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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Second Semester, M.Tech. - Mechanical Engineering (MMDN)

Semester End Examination; May/June - 2018

Theory of Plasticity

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

UNIT - I

1a. Explain spherical and deviatoric stress. Also, show that deviatoric stress invariants are :

$i)\ I_1' = 0 \qquad ii)\ I_2' = \frac{I_1^2}{3+I_2} \qquad iii)\ I_3' = \frac{1}{27}\left(27I_3 + 2I_1^3 + 9I_1I_2\right)$ 10

b. The stress tensor at a point is given by $\begin{bmatrix} 50 & 50 & 150 \\ 50 & 100 & 100 \\ 150 & 100 & 150 \end{bmatrix} N/mm^2$ 10

Calculate for the plane having direction cosines $l = \frac{1}{\sqrt{6}},\ m = \frac{1}{\sqrt{3}},\ n = \frac{1}{\sqrt{2}}$:

i) Total stresses ii) Normal stress iii) Shear stress and its direction

2a. Explain briefly :

i) Octahedral stress ii) Unloading and Reloading in plasticity 12

iii) Representative stress iv) Strain rate tensor

b. Obtain the relation between true stress and true strain. 8

UNIT - II

3 a. At a point in a member the state of stress is shown in Fig. 3(a). The tensile elastic limit is 413.7 MPa and shearing stress at a point is 206.85 MPa. At yielding, what is the tensile stress at the point according to :

i) Tresca's Criteria ii) Von-Mises Criteria 10

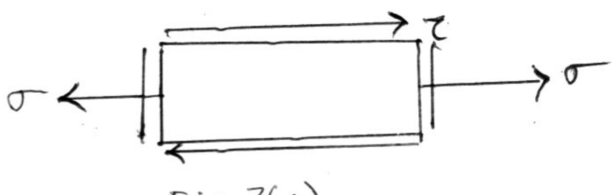

Fig 3(a)

b. Explain Haigh-Westergaard stress space. 10

4 a. Explain experimental verification of yield criteria by Taylor and Quinney's. 10

b. The state of stress at a point is given by σ_x = 70 MPa, σ_y = 120 MPa, τ_{xy} = 35 MPa. If the yield strength for the material 125 MPa, determine whether yielding will occur according to Tresca's and Von-Mises yield conditions or not. 10

UNIT - III

5 a. Write $\sigma - \varepsilon$ diagram for the following materials :
i) Rigid perfectly plastic ii) Rigid strain hardening iii) Elasto-Perfectly plastic 10
iv) Elastoplastic with strain hardening v) Linear elastic

b. Explain experimental verification of Prandtl-Reuss theory. 10

6 a. Briefly explain the concept of plastic potential. 10

b. Explain Saint Venants theory of plastic flow. 10

UNIT - IV

7 a. Derive and show the distribution of residual stress in a rectangular beam for the following cases : 10
i) Elasto Plastic yielding
ii) Fully plastic yielding

b. Obtain σ_r , σ_θ, σ_z for the plastic flow of a wide strip through a smooth taperd die. 10

8 a. For an elastic work hardening material derive expression for torque to cause :
i) Incipient yielding ii) Elasto plastic yielding 10
iii) Fully plastic yielding in torsion of a bar

b. A strip of steel 2 cm wide and 0.5 cm thick is drawn through frictionless dies to the final size of 1.5 cm wide and 0.5 cm thick. If the yield stress for the strip material is 175 N/mm^2, determine the stresses in the strip at the exit of the dies and the percentage of reduction based on Von-Mises criteria for plane strain condition. 10

UNIT - V

9 a. Explain the properties of slip lines. 10

b. Derive Geiringer equations for a slip line. 10

10 a. State and prove Heneky's first theorem. 10

b. Explain any two methods to construct slip-line Nets. 10

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