CBCS Scheme

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16/17CAE13

First Semester M.Tech. Degree Examination, June/July 2018
Continuum Mechanics

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Define Cauchy's stress principles and derive the equility of cross shear i.e. $\tau_{xy} = \tau_{yx}$. **(08 Marks)**

b. The state of stress at a point is given by the following array $\sigma_{ij} = \begin{bmatrix} -80 & 400 & 500 \\ 400 & 1200 & -600 \\ 500 & -600 & -400 \end{bmatrix}$ KPa.

(i) Determine the stresses on a plane whose normal has direction cosines $\eta_x = 0.25$, $\eta_y = 0.5$.

(ii) The resultant and shearing stresses on that plane. **(08 Marks)**

OR

2 a. Explain : (i) Invariants of stresses. (ii) Octahedral stresses (iii) Direction cosines. **(09 Marks)**

b. If the state of stress at a point in a body is given as follows. Determine the components of the body forces in order to satisfy the equation of equilibrium:
$\sigma_x = 20x^3 + y^2$; $\sigma_y = 30x^3 + 100$; $\sigma_z = 10(y^2 + z^2)$ and $\tau_{xy} = z$; $\tau_{yz} = x^3$; $\tau_{zx} = y^3$. **(07 Marks)**

Module-2

3 a. Derive the compitability equation in terms of strains and displacements. **(08 Marks)**

b. The state of strain at a point is given by, $\in_x = 0.001$, $\in_y = -0.003$, $\in_z = \gamma_{xy} = 0$, $\gamma_{xz} = 0.004$, $\gamma_{yz} = -0.001$. Determine the stress tensors at this point. Take $E = 210 \times 10^6$ KN/m^2. Poissons ratio = 0.28, also find Lame's constant. **(08 Marks)**

OR

4 a. Derive the expression for cubical dilatation. **(08 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) $l = 0, m = n = \frac{1}{\sqrt{2}}$ (ii) $l = 1, m = n = 0$ (iii) $l = 0.6, m = 0, n = 0.8$ **(08 Marks)**

Module-3

5 a. Write a note on plane stress and the plane strain problems. **(06 Marks)**

b. Investigate what problems is solved by $\phi = -\frac{F}{d^3} xy^2(3d - 2y)$ applied to the region included in $y = 0$ and $y = d$, $x = 0$ on the side x positive. **(10 Marks)**

OR

6 a. Explain the Airy's stress function. Derive the Biharmonic equation for two dimensional state of stress. **(08 Marks)**

b. Explain the following:

(i) Saint Venants theorem.

(ii) Principle of super position. **(08 Marks)**

Module-4

7 a. Derive the expression radial and tangential stresses in a rotating disc of uniform thickness. **(08 Marks)**

b. A steel cylinder which has an inside diameter of 1 m is subjected to an internal pressure of 8 MPa. Calculate the wall thickness if the maximum shearing stress is not to exceed 35 MPa. **(08 Marks)**

OR

8 a. Explain axy symmetric problem's with example. **(04 Marks)**

b. Write a note on thermo elastic stress-strain relations. **(04 Marks)**

c. Determine the radial and tangential stress equation where temperature symmetrical about centre is exhibited in thin circular disc. **(08 Marks)**

Module-5

9 a. Derive the expression for finding shear stresses on torsion of a circular shaft in terms of applied torque. **(10 Marks)**

b. A square shaft rotating at 250 rpm. Transmits torque to a crane, which is designed to lift maximum load of 150 KN at a speed of 10 m/min. If the efficiency of the crane gearing is 65%. Estimate the size of the shaft for the maximum permissible shear stress of 35 MPa. Also calculate the angle of twist of the shaft for a length of 3 mts take G = 100 GPa. $K_1 = 0.208$, $K_2 = 0.141$. **(06 Marks)**

OR

10 a. Explain the two visco-elastic models used for modeling and hence write generalized Kelvin and Maxwell models. **(08 Marks)**

b. Discuss creep and relaxation models used for modeling visco-elastic behavior. **(08 Marks)**

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