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14MDE252

Second Semester M.Tech. Degree Examination, June/July 2018
Theory of Plasticity

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Define and explain the following terms:
   (i) Deviatoric stress.
   (ii) Spherical stress.
   (iii) Octahedral stress.
   (iv) Representative strain. **(08 Marks)**

b. The state of stress at a point is given by the following stress tensor:

$$\begin{bmatrix} 100 & 25 & -15 \\ 25 & -60 & 40 \\ -15 & 40 & -75 \end{bmatrix} \text{MPa}$$

Calculate :
   (i) Stress invariants.
   (ii) Magnitude and direction of principal stresses.
   (iii) Spherical and deviatoric stress tensor. **(12 Marks)**

2 a. Explain cubical dilatation and obtain its expression in terms of linear strains. **(10 Marks)**

b. The stress at a point is given by,

$$\begin{bmatrix} -800 & 400 & 500 \\ 400 & 1200 & -600 \\ 500 & -600 & -400 \end{bmatrix} \text{MPa.}$$

Determine :
   (i) The stress on the plane whose direction cosines are $l = \frac{1}{4}$ and $m = \frac{1}{2}$ and
   (ii) The normal and shearing stress on plane.. **(10 Marks)**

3 a. A thin walled tube of average radius 100 mm and wall thickness 40 mm is subjected with torque of 10 Nm. If the yield strength of the tube material is 122.5 MPa, determine the values of axial load P to be applied to the tube so that the tube starts yielding according to the Von-mises yield criteria. **(08 Marks)**

b. Explain the experimental verification of Saint – Venants theory of plastic flow. **(12 Marks)**

4 a. Explain 'Haigh-Westergard' representation of yield criterion. **(10 Marks)**

b. The state of stress at a point is given by $\sigma_x = 70$ MPa, $\sigma_y = 120$ MPa and $\tau_{yx} = 35$ MPa. If the yield strength for the material is 125 MPa, determine in a uniaxial tensile test, whether the yielding will occur according to Tresca's and Von-mises yield conditions or not? **(10 Marks)**

5 a. Explain the following stress-strain diagram employed to describe elastic plastic behavior of material:
   (i) Perfectly linear elastic material.
   (ii) Rigid perfectly plastic.
   (iii) Rigid with strain hardening.
   (iv) Elastic perfectly plastic.
   (v) Elasto-plastic with strain hardening **(10 Marks)**

b. A rectangular beam having linear stress-strain behavior is 6 cm wide and 8 cm deep. It is 3 m long, simply supported at ends and carries a uniformly distributed load over the whole span. The load is increased so that the outer 2 m depth of the beam yields plastically. If the yield stress for beam material is 240 MPa, plot the residual stress distribution in beam. **(10 Marks)**

6 a. For a bar with non-linear stress – strain behavior, derive tension equation in the form,

$$\frac{T}{J^n} = \frac{\tau}{r^n} = F\left(\frac{\theta}{l}\right)^n$$ neglecting elastic shear strain. **(10 Marks)**

b. A strip of initial width 6.25 mm is drawn through tapered dies to a final width of 5.625 mm in a state of plane strain. Considering thickness to be equal to 10 mm, semi die angle 10°, co-efficient of friction 0.03, determine the draw stress when,
   (i) Back pull is zero and
   (ii) Back pull is 150 N.
   Yield stress for strip material is 250 N/mm^2. **(10 Marks)**

7 a. Derive equation for draw stress in a strip drawing process considering friction. **(10 Marks)**

b. In a four high roll mill, 25 mm thick mild steel plates are rolled to 20 mm. Determine the co-efficient of friction if this is the maximum reduction possible. The roll diameter is 500 m. Calculate backward and forward slips, maximum pressure and location of neutral plane. Yield strength of mild steel in simple tension is 120 MPa. **(10 Marks)**

8 Write a short note on:
a. Slip line theory.
b. Yield locus.
c. Symmetry convexity.
d. Generalized hooks law. **(20 Marks)**

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