CBCS SCHEME

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17ME34

Third Semester B.E. Degree Examination, July/August 2022
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. Explain with neat sketch Stress-Strain diagram for ductile materials. **(06 Marks)**

b. Find the stresses in various segments of the circular bar shown in Fig.Q1(b). Also find total elongation. E = 195 GPa.

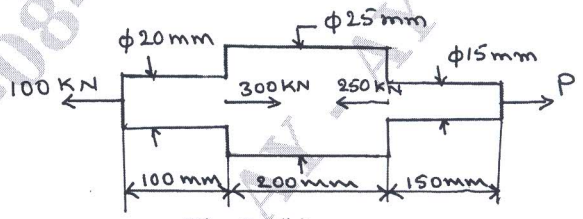

Fig.Q1(b) **(14 Marks)**

OR

2 a. At room temperature the gap between bar A and bar B shown in Fig.Q2(a) is 0.25mm. What are the stresses induced in the bars if the temperature rise is 35°C. Given that

$A_A = 1000\ mm^2$; $A_B = 800\ mm^2$; $E_A = 2\times10^5\ N/mm^2$; $E_B = 1\times10^5\ N/mm^2$

$\alpha_A = 12\times10^{-6}/°C$; $\alpha_B = 23\times10^{-6}/°C$; $L_A = 400$ mm ; $L_B = 300$ mm.

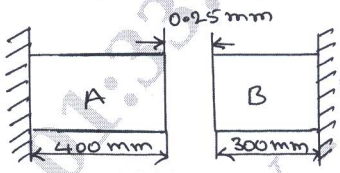

Fig.Q2(a) **(10 Marks)**

b. A bar of 20mm diameter is subjected to pull of 500 kN. The measured extension is 0.12mm on a gauge length of 250mm and the change in diameter is 0.00375 mm. Determine (i) Young's modulus (ii) Poisson's ratio (iii) Bulk modulus (iv) Modulus of rigidity (v) Change in volume. **(10 Marks)**

Module-2

3 a. A point in a strained material is subjected to a tensile stress of 500 N/mm^2 and 300 N/mm^2 in mutually perpendicular planes. Calculate the normal, tangential resultant stresses and its obliquity on a plane making an angle of 30° with the axis of the second stress. Also find maximum shear stress. **(10 Marks)**

b. A point subjected to a tensile stress of 60 N/mm^2 and a compressive stress of 40 N/mm^2 acting on a two mutually perpendicular planes and a shear stress of 10 N/mm^2. Determine principal and maximum shear stress by Mohr's circles method. **(10 Marks)**

OR

4 a. A thin cylindrical shell of one metre diameter and 3m long has a metal thickness of 10mm. It is subjected to an internal fluid pressure of 3 MPa. Determine (i) Circumferential stress (ii) Longitudinal stress (iii) Circumferential strain (iv) Longitudinal strain (v) Volumetric strain. **(10 Marks)**

b. A thick cylindrical pipe of outside diameter 300mm and internal diameter 200mm is subjected to an internal fluid pressure of 20 N/mm^2 and external fluid pressure of 5 N/mm^2. Determine the maximum hoop stress developed. Draw the variation of hoop stress and radial stress across the thickness indicating the values at every 25mm interval. **(10 Marks)**

Module-3

5 a. Explain the different types of beams. **(05 Marks)**

b. Find the reactions at the fixed end and draw SFD and BMD for the beam shown in Fig.Q5(b). Locate point of contraflexure.

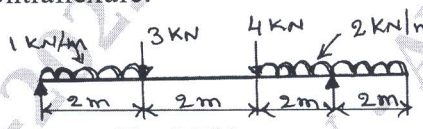

Fig.Q5(b) **(15 Marks)**

OR

6 a. Calculate the maximum stress induced in a cast iron pipe of external diameter 40 mm and internal diameter 20mm, length 4m when the pipe is supported at its ends and carry a point load of 80 N at its centre. **(10 Marks)**

b. A simply supported beam of span 5m has a cross section of 150mm × 250mm. If the permissible stress is 10 N/mm^2, find

(i) Maximum intensity of uniformly distributed load it can carry.

(ii) Maximum concentrated load P applied at 2m from one end it can carry. **(10 Marks)**

Module-4

7 a. Write the assumptions made in pure torsion and derive the torsional equation

$$\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{L}$$ **(12 Marks)**

b. A solid shaft rotating at 1000 rpm transmit 50 kW. Maximum torque is 20% more than the mean torque. Material of the shaft has the allowable shear stress of 50 MPa and modulus of rigidity 80 GPa. Angle of twist in the shaft should not exceed one degree in one metre length. Determine diameter of shaft. **(08 Marks)**

OR

8 a. Derive an expression for crippling load for a column when both of its ends are hinged. **(10 Marks)**

b. Find the Euler's crippling load for a hollow cylindrical steel column of 40 mm external diameter and 4mm thick. The length of the column is 2.5m and hinged at both ends. Also compute the Rankine's crippling load using constants 335 MPa and $\frac{1}{7500}$.

Take E = 205 GPa. **(10 Marks)**

Module-5

9 a. State and prove the Castigliano's first theorem. **(08 Marks)**

b. A rectangular block of 1m long, 0.5m wide and 0.25m thick is subjected to a shear stress of 100 N/mm^2. Determine

(i) Strain energy stored in the block (ii) Local strain energy per unit volume.

Take G = 80 GPa. **(06 Marks)**

c. A cantilever beam of length L carries uniformly distributed load W per unit length over its entire length. Determine (i) Strain energy stored in the beam (ii) If W = 10 kN/m, L = 2m and EI = 2×10^5 N/mm^2, determine strain energy stored in the beam. **(06 Marks)**

OR

10 a. Explain Maximum Principal stress theory and Maximum Shear stress theory. **(06 Marks)**

b. A plate of steel is subjected to stress σ_x = 150 N/mm^2 ; σ_y = 100 N/mm^2 and τ_{xy} = 50 N/mm^2. Yield stress of the material is 353 MPa. Find factor of safety using
(i) Maximum principal stress theory
(ii) Maximum shear stress theory. **(08 Marks)**

c. A load of 200 N falls through a height of 25mm on to a collar rigidly attached to the lower end of a vertical bar 2m long and 300mm^2 cross sectional area. The upper end of the vertical bar is fixed. Determine
(i) Maximum instantaneous stress induced in the vertical bar.
(ii) Strain energy stored in the vertical rod. **(06 Marks)**

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