U.S.N

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

(An Autonomous Institution affiliated to VTU, Belgaum)

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

Semester End Examination; June - 2016

Theory of Plasticity

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Assume suitable missing data if any.

UNIT - I

1 a. Define the following :

(i) Octahedral Stresses (ii) Stress invariants (iii) Representative stress (iv) Effective stress (v) Hydrostatic and Deviatoric stresses. 10

b. The stress components at a point are σ_x = 50 MPa, σ_y = -30 MPa, σ_3 = -100 MPa, τ_{xy}=50 MPa, τ_{zx} = -40MPa, τ_{yz} = 30MPa. Determine;

(i) Stress invariants 10

(ii) Magnitude and directions of maximum principal stresses

(iii) Spherical and deviator stress tensors.

2 a. Derive invariants of the deviator stresses in terms of invariants of stress tensors. 10

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

$$\in_{ij} = \begin{bmatrix} 0.001 & 0.0005 & 0.002 \\ 0.0005 & 0.002 & 0.001 \\ 0.002 & 0.001 & 0.003 \end{bmatrix}$$ 10

Determine the magnitude and direction of minimum principal strains.

UNIT - II

3 a. Explain :

(i) Tresca's yield Criteria (ii) Heneky-Von Mises Criteria. 10

b. Explain Haigh-Westergaard Stress space of yield criteria. 10

4 a. 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 is 125 MPa, determine whether yielding with occur according to Tresca's and Von Misco yield conditions or not. 10

b. Explain the experimental verification of yield criteria by Taylor and Quinney's. 10

UNIT - III

5 a. Explain Stress-Strain diagram for different material models. 10

b. Explain the experimental verification of St. Venants theory of plastic flow. 10

6 a. Explain the experimental verification of Prandtl-Rouss theory. 10

b. Describe; (i) Plastic Potential ii) Plastic work and strain hardening hypothesis. 10

UNIT - IV

7 a. Derive the relation $\frac{M}{I_n} = \frac{\sigma}{Y^n} = \frac{H}{R^n}$ in plastic bending for a material, following the non-linear stress Strain law. 12

b. A cantilever beam of 100 mm wide and 150 mm deep is 5 m long and is subjected to an end load of 6000 N. If the stress strain curve for beam material is given by $\sigma = 7000f^{\,0.25}$, determine the maximum stress induced in the beam. 8

8 a. For an elastic work hardening material, derive the expression for torque to cause, 12

(i) Incipient yielding

(ii) Elasto plastic yielding

(iii) Fully plastic yielding in torsion of a bar.

b. A solid circular shaft of radius 12 cm is subjected to transmit 600 kW at 540 rpm. The maximum torque is 30 percent greater than the mean torque. If the shear stress-shear strain curve for the shaft material is given by $\tau = 280\gamma^{0.25}$, determine the maximum stress induced in the shaft and the corresponding angle of twist. What would be these values if the stress-strain curve is a linear one? (G = 0.84×10^5 MPa). 8

UNIT - V

9 a. Explain the properties of slip lines. 8

b. Derive continuity equations for a slip line. 12

10 a. State and Prove Hencky's first theorem. 12

b. Explain Numerical method to construct slip line nets. 8

* * * *