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

(An Autonomous Institution affiliated to VTU, Belgaum)

First Semester, M. Tech – Mechanical Engineering (MMDN)

Make – up Examination; Feb - 2016

Theory of Elasticity

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, Selecting **ONE** full question from each **unit**.*

UNIT - I

1 a. Derive the Cauchy's formula. 10

b. The state of stress at a point is characterized by the components σ_x = 12.31, σ_y = 8.96, σ_z = 4.34, τ_{xy} = 4.2, τ_{yz} = 5.27, τ_{zx}= 0.84, find the values of Principal stress. 10

2 a. Stress components are given by σ_x = 15, σ_y = 10, σ_z = 40, τ_{xy} = 10, τ_{zx} = 10, τ_{zy} = 0. Determine normal and shear stress on a plane given by a equation 2x – y + 3z = 9. 10

b. Stress components with respect to Cartesian coordinate system given by array 10

$$\begin{bmatrix} 50 & 20 & 10 \\ 20 & 30 & 05 \\ 10 & 05 & 15 \end{bmatrix}$$

If coordinate rotated about y axis at angle of 30º. Determine the stress components with respect to new coordinate.

UNIT - II

3 a. Derive the strain displacement relations. 6

b. Strain components are given by ε_x = 0.1 ε_y = - 0.005 ε_z = 0.005 γ_{xy} = 0.03, γ_{yz} = 0.01, γ_{yz} = 0.008. Determine the principal strains and direction cosines for ε_1. 14

4 a. The displacement field are given by $u = k\left(x^2 + 2z\right),\ v = k\left(4x + 2y^2 + z\right),\ w = 4kz^2$ where K is small constant. Find strain at point. (2,2,3) in the direction $l = 0, m = \frac{1}{\sqrt{3}},\ n = \frac{1}{\sqrt{2}}$ 10

b. Displacement field for a body is given by $U = \left(x^2 + y\right)i + \left(3 + z\right)j + \left(x^2 + 2y\right)k$. 10

Find the (i) strain components at (3,1,2) (ii) Deformed position of point originally at (3,1,2)

UNIT - III

5 a. For steel, the following data is applicable $E = 207 \times 10^6 kPa,\ \ G = 80 \times 10^6 kPa$, For a given strain matrix at a point, determine the stress matrix. 10

$$\left[\in_{ij}\right] = \begin{bmatrix} 0.001 & 0 & -0.002 \\ 0 & -0.003 & 0.0003 \\ -0.002 & 0.003 & 0 \end{bmatrix}$$

Contd…2

b. A cubical element is subjected to the following state of stress $\sigma_x = 100MPa, \quad \sigma_y = -20MPa, \quad \sigma_z = -40MPa, \quad \tau_{xy} = \tau_{yz} = \tau_{zx} = 0$. Assuming the material to be homogeneous and isotropic, determine the principal shear strains and octahedral shear strain, $E = 2\times10^5 MPa, \quad \mu = 0.25$ 10

6. Describe the following: i) Hooke's law (ii) Prandtl's membrane analogy (iii) Plane stress (iv) Saint Venant's Principle 20

UNIT - IV

7 a. Show that a simply supported beam of length 2L, depth 2h and unit width loaded by a concentrated load at the midspan, the stress function satisfying the loading condition is $\phi = \frac{b}{6}xy^3 + Cxy$ .treat the concentrated load as shear stress suitably distributed to suit this function, so that $\int_{-h}^{+h} \tau_{xy}.dy - \left[\frac{w}{2}\right]$ on each half length of the beam. Also find the stresses in the beam. 10

b. Find the expression for shearing stresses induced in a bar of circular cross section subjected to a twisting moment 'T' 10

8 a. Determine the stress fields that arise from the following stress function 10

i) $\phi = Ax^4 + Bx^3y + Cx^2y^2 + Dxy^3 + Ey^4$ ii) $\phi = Ax^3 + Bx^2y + Cxy^2 + Dy^3$

b. A thin walled box section having dimensions $2x \times a \times t$ is to be compared with a solid circular section of diameter as shown in Fig. Q8.b. Determine the thickness 't' so that two sections have (i) Same maximum shear stress for same torque. (ii) the same stiffness. 10

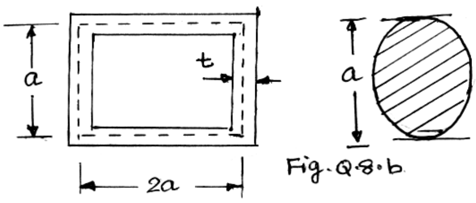

Fig.Q.8.b

UNIT - V

9 a. 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 and outer surfaces 10

b. Derive the relation for thin circular disk subjected to a temperature distribution which varies only with 'r' and is independent of θ. 10

10 a. Show that the resultant circumferential force across any radial section of a hollow disk subjected to thermal loading is zero. 10

b. A steel cylinder which has an inside diameter of 1m is subjected to an internal pressure of 8MPa. Calculate the wall thickness of the maximum stress is not to exceed 35MPa. 10

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