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M.E DEGREE EXAMINATIONS: JANUARY 2011

First Semester

STRUCTURAL ENGINEERING

SEE501: Theory of Elasticity and Plasticity

Time: Three hours **Maximum Marks: 100**

Answer All questions:-

PART A (10 x 2 = 20 Marks)

1. Write the equilibrium equations in Cartesian coordinates.

2. Why do we call strain as a tensor quantity?

3. Determine the shear stress component for the Airy's stress function, $\phi = -\frac{P}{d^3} xy^2 (3d - 2y)$

4. What are axi-symmetric problems? Write the equilibrium equations for such problems.

5. What are the analogous quantities for torsional problems in membrane analogy?

6. A circular section of mean diameter 300 mm and wall thickness 3 mm is subjected to a torque of 15 N-m. Calculate the maximum shear stress induced in it.

7. State the principle of virtual force.

8. Draw the finite difference module for the biharmonic equation.

9. What are the instability conditions in plasticity?

10. What are the limitations of Prandtl-Reuss theory of plastic flow?

PART B (5 x 16 = 80 Marks)

11. a) (i) Derive the strain transformation equations for a two dimensional strained element and hence obtain the expression for principal strain. (8)

(ii) The displacements at a point are given by u = $0.01y^2 + 0.15xyz$, v = $0.02 x^2y + 0.03 x^2z$, $w = 0.15\, xyz - 0.01\, x^2yz$. Determine the strain tensor and rotation tensor at the point (2, 2, -1). (8)

(OR)

b) (i) Derive the expressions for stresses in a plate of infinite dimensions with a central circular hole under uniaxial uniform tension. (8)

(ii) The state of stress at a point is given by $\sigma_x = 100 MPa$, $\sigma_y = 200 MPa$, $\sigma_z = -100 MPa$, $\tau_{xy} = -200 MPa$, $\tau_{yz} = 100 MPa$ and $\tau_{xz} = -300 MPa$

Determine (i) principal stresses (ii) maximum shear stress and (iii) direction cosines of intermediate principle plane.

12. a) A bar of length L, depth d and thickness t is simply supported and loaded at each end by a couple `C'. Show that the stress function $\phi = \Delta y^3$, adequately represents this problem. Determine the value of the coefficient A.

(OR)

b) Determine the radial and shear stresses for the Airy's stress function $\phi = \cos^3 \theta / r$ and sketch these on the periphery of a circle of radius `a'.

13. a) Derive the necessary equations for torsional analysis of any arbitrary section by Prandtl's approach.

(OR)

b) (i) A thin walled closed tube of non-circular section of constant thickness is subjected to a twisting moment T. Find the expression for shear stress and angle of twist. (8)

(ii) Explain membrane analogy. (8)

14. a) (i) Derive from first principles, for the total strain energy in terms of a general three dimensional state of stresses in Cartesian co-ordinates. (8)

(ii) Reduce the above expression for the case of symmetrical bending. (8)

(OR)

b) (i) Using Rayleigh Ritz technique, obtain the critical load for a long column fixed at the base and free at its top. (8)

(ii) Energy method always gives upper bound solution. Justify this statement with proper reasoning. (8)

15. a) A symmetrical I section beam 300 mm deep, has flanges 125 mm wide by 13 mm thick and a web 8.5 mm thick. Determine

(i) the applied bending moment to cause initial yield

(ii) the applied bending moment to cause full plasticity of the cross section

(iii) the shape factor of the cross section. Take σ_y = 250 MPa.

(OR)

b) Write short notes on the following:

(i) Mechanism of strain hardening (ii) Bauschinger's effect

(iii) St. Venant's theory of plastic flow (iv) Von Mises' yield criteria.

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