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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

September / October 2023 Supplementary Examinations

Programme: B.E. **Semester: V**
Branch: Civil Engineering **Duration: 3 hrs.**
Course Code: 20CV5PETOE **Max Marks: 100**
Course: Theory of Elasticity **Date: 25.09.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1 a) The state of stress at a point is given by the following array of terms in the xyz coordinates system **10**

$$\tau_{ij} = \begin{bmatrix} 10 & 15 & 20 \\ 15 & 25 & 15 \\ 20 & 15 & 30 \end{bmatrix} \text{MPa}$$

If this system of axes is rotated by 60° about the z-axis in the anticlockwise direction, determine the new stress tensor.

b) At a point in the structural member, the stresses (in MPa) are represented as in Figure 1. Employ Mohr's circle to determine: **10**
(a) Magnitude and orientation of the principal stresses
(b) Magnitude and orientation of the maximum shearing stresses and associated normal stresses.

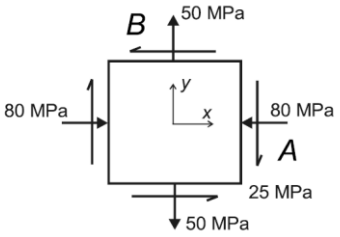

Figure 1

UNIT - II

2 a) Determine the strain components at point **(-3, 4, 5)** for the following displacement field. **10**

$$u = 8x^3 + 2y + 6z + 10$$
$$v = 3x^3 + 8x^2 + 6y^2 + z + 5$$
$$w = x^3 + 3y^3 + 8xy + 4$$

b) Given $\epsilon_\theta = \epsilon_x cos^2\theta + \epsilon_y sin^2\theta + \gamma_{xy} cos\theta sin\theta$. Derive the expression for principal strain and direction for the equiangular strain rosette. **10**

UNIT - III

3 a) Using usual notations derive the expressions for Cauchy's strain displacement relations. **10**

b) The following strains were measured in a structure during the test by means of strain gauges **10**

$$\varepsilon_0 = 650 \times 10^{-6}$$

$$\varepsilon_{60} = -200 \times 10^{-6}$$

$$\varepsilon_{120} = 250 \times 10^{-6}.$$

Determine the following
(a) Magnitude of principal strains
(b) Orientation of principal planes.

UNIT - IV

4 Determine the bending at the free end of a narrow cantilever beam loaded at free end by a concentrated load. Given **20**

$$\sigma_x = \frac{-Pxy}{I}$$

$$\sigma_y = 0$$

$$\tau_{xy} = \frac{-P(c^2 - y^2)}{2I}$$

OR

5 Derive the compatibility equation in terms of stress components for plane stress problems when body forces are absent **20**

UNIT - V

6 Show that the maximum stress concentration for an infinite plate with a circular hole $\sigma_\theta = 3\sigma_0$ when the plate is subjected to uniform tension far away from the hole. **20**

OR

7 a) A thick cylinder of inner radius 10 cm and outer radius 16 cm is subjected to an internal pressure of 14 MPa. Determine the radial and hoop stresses in the cylinder at the inner and outer surfaces. **10**

b) Given the stress function in polar coordinates determine the stress components and check for compatibility. **10**

$$\phi = \frac{P}{\pi} r\theta \cos\theta$$

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