

Reg. No. :

Question Paper Code : 12290

M.E./M.Tech. DEGREE EXAMINATIONS, JANUARY 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. Define Theory of Elasticity.
2. Define Hooke's law.
3. Define plane stress.
4. What are Cartesian coordinates?
5. Explain St. Venant's approach in torsion.
6. What is warping function?
7. State Elastic line method.
8. Define semi infinite beam.
9. What is meant by yield line?
10. Define Plastic torsion.

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PART B — (5 × 13 = 65 marks)

11. (a) The state of stress at a particular point relative to xyz coordinate system is given by stress matrix $\begin{bmatrix} 50 & 30 & -60 \\ 30 & -80 & 40 \\ -60 & 40 & 20 \end{bmatrix}$ kg/cm². Determine the normal stress, shear stresses and the resultant stresses on a plane where normal stress makes an angle 60° with x axis and 100° with y axis.

Or

- (b) The state of stress at a point is given by $\begin{bmatrix} 120 & 240 & -45 \\ 240 & 160 & 150 \\ -45 & 150 & 100 \end{bmatrix}$ MPa. Find the principal stresses and the orientation of major principal plane.

12. (a) Using Fourier Integral method determine the solution of biharmonic equation in Cartesian coordinates.

Or

- (b) A very thick component has the same boundary conditions on any given cross section leading to the following stress function $\Phi = x^5 - xy^4 - 4x^3y^2$
- check if this is a valid stress function
 - calculate all the stress components (use $m = 0.25$)
 - calculate all the strain components and displacements.

13. (a) Give a detailed account of Prandtl's membrane analogy explaining the principle of analysis of a thin-walled membrane under torsion.

Or

- (b) Derive the expression for shear stress of a bar with elliptical cross section subjected to a torque of "T" and compare are the same with hexagon of a side 'a'.

14. (a) Explain the basic principles involved in analysing beams on elastic foundation.

Or

- (b) Explain the finite difference method with suitable example.

15. (a) Write detailed notes on plastic stress strain relationship.

Or

(b) Explain the Bending and Torsion in elasto-plastic materials.

PART C — (1 × 15 = 15 marks)

16. (a) A simply supported rectangular beam of length 4 m and dimensions of 200 mm wide and 350 mm depth is subjected to a central point load. Taking yield stress as 250 MPa. Find the load at the

(i) Incipient yielding stage

(ii) Elasto plastic stage when the outer 75 mm depth of beam yields plastically.

Or

(b) Determine the diameter of the steel bolt according to the

(i) Tresca's criteria

(ii) Vonmises yield criteria if the yield stress in tension of the bolt material is 280 MPa. The bolt is subjected to a bending moment of 400 Nm and a torque of 200 Nm.

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