B.E. PRODUCTION ENGINEERING, THIRD YEAR
SECOND SEMESTER, SUPPLEMENTARY EXAM 2023

MATERIAL FORMING

Time: 3 hours

Full Marks: 100

Answer any FIVE questions

All parts of a question (a, b etc) should be answered a one place.

GROUP – A

1. (a) State Von Mises' maximum distortion energy criterion and show that

$(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2 = 2\sigma_{y.p.}^2$

where σ_1, σ_2 and σ_3 are the principle stresses and $\sigma_{y.p}$ is the tensile yield stress.

(b) Show that at the point of necking,

$$\frac{d\sigma}{d\varepsilon} = \sigma \quad \text{and} \quad \frac{d\sigma}{d\phi} = S$$

where σ = true stress, ε = true strain
and S = engg. stress, φ = engg. strain.

10+10

2. (a) Derive the following expression for cylindrical wire or rod drawing clearly stating the different assumptions

$$\frac{\sigma_d}{\bar{\sigma}_{yp}} = \frac{1+B}{B}\left[1-(1-r)^B\right] \quad \text{Where } B = \mu \cot a$$

σ_d = drawing stress
$\bar{\sigma}_{yp}$ = average yield stress
μ = coeff of friction
r = fractional reduction of area
α = semi die angle

(b) A bar of material has a stress strain curve given by $\sigma = 50\varepsilon^{0.5}$, σ is in tons per sq. inch. Such a bar which has already received an engineering tensile

strain of 0.25, is to be pulled in tension until it begins to neck. What further engineering strain may be expected?

(c) What is flow rule? Write down the expression for flow stress and flow strain.

10+6+4

3. (a) Describe variation of extrusion force with respect to punch displacement in case of forward and inverted extrusion.

(b) Discuss various extrusion defects.

(c)The following equation expresses the pressure for the extrusion of aluminum bar:

$$p = \sigma_0(0.47 + 1.2\ln R)e^{4\mu L/D}$$

Billets 200 mm in diameter and 400mm long are extruded into 19mm diameter bars. In order to increase the length of the product by 3m, would it be more economical in terms of pressure to increase the billet length or the diameter? (Assume μ =0.1)

5+5+10

4. (a) Describe three high rolling mill and discuss its advantages.

(c) Determine the roll pressure for strip rolling indicating the assumptions used in the method of roll pressure evaluation.

(d) Sketch a roll pressure versus angular coordinate curve. Why the peak pressure at neutral point decreases with increase in back and front tension? Explain why the neutral point shifts towards entry end with increase in front and back tension.

3+12+5

5. (a) Derive expressions for pressure distribution in forging of a strip considering both sliding and sticking friction.

(b) A 20 mm x 20 mm x 160 mm copper plate is forged between two flat dies to a final size of 10 mm x 40 mm x 160 mm. The co-efficient of friction is 0.2 and the tensile yield stress of copper can be taken as 70 N/mm^2. Determine the peak forging force

(i) Assuming no strain hardening.

(ii) Assuming the strain hardening characteristics for copper as

$\sigma_y = 70 + 30\varepsilon^{0.33}$ N/mm^2

10+10

6 (a) Derive an expression for deep drawing force. Indicate the assumptions.

(b) A cold rolled steel cup with an inside radius 30 mm and a thickness 3 mm is to be drawn from a blank of radius 40 mm. The shear yield stress and the maximum allowable stress of the material can be taken as 210 N/mm^2 and 600 N/mm^2, respectively.

i) Determine the drawing force, assuming that the coefficient of friction μ = 0.1 and β = 0.05.

ii) Determine the minimum possible radius of the cup which can be drawn from the given blank without causing a fracture.

10+10

7. (a) Explain different tube drawing operations with neat sketches.

(b) A steel wire is drawn from an initial diameter of 127 mm to final diameter of 102 mm at a speed of 90 m/min. The half-cone angle of the die is 6° and the coefficient of friction at the job-die interface is 0.1. A tensile test on the original steel specimen gives a tensile yield stress 207 N/mm^2. A similar specimen shows a tensile yield stress of 414 N/mm^2 at a strain of 0.5. Assuming a linear stress-strain relationship for the material, determine the drawing power and the maximum possible reduction with the same die. No back tension is applied.

(b) What is the purpose of ironing incase of deep drawing? Explain with sketch how the stripping of the job from the punch is achieved.

4+10+6

8. (a) What are the main features of High Energy Rate Forming (H.E.R.F.)? Describe electrohydraulic forming.

(b) What is strain hardening? Write down the reasons for strain hardening.

(c) What is recrystallization temperature?

(d) Discuss the adverse and beneficial effect of friction.

(e) Discuss how centre bursting may occur in bar drawing operation.

6+3+3+5+3