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Question Paper Code : 82307

M.E. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2013.

First Semester

Structural Engineering

ST 9203/ST 913/UST 9103/10211 SE 104 — THEORY OF ELASTICITY AND PLASTICITY

(Regulation 2009/2010)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define the term strain tensor.

2. Write the equilibrium and compatibility equations for a general three dimensional body.

3. Distinguish between 2D and 3D problems.

4. Write the by-harmonic equation in polar coordinates.

5. Draw shear stress variation across the section of rectangular and circular sections under pure torsion.

6. Mention how shear flows across the solid and thin sections.

7. Write shortly how finite difference method differs from theory of elasticity approach.

8. Define Principle of Virtual work.

9. Define the term plastic work.

10. Define Bauschinger's effect.

PART B — (5 × 16 = 80 marks)

11. (a) (i) What are stress invariants ? Express them in terms of Principal stresses σ_1, σ_2 and σ_3. (8)

(ii) The state of stress at a point is described as follows,

$\sigma_X = 300 \text{ kg/cm}^2; \sigma_y = 900 \text{ kg/cm}^2; \sigma_z = 1500 \text{ kg/cm}^2;$

$\tau_{XY} = 300 \text{ kg/cm}^2 \text{and } \tau_{YZ} = \tau_{ZX} = 0$

Calculate the three stress invariants at the point. (8)

Or

(b) (i) Derive the equilibrium equations in three dimensional Cartesian coordinate system. (8)

(ii) If an elastic body be isotropic and homogeneous. Show that the linear stress strain relationship can be expressed in terms of only two elastic constants. (8)

12. (a) (i) Explain the following :

(1) Stress function

(2) Boundary Conditions. (8)

(ii) Can the following be possible stress fields, if so under what conditions

(1) $\sigma_X = ax + by; \sigma_Y = cx + dy \text{ and } \sigma_Y = cy^2$

(2) $\sigma_X = ax^2y^2 + bx; \tau_{XY} = cx + fy \text{ and } \tau_{XY} = dxy$. (8)

Or

(b) (i) Derive the equilibrium equation in polar coordinate for a two dimensional stress system. (8)

(ii) Determine the stress components σ_r, σ_θ and τ_{XY} for the following stress function $\phi = \frac{P\gamma\theta}{\pi} \cos\theta$. (8)

13. (a) (i) Distinguish between the bahaviour of solid and hollow sections under torsion. (8)

(ii) Explain in detail Membrane analogy. (8)

Or

(b) (i) A thin walled rectangular shaft of 50 mm × 60 mm is having a wall thickness of 2.5 mm. The length of the shaft is 3000 mm and is subjected to a torque of 150 N-m at one end while the other end is rigidly fixed. Taking G = 1.05 × 105 N/mm² determine the maximum shear stress developed and the angle of twist of the shaft. (8)

(ii) Explain briefly how torsion of a hollow circular section experimentally. (8)

14. (a) Write short notes of the following :

(i) Explain how finite difference approach differs from theory of Elasticity approach. (6)

(ii) Explain the basics of finite difference method. (5)

(iii) Explain the basics of finite element method. (5)

Or

(b) Formulate the finite element model (Type of element boundary conditions loading and meshing) for the following cases

(i) Shallow rectangular beam subjected to two point loading under simple support conditions. (8)

(ii) Deep rectangular beam subjected to two point loading under simple support conditions. (8)

15. (a) (i) State the assumption that are usually made in the theory of perfectly plastic mass solid. (8)

(ii) Discuss the yield criteria of Tresca and VonMises as applied to the mathematical behaviour of perfectly plastic solids. Illustrate the yield condition by graphical representation. (8)

Or

(b) (i) State and explain in detail the flow laws of plastic mass. (8)

(ii) Enumerate the lower and upper bound theorems and briefly explain their application in the plastic analysis of structures. (8)