CBCS SCHEME

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21ME44

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
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. Define the following terms:
i) True stress
ii) Poisson's ratio
iii) Stiffness
iv) Volumetric strain. **(04 Marks)**

b. Derive the expression for the total elongation of a tapered circular bar cross-section of diameter 'd_1' and 'd_2' when subjected to an axial load 'P'. **(08 Marks)**

c. A steel bolt of 16mm diameter passes centrally through a copper tube of internal diameter 20mm and external diameter 30mm. The length of the whole assembly is 500mm. After tight fitting of the assembly, the nut is over tightened by quarter $\left(\frac{1}{4}\text{th}\right)$ of a turn. What are the stresses introduced in bolt and tube. If pitch of nut is 2mm. Take E_{steel} = 200GPa and E_{copper} = 120GPa. **(08 Marks)**

OR

2 a. State Hooke's law. Sketch the typical stress-strain curve for mild-steel specimen during tension test. Show the salient points on the graph and briefly explain them. **(10 Marks)**

b. Define Young's modulus and rigidity modulus. Derive relation between Young's modulus (E) and rigidity modulus (G). **(10 Marks)**

Module-2

3 a. Derive the expressions for normal and tangential stress on a plane inclined at 'θ' to the plane of stress in x-direction in a general two dimensional stress system and show that sum of normal stress in any two mutually perpendicular directions is constant. **(12 Marks)**

b. The state of stress in a two dimensionally stressed body is shown in Fig.Q.3(b). Determine graphically (by drawing Mohr's circle), the principal stresses, principal planes, maximum shear stress and its planes. **(08 Marks)**

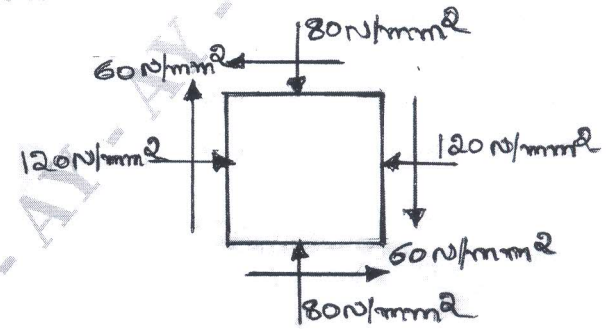

Fig.Q.3(b)

OR

4 The state of stress at a point in a strained material is shown in Fig.Q.4(a). Determine:
i) The direction of the principal planes.
ii) The magnitude of principal stresses.
iii) The magnitude of the maximum shear stress and its direction.
iv) Draw Mohr's circle and verify the results obtained analytically. **(20 Marks)**

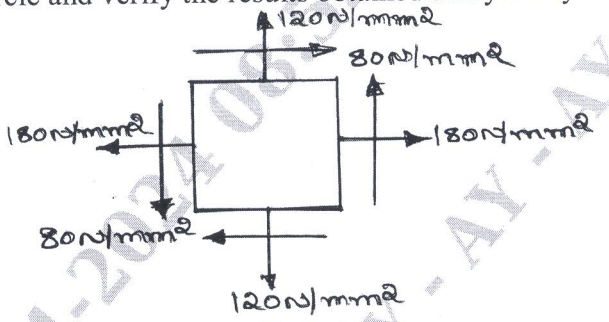

Fig.Q.4

Module-3

5 a. Define a beam. Explain with simple sketches, different types of beams. **(06 Marks)**
b. Draw the shear force and bending moment diagrams for the overhanging beam, carrying uniformly distributed load of 2kN/m over the entire length and a point load of 2kN as shown in Fig.Q.5(b). Locate the point of contra-flexure. **(14 Marks)**

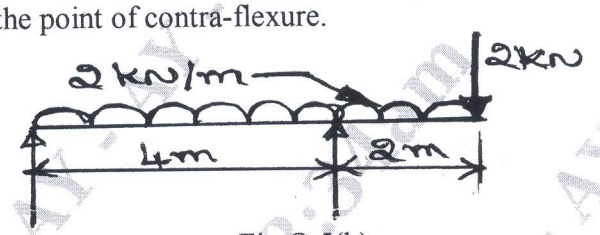

Fig.Q.5(b)

OR

6 Draw shear force and bending moment diagrams for the beam shown in Fig.Q.6. Locate the point of contraflexure. **(20 Marks)**

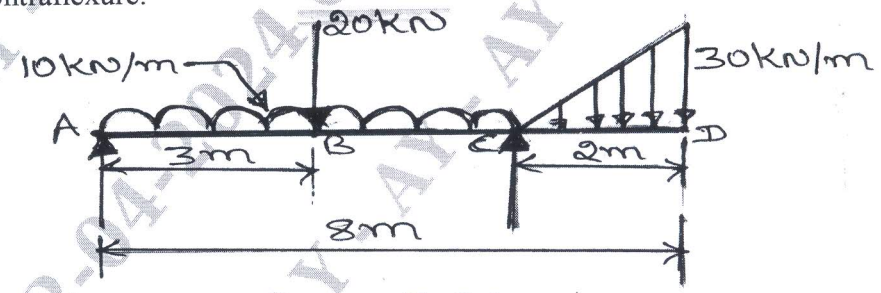

Fig.Q.6

Module-4

7 a. Prove the relation $\frac{M}{I}=\frac{\sigma}{Y}=\frac{E}{R}$ with usual notations. **(10 Marks)**
b. Prove that a hollow shaft is stronger and stiffer than the solid shaft of the same material, length and weight. **(10 Marks)**

OR

8 a. Derive the torsional equation for a circular shaft with usual notations. State the assumptions made. **(10 Marks)**

b. A hollow steel shaft transmits 392kW of power at 150rpm. The total angle of twist in a length of 3m of shaft is 2.5°. Find the inner and outer diameters of the shaft. If the permissible shear stress is 90MPa. Take G = 85GPa. **(10 Marks)**

Module-5

9 a. Differentiate between thin and thick cylinders. **(02 Marks)**

b. Derive an expression for circumferential and longitudinal stress for a thin cylinder subjected to an internal pressure 'P'. **(08 Marks)**

c. Derive the expression for radial and hoop stresses (Lame's equations) for a thick cylinder. **(10 Marks)**

OR

10 a. Derive an expression for Euler's buckling load in a column when both ends are fixed. **(10 Marks)**

b. Derive an expression for a critical load in a column subjected to compressive load, when both ends are hinged. **(10 Marks)**

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