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

(An Autonomous Institution affiliated to VTU, Belgaum)

First Semester, M. Tech - Mechanical Engineering (MMDN)

Semester End Examination; Jan -2017

Theory of Elasticity

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, Selecting **ONE** full question from each **unit**.*

UNIT - I

1 a. Explain the assumptions in theory of elasticity. 4

b. Derive Cauchy's stress formula. 8

c. For the following Tensor determine the Resultant stress, Normal stress and Shear stress on the Octahedral plane. 8

$$\tau_{ij} = \begin{bmatrix} 200 & 200 & 200 \\ 200 & -100 & 200 \\ 200 & 200 & -100 \end{bmatrix} MPa$$

2 a. The state of stress at a point is given by 10

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

Obtain the magnitudes of principal stresses.

b. The stress components at a point in a body are given by 10

$$\sigma_x = 3xy^2z + 2x, \quad \sigma_y = 5xyz + 3y \quad \sigma_z = x^2y + y^2z$$

$$\tau_{xy} = 0 \quad \tau_{yz} = \tau_{zx} = 3xy^2z + 2xy$$

Determine whether equilibrium exists. If not determine suitable body force vector at point (1, -1, 2)

UNIT - II

3 a. Explain the term cubical dilation and obtain an expression for the same. 5

b. Explain the significance of strain compatibility and derive 2 dimensional strain compatibility equations and extend it to 3D. 10

c. The displacement field at a point in a body is $U = \left[\left(x^2+3\right)i + 3y^2zj + \left(x+3z\right)k\right] \times 10^{-3}$. Obtain the strain tensor at (1, 2, 3) 5

4 a. The strain components at a point is a body are given by; 8

$\in_x = 0.01 \;\; \in_y = -0.02 \;\; \in_z = 0.03 \;\; \gamma_{xy} = 0.015 \;\; \gamma_{yz} = 0.02 \;\; \gamma_{zx} = -0.01$. Obtain the normal, shear and resultant strains on Octahedral plane.

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b. Obtain 2D strain displacement relations and hence deduce 3D relation. 8

c. Write the expressions for strain invariants. 4

UNIT - III

5 a. State and prove the following :

(i) Principle of superposition 16

(ii) Existence of uniquries of solution

b. State and explain generalized Hook's law. 4

6 a. Explain plane stress and plane strain analysis with example. 8

b. Derive the strain compatibility equation in terms of stresses. 8

c. Explain the inverse method of solving elasticity problem. 4

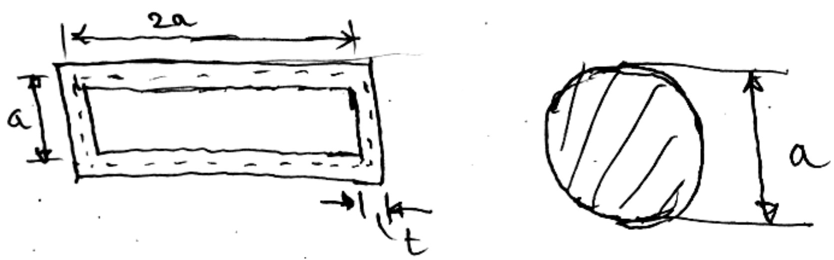
UNIT - IV

7 a. Explain the term Airy's stress function. Obtain the biharmonic equation in polar form. 10

b. Discuss the analysis of a cantilever beam subjected to an edge load using stress function and obtain stress components. 10

8 a. Prove that the warping function and satisfier Laplacion equation in tosion of prismatic bars of solid section. 10

b. A thin walled section of dimensions 2a x a x t is to be compared to a solid circular section of diameter 'a'. Determine the thickness t, so that the two sections have (i) Same τ_{max} (ii) Same stiffness



UNIT - V

9 a. Derive the expression for the radial and tangential stresses in a thick cylinder (Lami's equations) subjected to an internal pressure P_a and external pressure P_b. The inside radius of cylinder is 'a' and the external radius is 'b'. 10

b. A steel cylinder has an inside dia of 1 meter and it is subjected to an internal pressure of 8 MPa. Compute the thickness if the maximum shear stress is not to exceed 35 MPa. 10

10 a. Write the thermo elastic stress strain relations for a plane stress. 4

b. Obtain the expression for a solid circular thin disk (non-rotating) of uniform thickness subjected to a uniform temperature distribution T = T(r). 16

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