CBCS SCHEME

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18MDE13

First Semester M.Tech. Degree Examination, June/July 2019
Continuum Mechanics

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Define surface forces and body forces. Derive equations of equilibrium in three dimensions. **(12 Marks)**

b. Define principal stress and octahedral stress. **(04 Marks)**

c. What are stress invariants? Explain. **(04 Marks)**

OR

2 a. Derive Cauchy's stress relations for the resultant normal and shear stress on an arbitrary plane. **(10 Marks)**

b. The state of stress at a point is given by the following matrix,

$$\begin{bmatrix} 9 & 6 & 3 \\ 6 & 5 & 2 \\ 3 & 2 & 4 \end{bmatrix} \text{ MPa}$$

Determine the principal stresses and direction of maximum principal stress. **(10 Marks)**

Module-2

3 a. Derive 3-D strain compatibility equations in Cartesian co-ordinate system. **(10 Marks)**

b. The displacement field is given by, $u = K(x^2 + 2z)$, $v = K(4x + 2y^2 + z)$, $w = 4Kz^2$, where 'K' is a very small constant. What are the strains at (2, 2, 3) in the directions:

i) $l = 0$, $m = \frac{1}{\sqrt{2}}$, $n = \frac{1}{\sqrt{2}}$

ii) $l = 0.6$, $m = 0$, $n = 0.8$

iii) $l = 1$, $m = n = 0$ **(10 Marks)**

OR

4 a. State generalized Hooke's law in terms of engineering constants for homogeneous elastic material. **(10 Marks)**

b. The stress tensor at a point is given as,

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

Determine the strain tensor at this point, Take $E = 210 \times 10^6$ kN/m^2 and $\gamma = 0.3$. Also find Lame's constants. **(10 Marks)**

Module-3

5 a. Explain Airy's stress function. Derive the biharmonic equation is Cartesian co-ordinates for a two dimensional case. **(10 Marks)**

b. Derive an equation for stress for bending of a narrow cantilever beam of length 'L' and rectangular cross-section subjected to end load from stress function approach. **(10 Marks)**

OR

6 Explain the following:
a. Saint-Venant's principle
b. Reciprocal theorem
c. Principle of superposition
d. Uniqueness of solution. **(20 Marks)**

Module-4

7 a. Obtain the expression for radial and tangential stresses due to centrifugal load for rotating solid disc of uniform thickness. **(10 Marks)**
b. Show that in a rotating hollow disc, the maximum radial stress occurs at the geometric mean of outer and inner radii of the disc and hence determine maximum radial stress. **(10 Marks)**

OR

8 a. Explain thermoelastic stress and their significance. Also write down the thermoelastic stress strain relations. **(10 Marks)**
b. Obtain an expression for thermal stresses due to uniform temperature distribution in long solid and hollow cylinder. **(10 Marks)**

Module-5

9 a. A shaft consisting of a prismatic bar having an elliptical cross section with a major axis of '2h' and minor axis '2b', is subjected to a twisting moment of 'T'. Find the shearing stresses in the shaft at the ends of major and minor axis of the cross-section interms of applied torque. **(12 Marks)**
b. Explain the concept of membrane analogy. **(08 Marks)**

OR

10 a. What is understood by viscoelastic deformation? Name the materials which exhibit viscoelastic behaviour. **(06 Marks)**
b. State and explain the mechanical models to demonstrate viscoelastic beahviour of materials. **(14 Marks)**

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