

MANIPAL (A constituent unit of MAHE, Manipal)

V SEMESTER B. TECH (IP ENGG.) END SEMESTER EXAMINATIONS, JANUARY 2020

SUBJECT: THEORY OF METAL FORMING [MME 4045]

REVISED CREDIT SYSTEM

Time: 3 Hours

MAX. MARKS: 50

Instructions to Candidates:

- ✤ Answer ALL the questions.
- Missing data may be suitably assumed.
- Draw neat and proportionate sketches wherever necessary.
- **1A.** A metal is yielding plastically under the stress state shown in Figure 1. (a) **4** Label the principal axis according to their proper numerical convention, (b) What is the yield stress considering Tresca criterion, (c) If Von Mises yield criterion is used, (d) The value of ε_3 , if $\varepsilon_1 = 0.45$ and $\varepsilon_2 = 0.22$ when the material is plastically deformed.



Figure 1 State of stress

- **1B.** With suitable sketches, describe the mechanisms involved in slip and **3** twinning.
- 1C. How can you tell whether a certain part is forged or cast? Describe the 3 features that you would investigate to arrive at a conclusion
- 2A. Considering slab analysis of an open die forging process and by making 3 suitable assumptions, show that the forging pressure is given by the expression,

$$p = \sigma_o' \left[1 + \frac{2\mu(a-x)}{h} \right]$$

2B. A solid cylindrical slug made of 304 stainless steel having K = 1160 MPa and **3** n = 0.43 is 125 mm in diameter and 70 mm high. It is reduced in height by 60% at room temperature by open-die forging with flat dies. Assuming that the coefficient of friction is 0.15, calculate the forging force at the end of the stroke using the average pressure.

- **2C.** Differentiate between a forging hammer and a press. With a neat sketch **4** comment of the working of board drop hammer.
- **3A.** A 200 mm wide annealed brass strip having K = 895 MPa and n = 0.20 is rolled from a thickness of 22 mm to 16 mm. For a roll radius of 500 mm and roll RPM of 125, estimate the torque per roll and total power required for this frictionless operation.
- **3B.** With suitable sketches, differentiate between flat rolling and roll bending **3** operations.
- **3C.** Comment on variation in roll pressure distribution along the arc of contact **4** during flat rolling process.
- 4A. Explain Ugine-Sejournet process used for hot extrusion of metals. Comment 3 on how the ram speed influences the lubricant coating.
- **4B.** Low carbon steel billet of initial diameter 60 mm and length 150 mm is hot extruded using a square die ($\alpha = 45^{\circ}$) at a speed of 130 mm/s. Estimate the extrusion force for extruding the billet to a final diameter of 30 mm. The average flow stress of material is $\bar{\sigma} = 100 \dot{\varepsilon}^{0.1}$ (MPa) and the Johnson strain equation constants are a = 0.8 and b = 1.5 respectively. Assuming poor lubrication ($\mu = 0.2$) and dead zone formation, determine the total extrusion load considering the die and frictional pressure.
- 4C. With a suitable sketch explain the construction features of a conical drawing 3 die.
- 5A. With a suitable sketch explain the principle involved in V-bending operation.4 Comment on the springback effect and ways to overcome it.
- 5B. Describe the cupping test which is used to determine the formability of sheet 3 metals with a suitable sketch. How does the test performed to determine the forming limit diagram differ from the cupping test?
- 5C. Depressed groove has to be formed on a hollow copper tube. Suggest a suitable HERF process for the same. Sketch and explain the stages of production.