CBCS SCHEME

USN | | | | | | | | | | | 18MDE13

First Semester M.Tech. Degree Examination, Dec.2019/Jan.2020
Continuum Mechanics

Time: 3 hrs. Max. Marks: 100

Note: ***Answer FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Explain : i) Octahedral stresses ii) Stress invariants. **(08 Marks)**

b. The stress tensor at a point is given by the following matrix :

$$[\tau_{ij}] = \begin{bmatrix} 9 & 6 & 3 \\ 6 & 5 & 2 \\ 3 & 2 & 4 \end{bmatrix} \text{MPa}$$

Determine the principal stresses and principal planes. **(12 Marks)**

OR

2 a. Describe the Mohr's circle for 3D state of stress. **(08 Marks)**

b. The state of stress at a point is given as follows :

$\sigma_x = 150\text{MPa}$ $\sigma_y = -75\text{MPa}$ $\sigma_z = -75\text{MPa}$ $\tau_{xy} = \tau_{yz} = \tau_{zx} = 150$ MPa.

Determine normal stress, tangential stress, resultant stress on a plane whose normal has the following direction cosine :

i) $\ell = m\dfrac{1}{\sqrt{2}}$ and $n = 0$

ii) $\ell = m = n = \dfrac{1}{\sqrt{3}}$. **(12 Marks)**

Module-2

3 a. Derive the expression for cubical dilatation. **(10 Marks)**

b. The strain components at a point with respect to xyz co-ordinate system are

$\varepsilon_x = 2 \times 10$ $\varepsilon_y = 0.20$ $\varepsilon_z = 0.30$

$\gamma_{xy} = \gamma_{yz} = \gamma_{zx} = 0.16$

If the coordinate axes are rotated about the z – axis through 45° in the anticlockwise direction, determine the new strain components. **(10 Marks)**

OR

4 a. State and explain generalized Hook's law. **(04 Marks)**

b. Under what conditions are the following expressions for the components of strain at a point compatible?

$\varepsilon_x = 2axy^2 + by^2 + 2cxy$

$\varepsilon_y = ax^2 + bx$

$\gamma_{xy} = \alpha x^2 y + \beta xy + ax^2 + \eta y.$ **(06 Marks)**

c. The state of strain at a point is given by :

$\epsilon_x = 0.001$ $\epsilon_y = -0.003,$ $\epsilon_z = 0$

$\gamma_{xy} = 0$ $\gamma_{yz} = 0.001$ $\gamma_{zx} = -0.004$

Determine the stress tensor at this point. Take E = 210GPa, Poisson's ratio = 0.28. Also find Lame's constants. **(10 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-3

5 a. State and prove uniqueness theorem. **(08 Marks)**

b. Investigate what problem of plane stress is satisfied by the stress function :

$$\phi = \frac{3F}{4h}\left[xy - \frac{-xy^3}{3h^2}\right] + \frac{P}{2}y^2$$

applied to the region included in $y = 0$, $y = h$ and $x = 0$ on the x – side positive. **(12 Marks)**

OR

6 a. Explain :

i) St. Venant's principle

ii) Principle of superposition. **(08 Marks)**

b. Given the stress function :

$$\phi = \frac{H}{\pi} z \tan^{-1}\left(\frac{x}{z}\right)$$

Determine whether stress function ϕ is admissible. If so determine stresses. **(12 Marks)**

Module-4

7 a. Obtain expression for stresses induced in rotating disk in the following cases :

i) A disk of solid radius "b"

ii) A disk with a hole of radius "a". **(14 Marks)**

b. A steel tube, which has an outside diameter of 10cm and inside diameter of 5cm is subjected to an internal pressure of 14MPa and an external pressure of 5.5Mpa. Calculate the maximum hoop stress in the tube. **(06 Marks)**

OR

8 a. Write a note on thermo elastic stress strain relation. **(06 Marks)**

b. Explain stress concentration with sketch. **(06 Marks)**

c. A steel disc 150mm diameter and rotating at 12000rpm is subjected to temperature rise from 0°C at centre to 50°C at outer periphery of disc. Calculate the maximum stresses setup in the disc. Take $\gamma = 0.3$ $E = 200$GPa, $\alpha = 12.5 \times 10^{-6}$/°C and $\rho = 7470$ kg/m^3. **(08 Marks)**

Module-5

9 a. Write a note on Prandtl's membrane analogy. **(06 Marks)**

b. A thin walled steel section shown in Fig.Q9(b) is subjected to a twisting moment T. Calculate the shear stresses in the walls and angle of twist per unit length of the box. **(14 Marks)**

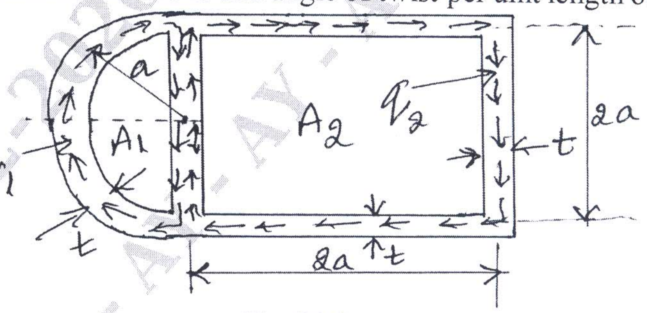

Fig.Q9(b)

OR

10 Write a short note on :

a. Elastic versus viscoelastic behavior

b. Maxwell model

c. Kelvin's model

d. Viscoelastic creep. **(20 Marks)**