

**M.E. METALLURGICAL AND MATERIAL ENGINEERING FIRST YEAR  
FIRST SEMESTER - 2024**

**Subject: MATERIALS PROCESSING**

**Time: 3 hours**

**Full Marks = 100**

**(Answer all the questions)**

**1. Answer any four: (4 × 5 = 20)**

- Explain the Concept of Plane Stress and Plane Strain Conditions Using Tensor Notation.
- Discuss the Influence of Deviatoric Stress Components on the Mechanical Response of a Solid Body under Loading.
- Distinguish Between Simple Shear and Pure Shear Stress States and Provide Examples of Each.
- Derive the stress-strain relations in 3-D state of stress and prove that the volumetric strain  $\Delta = \frac{1-2\nu}{E} 3\sigma_m$ ,  $\nu$  and  $E$  = Poisson's ratio and Elastic constant of the material, and  $\sigma_m$  is hydrostatic stress.
- State the yield criteria and its importance in metal working.

**2. Answer any two: (8 + 8 = 16)**

- Describe the fundamental principles involved in the forging process. Explain how temperature, and strain rate influence the final properties of forged components.
- A cylindrical disc of Aluminium of initial diameter of 35 mm and height 12 mm is to be cold forged to a final diameter of 42 mm. Calculate the plastic work of the above forging operation. The strength coefficient of Aluminium is 160 MPa and the work hardening exponent is 0.25.
- Discuss how the following defects form and possible remedies:
  - Alligatoring
  - Cold shut
  - Hot shortness
  - Chevron cracking

**3. Answer any two: (8 + 8 = 16)**

- Compare and contrast the rolling processes of hot rolling and cold rolling for producing steel sheets. Discuss the effects of temperature, deformation rate, and surface finish on the final product properties.
- Design a sheet metal forming process sequence for manufacturing a complex automotive panel. Consider factors such as material selection, blanking, bending, stretching, and finishing operations to achieve the desired part geometry and mechanical properties.
- Provide a concise explanation of the following concepts: i) Limiting Draw Ratio (LDR) and ii) Formability Limit Diagram.

**4. Answer any one: (16)**

- a. Create a labeled schematic illustrating the distribution of roll pressure along the arc of contact during the cold rolling process of sheet material. Clearly identify the neutral point on your diagram. Explain how the neutral point shifts with the application of front tension and back tension. Describe the method for applying front tension and back tension in cold rolling of sheet metal and discuss its significance in improving the process. Elaborate on the purpose of applying front tension and back tension and its effects on product quality.
- 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 revolutions/minute. Copper follows a flow curve (i.e. true stress vs. true strain curve) defined by  $\sigma = K\epsilon^n$ , where  $K = 275$  MPa and  $n$  is 0.15, and the coefficient of friction ( $\mu$ ) between the rolls and the strip is 0.12. Determine the followings:
  - i. Is the frictional condition sufficient to permit the rolling operation to be accomplished?
  - ii. If so, then calculate the required Rolling Force
  - iii. 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).

**5. Answer all questions: (8 + 8 = 16)**

- a. Discuss the factors influencing wire drawing force and describe strategies for optimizing wire drawing operations to minimize energy consumption.
- b. In a wire drawing operation, a 10 mm diameter stainless steel wire drawn to 8 mm. Determine the drawn stress required for this drawing operation. The flow stress is given by  $\sigma = K\epsilon^n$ , where  $K = 1250$  MPa and  $n$  is 0.28.

**6. Answer all questions: (8 + 8 = 16)**

- a. Discuss the different types of extrusion process and their merits and demerits. How you will determine the extrusion pressure under ideal condition?
- b. Examine the role of lubrication in extrusion processing and its impact on product quality and tool life. Discuss the types of lubricants used in extrusion and the factors influencing lubricant selection.