MVSE–102

M. E. (First Semester)
EXAMINATION, Feb./March, 2009
(Structure Engg.)
STRENGTH OF MATERIAL AND ELASTICITY THEORY
(MVSE – 102)

Time : Three Hours

Maximum Marks : 100

Minimum Pass Marks : 40

Note : Solve any *five* questions. All questions carry equal marks. Draw neat sketches wherever necessary.

1. (a) What are plane stress and plane strain problems ? What are the advantages of reducing 3D problems to 2D ? Explain with at least *one* example of each type.

   (b) Establish differential equations for a small rectangular block subjected to σ_x, σ_y and τ_{xy} at centre for a 2-D problem.

2. (a) What is condition of compatibility ? Write down compatibility equation for a plane strain case.

   (b) Explain in brief the generalized Hook's law.

3. (a) What is Saint Venant's principle ?

   (b) Determine displacement for the two cases of plane stress and plane strain. Why displacements are different for these two problems ? Show that strain

3. (a) Describe principal stresses.

   (b) The stresses at a point are : 15

$$\sigma_x = 80 \text{ N/mm}^2$$
$$\sigma_y = -90 \text{ N/mm}^2$$
$$\tau_{xy} = -40 \text{ N/mm}^2$$

If the axes are transformed by rotating them about the z-axis by 60°, find new value of σ'_x, σ'_y and τ'_{xy}.

4. (a) Prove that $\sigma_{xy} = \sigma_{yx}$. 5

   (b) Derive the equations of compatibility for plane stress conditions. 15

5. (a) Describe Airy stress function. 5

   (b) For steel the following data is applicable : 15

$$E = 2{\cdot}07 \times 10^5 \text{ MPa}, \nu = 0{\cdot}3$$

For the given strain matrix at a point, determine the stress matrix :

$$[\in_{ij}] = \begin{bmatrix} 0{\cdot}001 & 0 & -0{\cdot}002 \\ 0 & -0{\cdot}003 & 0{\cdot}0003 \\ -0{\cdot}002 & 0{\cdot}0003 & 0 \end{bmatrix}$$

6. (a) Describe Superposition theorem. 5

   (b) Show that for same twist, the elliptical section has a greater shearing stress than the inscribed circular section which takes the greater torque for same allowable stress. 15

7. Write short notes on the following : 5 each

   (a) Invariants of stress tensor

   (b) Octahedral shear stress

   (c) Uniqueness theorem

   (d) Plane stress and plane strain problems

Derive the strain compatibility equations. Explain its significance. 20

8. Write short notes on the following : 20

   (a) Anisotropic and Isotropic materials

   (b) Saint-Venant's principle

   (c) Pure bending of curved bars

   (d) Membrane analogy