M. Tech 1st Semester (Civil Enggineering Computer Aided Structural Engg.) Examination, December-2023

THEORY OF ELASTICITY

Paper–21MTCASE21C3

Time allowed : 3 hours]   [Maximum marks : 100

Note : Question 1 is compulsory. Attempt one question from each Section. All questions carry equal marks. Assume missing data, if any, suitably.

1. (a) What is elasticity?

    (b) Write Saint Venant's principle.

    (c) Write applications of polar coordinates and advantages of considering problem using polar coordinates.

    (d) What do you mean by traction boundary conditions?

    (e) What is contraction applied to tensors?

    (f) Classify isotropic tensors

    (g) What is the difference between strain energy and complementary energy.

    (h) Write principle of linear superposition.

                              $2.5 \times 8 = 20$

Section–A

2. Explain the procedure for determination of stresses on any plane inclined to regular set of axes. The inclination of the plane is defined by direction cosines.   20

3. Discuss Hooks law.   20

Section—B

4. The components of a first-and second-order tensor in a particular coordinate frame are given. Determine the components of each tensor in a new coordinate system found through a rotation of 60° ($\pi/3$ radians) about the x3-axis. 20

$$a_i = \begin{bmatrix} 1 \\ 4 \\ 2 \end{bmatrix}, \ a_{ij} = \begin{bmatrix} 1 & 0 & 3 \\ 0 & 2 & 2 \\ 3 & 2 & 4 \end{bmatrix}$$

5. Explicitly verify the following properties of the Kronecker delta 20

$$\delta_{ij} a_j = a_i$$

$$\delta_{ij} a_{jk} = a_{ik}$$

Section—C

6. Investigate what problem of plane stress is solved by the stress function 20

$$\phi = \frac{3F}{4c}\left(xy - \frac{xy^3}{3c^2}\right) + \frac{P}{2}y^2$$

7. Show that—   20

$$\phi = \frac{q}{8c^3}\left[x^2(y^3 - 3c^2y + 2c^3) - \frac{1}{5}y^3(y^2 - 2c^2)\right]$$

Is a stress function and find what problem it solves when applied to the region included in $y = \pm c$, $x = 0$, on the side x positive.

Section–D

8. Find an expression in terms of $\alpha_x, \alpha_y, \iota_{xy}$ for strain energy V per unit thickness of a cylinder or prism in plane strain ($\epsilon x = 0$).   20

9. Explain in detail-   20

   (a) Principle of linear superposition
   (b) Clapeyron's theorem