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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; June - 2017

Theory of Plasticity

Time: 3 hrs *Max. Marks: 100*

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

UNIT - I

1 a. Write the Spherical and Deviatoric stress tensors starting from three dimensional stress tensor and state their significances. 5

b. Given $\sigma_{xx} = -5c, \sigma_{yy} = c, \sigma_{zz} = c, \tau_{xy} = -c, \tau_{yz} = 0, \tau_{xz} = 0$ where $c = 1000\ kPa$. Determine the Principal stresses, stress deviators, principal axes, maximum shearing stress and the octahedral stresses. 15

2 a. Discuss the following :

i) Cubical dilation ii) Octahedral strains iii) Strain rate. 12

b. The strain tensor at a point is given by,

$$\varepsilon_{ij} = \begin{pmatrix} 0.002 & -0.005 & 0.003 \\ -0.005 & 0.003 & 0.002 \\ 0.003 & 0.002 & 0.004 \end{pmatrix}$$

Determine the deviator and spherical strain tensors. 8

UNIT - II

3 a. Stating the importance of yield criteria, discuss Tresca's and Von-Mises-Hencky's yield criteria. 12

b. The state of stress at a point in material is given by

$\sigma_{xx} = 80$ MPa, $\sigma_{yy} = 100$ MPa, $\sigma_{zz} = 0$, $\tau_{xy} = 60$ MPa, $\tau_{yz} = \tau_{xz} = 0$,

if the yield point of the material is 150 MPa, determine whether yielding occurs according to Tresca's and Mises-Hencky yield criteria. 8

4 a. Discuss the following with reference to yielding of materials :

i) Yield criteria for an elastic materials ii) Perfectly plastic materials

iii) Yield criteria for anisotropic materials. 10

b. Explain the Haigh-Westergaard stress space representation for yielding of materials. 10

UNIT - III

5 a. Write the elastic and plastic stress-strain relations for the following materials :

i) Rigid-perfectly plastic ii) Rigid-strain hardening

iii) Elasto-plastic with strain hardening iv) Visco-elastic. 10

Contd…2

b. State and explain Saint-Venant's theory for plastic flow phenomenon. 10

6 a. Discuss the experimental verification of Saint Venant's theory of plastic flow. 10

b. Discuss the following in relation to plastic deformation of material :

i) Plastic potential of a material ii) Prandtl-Reuss hypothesis. 10

UNIT - IV

7 a. Discuss the elasto-plastic recovery of residual stresses in beams. 10

b. A cantilever beam of 100 mm wide, 120 mm depth and 4 m length is subjected to an end load of 5 kN. If the stress-strain curve for the beam material is given by $\sigma = 700 \in^{0.2}$, determine the maximum stress induced in the beam and its radius of curvature. 10

8 a. Discuss the following in respect of plastic torsion of circular bar :

i) Elasto-plastic yielding ii) Full yielding. 10

b. An aluminum rod 6.25 mm in diameter is drawn into a wire of 5.60 mm diameter. Neglecting friction between the rod and the dies, determine the drawing stress and the reduction in area when the yield stress for aluminum is 35 N/mm^2. Calculate the tangential stress at the exit and the stresses in the rod at the entrance to the dies if the rod is extruded. 10

UNIT - V

9 a. Show that a plain strain condition exists in a 2-dimensional incompressible flow, and hence obtain principal strain equation. 8

b. Deduce the Geiringer velocity equations for 2-dimensional incompressible flow. 8

c. Write the conventions for the slip-lines. 4

10 a. Deduce the Hencky's equations of equilibrium for slip lines. 10

b. State and explain the Hencky's second theorem for geometry of the slip-line method. 10

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