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

(An Autonomous Institution affiliated to VTU, Belagavi)

Sixth Semester, B.E. - Mechanical Engineering

Semester End Examination; June - 2017

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. Determine the principal stresses and principal direction for their major axes for the state of stress by the following stress matrix

$$\sigma_{ij} = \begin{bmatrix} 18 & 0 & 24 \\ 0 & -50 & 0 \\ 24 & 0 & 32 \end{bmatrix}$$ 12

b. Derive an equation of equilibrium for 3D state of stress. 8

2 a. Stress components are given by $\sigma_x = \sigma_y = \sigma_z = 100,\ \tau_{xy} = 0,\ \tau_{zy} = 400x,\ \tau_{zx} = 200y$

Determine normal and shear stress at point $(1,2,3)$ on a plane $x + y + z = 6$. 12

b. Derive an equation to find the stress components on an arbitrary plane. 8

UNIT - II

3 a. The strain tensor at a point in a body is given by

$$\in_{ij} = \begin{bmatrix} 0.0001 & 0.0002 & 0.0005 \\ 0.0002 & 0.0003 & 0.0004 \\ 0.0005 & 0.0004 & 0.0005 \end{bmatrix}$$ 12

Determine;

(i) Octahedral normal and shearing strain (ii) Deviatoric and spherical strain tensor.

b. Derive strain-displacement relation. 8

4 a. The displacement at point given by $u = \left(x^2 + 3\right) * 10^{-3}\ \ v = 3y^2 z \times 10^{-3}\ \ w = \left(x + 3z\right)10^{-3}$

Determine the strain components at point $(1,2,3)$ 6

b. For a given strain field,

$\in_x = 5 + x^2 + y^2 + x^4 + y^4;\qquad \in_y = 6 + 3x^2 + 3y^2 + x^4 + y^4;$

$\gamma_{yz} = 10 + 4xy\left(x^2 + y^2 + 2\right);\quad \in_z = \gamma_{yz} = \gamma_{zx} = 0$ 10

Determine if this system of strain is possible and find displacement components in terms of *x, y* assuming their displacement and rotation about origin is zero.

c. List the six compatibility equations. 4

Contd….2

UNIT - III

5 a. A cubical element is subjected to the following state of stress:

$\sigma_x = 100MPa,\ \sigma_y = -20MPa,\ \sigma_z = -400MPa,\ \tau_{xy} = \tau_{zy} = \tau_{zx} = 0$

Assuming material to be homogeneous and isotropic, determine the principal shear strains and the octahedral shear strain, if $E = 2\times10^5$ MPa and $\mu = 0.25$. 10

b. The displacement field is given by $u_x = 0.06x + 0.05y - 0.01z,\ u_y = 0.01y - 0.03z,$ $u_z = -0.02x + 0.01z$ at point (1, 2, 3). Determine stress components assuming E = 196 GPa and G = 78.48 GPa. 10

6. Discuss the following :

i) Principle of superposition ii) Hooke's law

iii) Uniqueness theorem iv) Saint-Venant's principle. 20

UNIT - IV

7 a. Define the stress function. Derive the equations for stress function for the plane strain case. 10

b. Obtain expressions for the torsion in a bar of circular cross section. 10

8 a. Given the stress function $\phi = \left(\frac{H}{\pi}\right) z \tan^{-1}\left(\frac{x}{z}\right)$. Determine whether stress function ϕ is admissible. If so determine the stresses. 10

b. Obtain expression for the torsion in a bar of elliptical cross section. 10

UNIT - V

9. Derive the equation for thick walled cylinder subjected to internal and external pressures. 20

10 a. Determine the stress in thin circular disk subjected temperature symmetrical about centre. 10

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

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