[This question paper contains 3 printed pages.]

3083 *Your Roll No.* ....

MEM (PE) **J**

Paper – ME.556

PLASTICITY AND METAL FORMING

Time : 3 Hours *Maximum Marks : 100*

(Write your Roll No. on the top immediately on receipt of this question paper.)

Answer any **five** *questions.*

1. (a) Whether the deformation theory may be used reasonably instead of the flow theory for calculating stresses & strain in a plastically deformed rotating disc

If yes why ?

If No why ? (10)

(b) What is upper bound theorem ? (10)

2. An aluminium alloy is hot extruded at 400°C through square dies without lubrication from 125 mm dia to 40 mm dia. The extrusion speed is 45 mm/s. The flow stress at 400°C is 250 N/mm^2. The length of the billet is 450 mm. Determine the extrusion load. (20)

3. Annealed brass wire is to be drawn from 6 mm dia to 1.5 mm dia with an intermediate annealing at about 3 mm. Suggest a suitable drawing schedule for a wire drawing machine with a maximum put of 4.5 Kal. The dies may be ground to any angle but the best available lubricant gives $\mu = 0.04$. (20)

4. (i) What roll load is required to roll 500 mm × 2.5 mm mild steel strip previously rolled, 30% to 2.4 mm thick with 350 mm dia steel rolls ? (10)

   (ii) What is the Hitchcock flattening

   (a) In the absence of tension

   (b) With front tension equal to 150 N/mm^2 & back tension 75 N/mn). (10)

5. Estimate the maximum force required for extruding a cylindrical Al. billet of 50 mm dia & 75 mm length in a final diameter of 10 mm. The average tensile yield stress for Al is 170 N/mm^2. What percent of the total input power will be lost in friction at the start of operation. (20)

6. (a) State various assumptions made in slip line field analysis.

   (b) State the boundary conditions of slip line field analysis.

(c) Briefly explain plane strain indentation.

(d) Analyse slip line field for forging process. (20)

7. At a point P the stress tensor is

$$\begin{bmatrix} 1 & 2 & 1 \\ 2 & -2 & -3 \\ 1 & -3 & 4 \end{bmatrix} \text{ all in units } 50\ \text{N/mm}^2$$

Find directions of the principal axes and the values of corresponding principal stresses. (20)

8. (a) Show that in the principal axes the power of deformation is reduced to

$$\dot{W}_i = \frac{2}{\sqrt{3}}\sigma_0 \int_V \sqrt{\frac{1}{2}\left(\dot{\epsilon}_I^2 + \dot{\epsilon}_{II}^2 + \dot{\epsilon}_{III}^2\right)}\, dV$$

and with assumption of volume constancy becomes

$$\dot{W}_i = \frac{2}{3}\sigma_0 \int_V \sqrt{\left(\dot{\epsilon}_I^2 + \dot{\epsilon}_{II}^2 + \dot{\epsilon}_{III}^2\right)}\, dV \qquad (10)$$

(b) The given velocity field inplastic deformation is

$$\dot{U}_x = \frac{0.75}{E}axy \qquad \dot{U}_y = \frac{0.375}{E}a\left(x^2 - y^2\right) \qquad \dot{U}_z = 0$$

Show that the strain rate components are,

$$\dot{\epsilon}_{xx} = \frac{0.75}{E}ay, \quad \dot{\epsilon}_{yy} = \frac{-0.75}{E}ay, \quad \dot{\epsilon}_{xy} = \frac{0.75}{E}ay \qquad (10)$$

(100)****