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Third Semester B.E. Degree Examination, June/July 2019 Mechanics of Materials

Time: 3 hrs.

Max. Marks: 100

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

Module-1

- 1 a. Analyze the stress at point in 3D elastic material and reduce the stress equations to two dimensional state. (10 Marks)
- b. A structure is loaded and displacements associated with the deformed state are mapped. Find all the strains associated with the following observed displacement field at point (0.6, -0.75, 1)m.

$$u = (-x^4 + 3x - 3y^2 + 8yz + 5) \times 10^{-3} \text{ m}$$

$$v = (-4y^4 + y + 8xz + 1) \times 10^{-3} \text{ m}$$

$$w = (2z^2 + 3z - 8xy + 8) \times 10^{-3} \text{ m}$$
(10 Marks)

OR

- 2 a. Derive the constitutive laws for the isotropic material and express the equations in matrix form. (10 Marks)
- b. Discuss and illustrate the stress-strain curves for the following materials (i) mild steel (ii) aluminum (iii) cast iron, with salient features. (10 Marks)

Module-2

- 3 a. List and explain the implications of Euler-Bernoulli's assumptions. (06 Marks)
- b. Consider a beam subjected to axial loading 'P' and derive for the sectional constitutive law of beam under axial loads. (08 Marks)
- c. Discuss the kinematic description of beam under transverse loads. (06 Marks)

OR

- 4 a. Analyze the 3D elastic beam for the sectional constitutive laws and express in matrix form. (10 Marks)
- b. The T-section shown in Fig.Q4(b) is used as a simply supported beam over span of 4 meters it carries an uniformly distributed load of 8 kN/m over its entire span. Calculate the maximum tensile and compressive stresses occurring in the section.

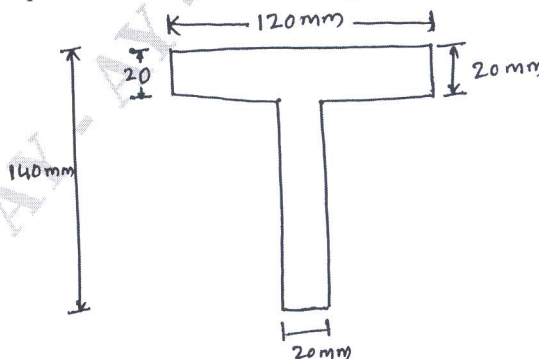


Fig.Q4(b)

(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. Show that maximum shear stress in the shaft under torsion is given by $\tau_{\max} = \frac{TR}{J}$. (10 Marks)
- b. A square aluminum tube has the dimensions shown in Fig.Q5(b). Determine the average shear stress in the tube at point A if it is subjected to torque of 90 Nm. Also compute the angle of twist due to this loading. Take $G_{al} = 25$ GPa and thickness = 10 mm.

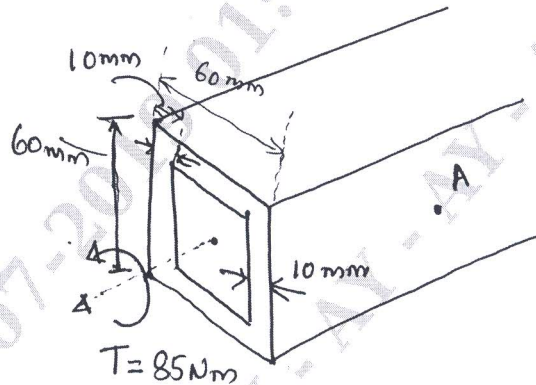


Fig.Q5(b)

(10 Marks)

OR

- 6 a. Explain the procedure to determine the shear flow distribution over the open cross-section of thin walled beam subjected to transverse shear forces. (10 Marks)
- b. Derive the shear flow equation in the closed thin wall beams. (10 Marks)

Module-4

- 7 a. Explain the principle of virtual work for a particle under equilibrium state. (10 Marks)
- b. Derive for the virtual work in truss system by taking truss as example. (10 Marks)

OR

- 8 a. Define conservative force. Derive the expression for work done by conservative forces along any path joining two points. (08 Marks)
- b. Consider a beam of length 2 m and diameter 100 mm is applied with point load at the end 2000 N and other end is fixed as cantilever. Determine the strain energy of the beam. Take $E = 200$ GPa. (08 Marks)
- c. Define the following: (i) Betti's reciprocity theorem (ii) Clapeyron's theorem (04 Marks)

Module-5

- 9 a. Explain the following theories of failures:
 i) Maximum Principal stress theory
 ii) Maximum shear stress theory
 iii) Von misses stress theory (10 Marks)
- b. If the principal stresses at a point in an elastic material are $2F$ tensile, $1.5E$ tensile and F compressive. Calculate the value of F at failure according to four different failure theories. The elastic limit in simple tension is 210 N/mm^2 and $\mu = 0.3$. (10 Marks)

OR

- 10 a. Mention the Kirchhoff's assumption for the plate bending and explain the displacement field for the plate. (10 Marks)
- b. Derive for the bending stiffness in the plate. (10 Marks)
