Reg. No.

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

V SEMESTER B. TECH (IP ENGG.) END SEMESTER EXAMINATIONS, NOVEMBER 2018

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.
- ❖ Use of Design data hand book is permitted
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1A. With illustrations, describe the effects of hot and cold working on the microstructure of a metallic material. **3**

1B. Derive the relationship between engineering stress and true stress. What is the merit of using true stress-strain curve in metal forming processes? **3**

1C. A metal is yielding plastically under the stress state shown in the figure. (a) 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 $\varepsilon_2 = 0.15$ when the material is plastically deformed.

2
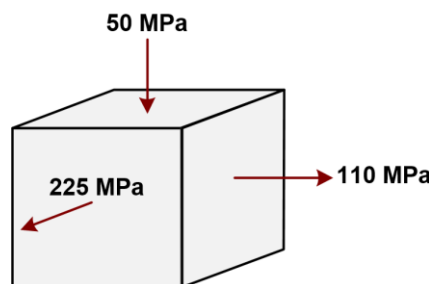
1D. What is twinning? How does it differ from slip phenomenon? **2**

2A. With a neat sketch, explain the working principle of a board drop hammer. **3**

2B. Considering slab analysis of an open die forging process and by making suitable assumptions, show that the forging pressure is given by the expression,

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

4

2C. A solid cylindrical slug made of annealed Molybdenum having $K = 725$ MPa and $n = 0.13$ is 110 mm in diameter and 60 mm high. It is reduced in height by 40% at room temperature by using open flat dies. Assuming that the coefficient of friction is 0.15, **3**

calculate the forging force at the end of the stroke considering the average pressure.

3A. Can the front and back tension applied to a strip influence the rolling pressure? Clarify with a neat sketch. **3**

3B. A rolling operation takes place under the conditions shown in the figure. What is the position of the neutral point (x_n) from plane Y-Y if the thickness of the plate at the neutral point is 4 mm? Also determine the bite angle (α) ignoring the front and back tension.

2
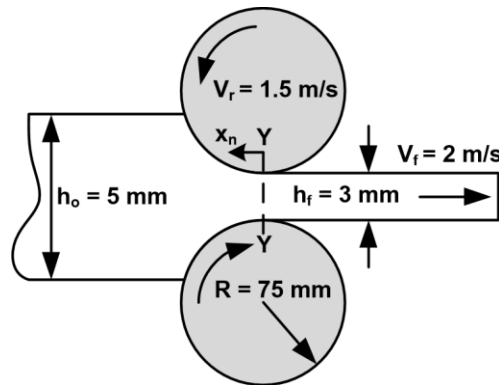
3C. Illustrate the working of a planetary type rolling mill. **3**

3D. A thick plate is flat rolled from 35 mm to 30 mm using 500 mm diameter mills rotating at 800 mm/s. The plate widens by 5% during the process. Calculate, (a) Length of arc of contact, (b) Forward slip if the plate velocity at the entrance is 750 mm/s. **2**

4A. Analyze the influence of die angle on extrusion force using a suitable sketch. **3**

4B. Explain with a neat sketch, the working of a conical die used in rod drawing process. **3**

4C. Low carbon steel billet of initial diameter 60 mm and length 150 mm is hot extruded using a square die ($\alpha = 45°$) 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 $\bar{\sigma} = 100\dot{\bar{\varepsilon}}^{0.1}$ (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. **4**

5A. Depressed groove has to be formed on a hollow copper tube. Which of the HERF process can be used? Sketch and explain the stages of production. **4**

5B. Sketch the deformed shaped of a grid used in forming limit diagram considering plane strain and biaxial tension. In a forming limit diagram, what does the forming limit curve represent? How can the forming limit of a sheet metal be increased? **3**

5C. With a neat sketch outline the working of V-bending operation. Comment on the spring back effect in the context V-bending operation. **3**