Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 31390

M.E./M.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

First Semester

Structural Engineering

ST 4101 – THEORY OF ELASTICITY AND PLASTICITY

(Regulations – 2021)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. List any four assumptions in theory of elasticity?
2. State the generalized Hooke's law.
3. Write the equilibrium equations in Cartesian coordinate.
4. What are Plane stress problems? Give any two examples.
5. Write short notes on St. Venant's approach for torsion analysis.
6. Give the basis for membrane analogy?
7. How the idealization of Soil medium can be done? Give any two examples.
8. Write the importance of plate load test.
9. What is Tresca's Yield Criteria.
10. List any two assumptions made in plastic theory.

PART B — (5 × 13 = 65 marks)

11. (a) When the stress tensor at a point with reference axes (x,y,z) is as given below, Show that the stress invariants remain unchanged by transformation of the axes by 45° about the z-axis.

$$\begin{bmatrix} 4 & 1 & 2 \\ 1 & 6 & 0 \\ 2 & 0 & 8 \end{bmatrix} \ MPa$$

Or

(b) The components of strain at a point is given by $\varepsilon_x = 0.01,\ \varepsilon_y = 0.25,\ \varepsilon_z = 0.025,\ \delta_{xy} = 0.01,\ \delta_{yz} = 0.10,\ \delta_{zx} = 0.02$

Find the principal strains and the orientation of the major principal strain.

12. (a) Show that Airy's stress function $\phi = A(xy^3 - (3/4)\,xyh^2$ represents stress distribution in a cantilever beam loaded at free end with load P. Find the value of A if $V_{xy} = 0$ at $y = \pm h/2$ where b and h are width and depth respectively.

Or

(b) Determine the stress fields that arises from the following stress functions

(i) $\phi = cy^2$ (4)

(ii) $\phi = Ax^2 + Bxy + cxy^2$ (4)

(iii) $\phi = Ax^3 + Bx^2y + Cxy + Dy^3$ (5)

13. (a) If the allowable shear stress is 60 MPa, Determine the torque that can be applied to the copper bars (Pandtl stress function) of size (i) 50mm × 50mm (ii) 70mm × 45mm (iii) 25mm × 60mm Also find the angle of twist. Take G=48 GPa.

Or

(b) Derive the expression for shear stress and warping constant of a bar with elliptical cross-section subjected to a torque T.

14. (a) Find out bending moment and shear force for Semi-infinite beams with concentrated load at the end.

Or

(b) Derive the expression for deflection in an infinitely long beam subjected to a concentrated load at the centre.

15. (a) A simply supported rectangular beam of length 4m and dimensions of 200mm wide and 350mm depth is subjected to a central point load. Taking yield stress as 250MPa, find the load at the (i) Incipient yielding stage (ii) Elasto plastic stage when the outer 75mm depth of beam yields plastically (iii) Plastic stage Assume elasto-plastic behaviour.

Or

(b) A cantilever beam 150mm wide and 150mm deep is 2m long. It is subjected to a udl of 3 kN/m throughout the span. The stress-strain curve for the material is given by $\sigma = 700t^{0.2}$ Determine the maximum stress and the corresponding radius of curvature.

PART C — (1 × 15 = 15 marks)

16. (a) A multi-cellular aluminium tube of cross-section as shown in Fig. Q16a resists a torque of 10kN-m. The wall thickness $t_1 = t_2 = t_3 = 2\ mm$, $t_4 = t_5 = 3\ mm$, $t_6 = 4\ mm$. Determine the maximum shear stress and angle of twist per unit length. Take G=40 GPa and A=100 mm².

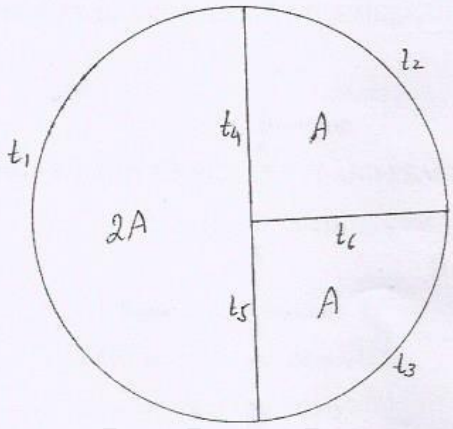

Fig. Q16a

Or

(b) For the frame shown in Fig. 16b determine the maximum shear stress and angle of twist when subjected to a maximum torque of 10 MNm. The frame is made of 20 mm steel plates having E = 200 GPa and $\mu = 0.3$.

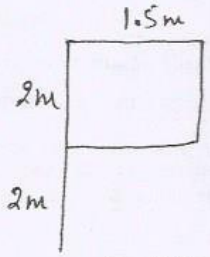

Fig. Q16b