CBCS SCHEME

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17ME34

Third Semester B.E. Degree Examination, June/July 2023
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. Derive an expression for the deformation of a tapered bar varying diameter from d_1 to d_2 subjected to axial load 'P'. **(10 Marks)**

b. The stepped round bar is subjected to the forces as shown in Fig.Q.1(b). Determine the value of 'P' such that the net deformation in the bar does not exceed 1mm. Big end diameter and small end diameter of tapering bar are 40mm and 12.5mm respectively. Take $E_{steel} = 200GPa$, $E_{Aluminum} = 70GPa$. **(10 Marks)**

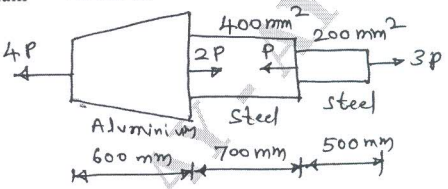

Fig.Q.1(b)

OR

2 a. Derive the relation between Young's modulus and modulus of rigidity. **(10 Marks)**

b. A bar of brass 25mm diameter is enclosed in a steel tube of 50mm external diameter and 25mm internal diameter. The bar and the tube are both initially 1.5m long and are rigidly fastened at both ends using 20mm diameter pins. Find the stresses in the two materials when the temperature rises from 30°C to 100°C.

Take E for steel = 200 kN/mm²
E for brass = 100 kN/mm²
α for steel = 11.6×10^{-6}/°C
α for brass = 18.7×10^{-6}/°C **(10 Marks)**

Module-2

3 A plane element is subjected to stresses as shown in Fig.Q.3. Determine:
i) Normal and shear stress acting on an inclined plane BE.
ii) Principal stresses and principal planes.
iii) Maximum shear stress and it plane.
Also draw the Mohr's circle to verify the results obtained analytically.

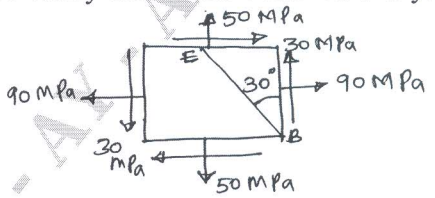

Fig.Q.3

(20 Marks)

OR

4 a. Derive expressions for circumferential and longitudinal stresses for a thin cylinder subjected to internal pressure 'P'. **(10 Marks)**

b. A thick cylindrical pipe outside diameter 300mm and internal diameter 200mm is subjected to an internal fluid pressure of 14N/mm². Determine the maximum and minimum hoop stress across the cross-section. Sketch the variation of radial pressure and hoop stress across the thickness of the pipe. **(10 Marks)**

Module-3

5 Draw shear force and bending moment diagrams for the beam loaded as shown in Fig.Q.5(a). Locate the point of contraflexure.

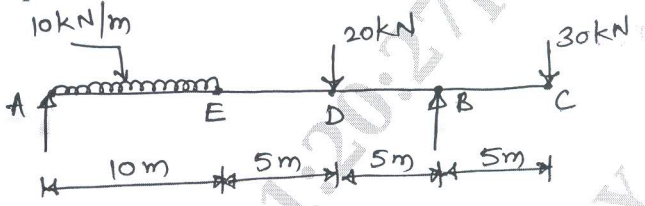

Fig.Q.5

(20 Marks)

OR

6 a. Derive the bending equation $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$. **(10 Marks)**

b. A beam of an I-section consists of 180mm × 15mm flanges and a web of 280mm × 15mm thickness. It is subjected to a bending moment of 120kN-m. Sketch the bending stress distribution along the depth of the section. **(10 Marks)**

Module-4

7 a. Derive the torsion equation with usual notations. **(10 Marks)**

b. Determine the diameter of solid shaft which will transmit 440kW at 280rpm. The angle of twist must not exceed one degree per metre length and the maximum torsional shear stress is to be limited to 40N/mm^2. Assume G = 84kN/mm^2. **(10 Marks)**

OR

8 a. Derive an expression for Euler's buckling load for a column, when both the ends are hinged. **(10 Marks)**

b. A hollow cast iron whose outside diameter 200mm and inside diameter 160mm is 4.5m long fixed at both ends. Find the ratio of Euler's load to Rankine's load. Take E = 1 × 10^{5}N/mm^2, Rankine's constant = 1/1600 and σ_c = 550N/mm^2. **(10 Marks)**

Module-5

9 a. Derive an expression for strain energy due to shear stress. **(10 Marks)**

b. A hollow circular shaft 2m long is required to transmit 1000kW power when running at a speed of 300rpm. If the outer diameter of the shaft is 150mm and inner diameter is 120mm, find the maximum shear stress and strain energy stored in the shaft. Take G = 80kN/mm^2. **(10 Marks)**

OR

10 a. Write a note on:
i) Maximum principal stress theory
ii) Maximum shear stress theory. **(08 Marks)**

b. A solid circular shaft is subjected to a bending moment of 40kN-m and a torque of 10kN-m. Design the diameter of the shaft according to
i) Maximum principal stress theory.
ii) Maximum shear stress theory.
Take μ = 0.25, stress at elastic limit = 200N/mm^2 and factor of safety = 2. **(12 Marks)**

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