compare to von-mises yield criteria? **(6)** *c.* Explain the concept of a yield locus and its role in material plasticity. **(6)** *d.* Like area, the shape of the pressure distribution curve is very important in rolling - Justify the statement. **(6)**	CO2
3. Answer any two: (9 × 2 = 18) *a.* Explain the role of flash in closed-die forging. Discuss the significance of saddle width and flash thickness in the flash region of a die. **(3+6=9)** *b.* Compare and contrast metalworking and shaping processes. Discuss how the choice of fabrication process is influenced by material properties. **(3+6=9)** *c.* Discuss the key variables in the extrusion process and their role in determining the required extrusion pressure. Define redundant work in the context of material deformation under extrusion process. **(7+2=9)**	CO3
4. Answer any two: (8 × 2 = 16) *a.* An Al ingot of 400 mm diameter is extruded with an extrusion ratio of 25. Find the diameter of the final product? What is the ideal extrusion pressure if the effective flow stress in compression is 280 MPa? **(8)** *b.* A copper strip of 300 mm wide and 25 mm thick is fed through a rolling mill with two steel rolls each 500 mm diameter. The work piece is to be reduced to 22 mm in one pass at a roll speed of 50 rpm. Copper follows a flow curve (i.e., true stress vs. true strain curve) defined by $\sigma = K\varepsilon^n$, where K = 275 MPa and n is 0.15, and the coefficient of friction (μ) between the rolls and the strip is 0.12. **I.** Is the frictional condition sufficient to permit the rolling operation to be accomplished? **(3)**	CO4

	II. If roll flattening occurs during rolling, determine the deformed radius of curvature of the steel rolls, considering the Young Modulus of steel rolls = 210 GPa and Poisson's ratio = 0.35 (Show up to two iterations). Note: $R' = R\left[1 + \frac{CP'}{b(h_0 - h_f)}\right]$ and $C = \frac{16(1-\vartheta^2)}{\pi E}$ **(5)** ***c.*** What factors influence the torque and power applied in a rolling mill? Explain how torque and required power can be calculated and controlled to optimize the rolling process. **(3+5=8)**	
	5. Answer any two: (8 × 2 = 16) ***a.*** Discuss the common defects encountered in hot rolling and propose strategies to minimize or eliminate them. **(8)** ***b.*** Explain the various residual stress patterns that can form in cold-drawn rods and wires. How does the degree of deformation (% reduction) affect the residual stress distribution across the cross-section? **(8)** ***c.*** Discuss common defects encountered in wire and tube drawing processes. Explain the causes of defect like surface scratches or irregularities and propose strategies for possible remedies. **(3+5=8)**	CO5
	6. Answer any two: (8 × 2 = 16) ***a.*** Discuss the role of friction and lubrication in metalworking processes concerning workability. **(8)** ***b.*** Discuss the influence of metallurgical structure on the extrusion process. Explain how material properties and microstructural features affect the success of extrusion and the quality of extruded products. **(4+4=8)** ***c.*** How can seamless tubes be produced without using a mandrel? Discuss the material properties and techniques involved in achieving this. **(8)**	CO6