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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Sixth Semester, B.E. - Mechanical Engineering

Semester End Examination; June - 2016

Theory of Elasticity

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each **unit**.*
ii) Missing data may suitably assume.

UNIT - I

1 a. Derive the differential equation of equilibrium for 3D elastic body subjected to body forces. 8

b. The rectangular stress components at a point in a three dimensional stress system are as follows: 12

σ_x = 20 MPa; σ_y = - 40 MPa; σ_z = 80 MPa

τ_{xy} = 40 MPa; τ_{yz} = - 60 MPa; τ_{zx} = 20 MPa

2 a. What is meant by octahedral normal & shear stress? Arrive at its value in terms of Principal stress. 8

b. A body is subjected to three-dimensional forces and the state of stress at a point in it is represented as: 12

$$\begin{bmatrix} 200 & 200 & 200 \\ 200 & -100 & 200 \\ 200 & 200 & -100 \end{bmatrix} MPa$$

Determine the normal stress, shearing stress and resultant stress on the octahedral plane.

UNIT - II

3 a. Derive the compatibility equations using strain-displacement relations. 10

b. If the displacement field in a body is specified as $u = (x^2 + 3)10^{-3}$; $v = 3y^2z \times 10^{-3}$ *and* $w = (x + 3z) \times 10^{-3}$, determine the strain components at a point whose co-ordinates are (1, 2 ,3) 10

4 a. The strain components at a point with respect to xyz co-ordinate system are $\in_x = 0.1$; $\in_y = 0.2$; $\in_z = 0.3$; $\gamma_{xy} = \gamma_{zy} = \gamma_{zx} = 0.16$. If the co-ordinate axes are rotated about Z - axis through 45º in the anticlockwise direction, determine the new strain components. 10

b. The components of strain at a point in a body are as follows: 10

$\in_x = 0.1$ $\in_y = -0.05$ $\in_z = 0.05$ $\gamma_{xy} = 0.3$

$\gamma_{yz} = 0.1$ $\gamma_{xz} = -0.08$

Determine the principal strains and directions of any one of the principal strain.

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UNIT - III

5 a. Write a short notes on:

(i) St. Venant's Principle (ii) Principle of super position

(iii) Existence of uniqueness solution (iv) Inverse and semi Inverse methods in solving elasticity problems. 20

6 a. The following are the principal stresses at a point in a stressed material. Taking $E = 210\ kN/m^2$ *and* $\mu = 0.3$ calculate the volumetric strain and the lame's constants 10

$\sigma_1 = 200\ MPa;\quad \sigma_2 = 150\ MPa;\quad \sigma_3 = 120\ MPa.$

b. The stress tensor at a point is given by

$$\begin{bmatrix} 200 & 160 & -120 \\ 160 & -240 & 100 \\ -120 & 100 & 160 \end{bmatrix} KN/m^2$$ 10

Determine the strain at this point. Take $E = 210\times10^{-6}\ KN/m^2$ *and* $\mu = 0.3$

UNIT - IV

7 a. Given the stress function $\phi = -\left(\frac{F}{h^3}\right)xy^2(3h-2y)$. Determine the stress component and sketch their variations in a region included in $y = 0, y = h, x = 0$ on the side x positive. 12

b. Write a short notes on:

(i) Plane stress and plane strain problems. 8

(ii) Airy's stress function.

8 a. Derive an expression for the shear stress induced in a bar of elliptical cross section subjected to a twisting moment and show that maximum stress occurs at the ends of the minor axis. 10

b. A hallow aluminum tube of rectangular cross section shown in Fig. Q.8(b) is subjected to a torque of 56,500N-m along its longitudinal axis. Determine the shearing stress and angle of twist. Assume $G = 27.6\times10^9\ N/m^2$

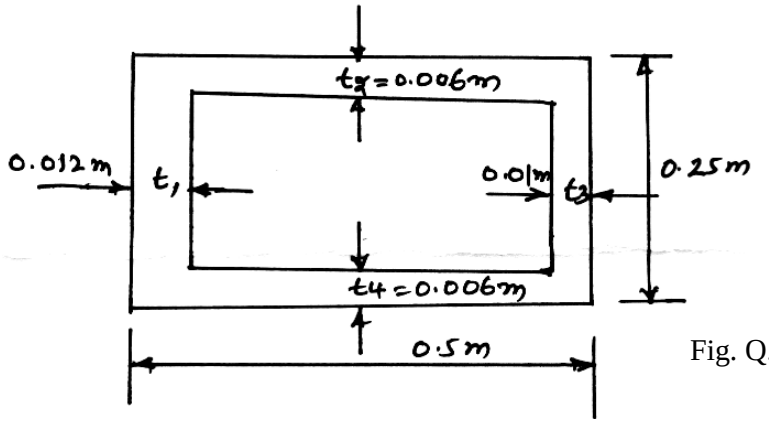

Fig. Q.8(b) 10

UNIT - V

9 a. Derive an expression for radial and tangential stress in a thick cylinder subjected to internal and external fluid pressure. 10

b. A thick cylinder of inner radius 100 mm and outer radius 150 mm is subjected to an internal pressure of 12 MPa. Determine the radial and hoop stresses in the cylinder at the inner outer surface. 10

10 a. A thin hallow tube has its inner surface at temperature Ti and its outer surface at zero temperature. Assuming steady-state conditions calculate the stresses. The inner radius is 'a' and thickness of the tube is t. 10

b. The temperature distribution in a long cylindrical conductor due to the package of current is given by $T = \lambda\left(b^2 - r^2\right)$ where λ is a constant. Determine the stresses due to thermal loading only. 10

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