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Third Semester B.E. Degree Examination, Dec.2018/Jan.2019 Mechanics of Materials

Time: 3 hrs.

Max. Marks: 80

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

Module-1

- 1 a. Draw the stress-strain diagram of a M-S specimen subjected to tension test and explain the salient points. (06 Marks)
- b. Determine the magnitude of the load P necessary to produce zero net change in the length of a straight bar shown in Fig.Q1(b). Area $A = 400 \text{ mm}^2$.

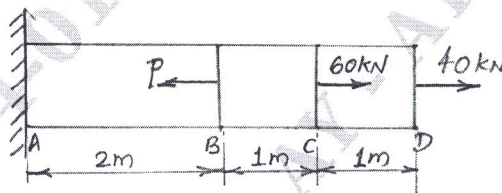


Fig.Q1(b)

(10 Marks)

OR

- 2 a. Define Poisson's ratio. Derive an expression for volumetric strain of a rectangular bar subjected to normal stress along the three axis. (08 Marks)
- b. A composite bar is rigidly fitted at the supports A and B as shown in Fig.Q2(b). Determine the reactions at the supports when temperature rises by 20° . Take $E_A = 70 \text{ GPa}$, $E_S = 200 \text{ GPa}$, $\alpha_A = 11 \times 10^{-6}/^\circ\text{C}$ and $\alpha_S = 12 \times 10^{-6}/^\circ\text{C}$.

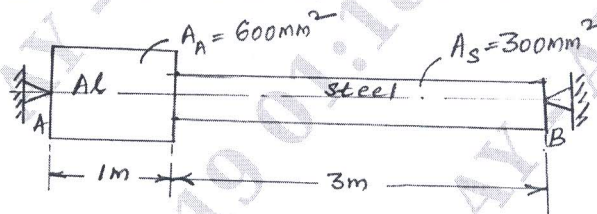


Fig.Q2(b)

(08 Marks)

Module-2

- 3 a. Derive an expression for the normal stress and shear stress on a plane inclined at ' θ ' to the vertical axis in a biaxial stress system. (06 Marks)
- b. At a point in a strained material, the stresses on two planes at right angles to each other are 80 N/mm^2 (tensile) and 40 N/mm^2 (tensile). Each of the above stresses are accompanied by a shear stress of 60 N/mm^2 . Determine normal stress, shear stress and resultant stress on an inclined plane (oblique plane) at an angle of 45° to the axis of minor tensile stress. Also find major principal stress, minor principal stress and their location. (10 Marks)

OR

- 4 a. Derive an expression for circumferential and longitudinal stress in a thin cylinder subjected to internal pressure p. (06 Marks)
- b. A thick cylindrical pipe of outside diameter 300 mm and internal diameter 200 mm 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 of the pipe indicating the values at every 25 mm interval. (10 Marks)

Module-3

- 5 a. Derive an expression to establish a relationship between intensity of load, shear force and bending moment. (06 Marks)
- b. Draw the shear force and bending moment diagram for the beam loaded as shown in Fig.Q5(b). Locate the point of contraflexure if any.

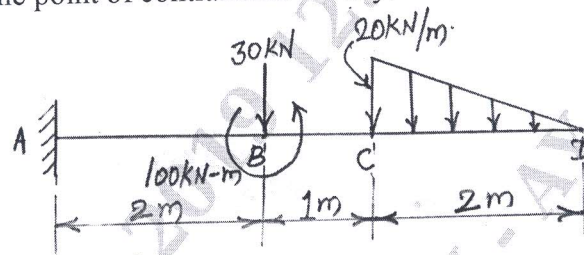


Fig.Q5(b)

(10 Marks)

OR

- 6 a. A simply supported beam of 'I' section carries a uniformly distributed load of 40 kN/m run on entire span of beam of 10 m. If 'I' section is having dimensions as shown in Fig.Q6(a), determine the maximum stress developed due to bending.

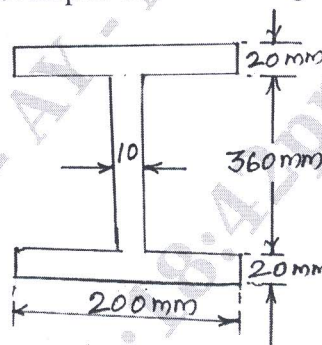


Fig.Q6(a)

(08 Marks)

- b. Find the deflection at the free end of cantilever beam shown in Fig.Q6(b). Take $E = 2 \times 10^5 \text{ N/mm}^2$, $I = 180 \times 10^6 \text{ mm}^4$.

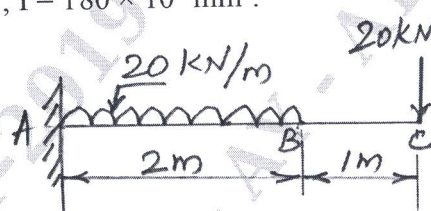


Fig.Q6(b)

(08 Marks)

Module-4

- 7 a. Derive the torsion equation $\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{L}$ with usual notations. (08 Marks)
- b. A hollow circular shaft has to transmit 60 kW at 210 rpm such that the maximum shear stress does not exceed 60 MN/m^2 . If the ratio of internal to external diameter is equal to $\frac{3}{4}$ and the value of rigidity modulus is 84 GPa, find the dimensions of the shaft and angle of twist in a length of 3m. (08 Marks)

OR

- 8 a. Derive Euler's equation of a column with one end fixed and other end free. (06 Marks)
- b. A 1.5 m long column has a circular cross-section of 50 mm diameter. One end of the column is fixed and the other end is free. Taking factor of safety as 3, calculate the safe load using:
- Rankine's formula, taking yield stress 560 N/mm^2 and $\alpha = \frac{1}{1600}$.
 - Euler's formula, taking $E = 1.2 \times 10^5 \text{ N/mm}^2$. (10 Marks)

Module-5

- 9 a. State and explain three main theories of failure applicable to complex stress system. (06 Marks)
- b. A bolt is acted upon by an axial pull of 16 kN along with a transverse shear force of 10 kN. Determine the diameter of the bolt required, using
- Max. principal stress theory
 - Max. shear stress theory
 - Max. strain theory
- Elastic limit in tension = 250 MPa
Factor of safety = 2.5
Poisson's ratio = 0.3 (10 Marks)

OR

- 10 a. Write a note on:
- Castigliano's I theorem
 - Strain energy due to bending and torsion. (06 Marks)
- b. The maximum stress produced by a pull in a bar of length 1100 mm is 100 N/mm^2 . The area of cross sections of length are shown in Fig.Q10(b). Calculate the strain energy stored in the bar if $E = 2 \times 10^5 \text{ N/mm}^2$.

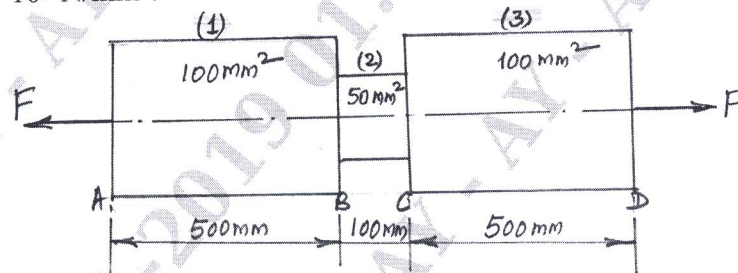


Fig.Q10(b)

(10 Marks)
