CBCS SCHEME

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18ME32

Third Semester B.E. Degree Examination, Dec.2019/Jan.2020
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) Stress (ii) Strain (iii) Young's Modulus (iv) Poisson's ratio (v) Hooke's law. **(05 Marks)**

b. Derive an expression for the total elongation of a tapered circular bar cross section of diameter 'D' and 'd', when subjected to an axial load 'P'. **(05 Marks)**

c. A brass bar having cross sectional area of 1000 mm^2, is subjected to axial forces shown in Fig. Q1 (c). Find the total elongation of the bar. Take E = 100 GN/m^2. **(10 Marks)**

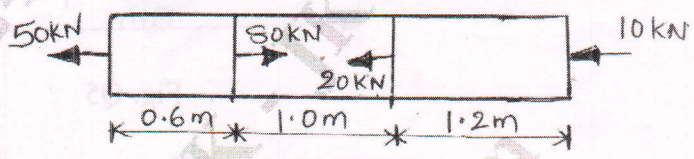


Fig. Q1 (c)

OR

2 a. Draw stress strain diagram for mild-steel and mark all the salient points. **(04 Marks)**

b. A concrete column of cross sectional area 400mm × 400mm is re-inforced by 4 longitudinal 50 mm diameter steel bars placed at each corner. If the column carries a comprehensive load of 300 kN, determine (i) Loads carried (ii) Stress produced in the concrete and Steel bars. **(08 Marks)**

c. A steel rod 15 m long at a temperature of 15°C. Find the free expansion of length when the temperature is raised to 65°C. Find the temperature stresses produced, when
(i) The expansion of the rod is prevented.
(ii) The rod is permitted to expand by 6 mm.
Take $\alpha = 12\times10^{-6}/^{\circ}C$ and $E = 2\times10^{5}\ N/mm^2$ **(08 Marks)**

Module-2

3 The state of stress at a point in a strained material is shown in Fig. Q3. Determine
a) The direction of the principal planes.
b) The magnitude of principal stresses.
c) The magnitude of the maximum shear stress and its direction.
d) Draw Mohr's circle and verify the results obtained analytically.

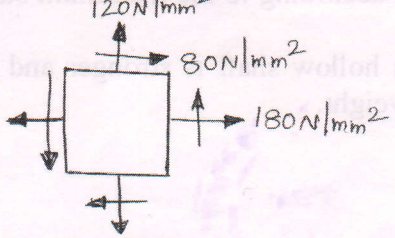


Fig. Q3 **(20 Marks)**

OR

4 a. Differentiate between thin and thick cylinders. **(04 Marks)**

b. Derive an expression for circumferential stress and longitudinal stress for a thin cylinder subjected to an internal pressure 'P'. **(06 Marks)**

c. A thick cylinder of 400 mm internal diameter and 100 mm thickness contains a fluid at a pressure 80 N/mm^2. Find hoop stresses across the section. Also sketch the radial and hoop stress distribution across the section. **(10 Marks)**

Module-3

5 Draw shear force and Bending Moment Diagrams for the beam shown in Fig. Q5. Locate the point of contraflexure. **(20 Marks)**

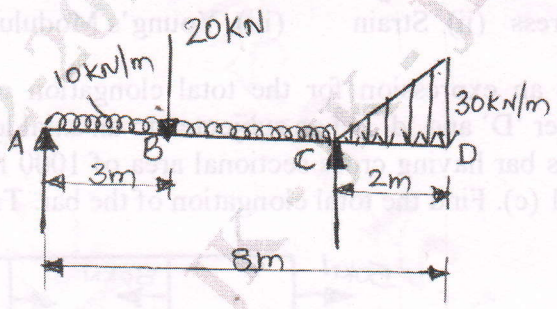
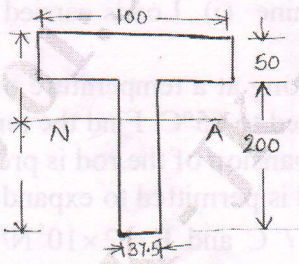


Fig. Q5

OR

6 a. Prove the relation $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$ with usual notations. **(10 Marks)**

b. The T-section of a beam is shown in Fig. Q6 (b). The material of the beam has yield strength of 250 MPa. Determine maximum moment of resistance that the beam can support if yielding is to be avoided. **(10 Marks)**



Note : All dimensions are in mm.

Fig. Q6 (b)

Module-4

7 a. A mild steel shaft 120 mm diameter is subjected to a maximum torque of 20×10^6 N-mm and a maximum bending moment of 12×10^6 N-mm at a particular section. Find the factor of safety (FoS) according to the maximum stress theory, if the elastic limit in simple tension is 220 N/mm^2. **(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 shaft is to transmit 300 kW power at 80 rpm. If the shear stress is not to exceed 60 N/mm^2 and internal diameter is 0.6 times the external diameter. Find the external and internal diameters, assuming that the maximum torque is 1.4 times the mean. **(10 Marks)**

Module-5

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

b. A 2 m long column has a square cross section of side 40 mm. Taking the factor of safety as 4, determine the safe load for the end conditions,

(i) Both ends are hinged.
(ii) One end fixed and other end is free.
(iii) Both ends are fixed.
(iv) One end fixed and other end is hinged.

Take E = 210 GPa **(10 Marks)**

OR

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

b. The bar with circular cross section shown in Fig. Q10 (b) is subjected to a load of 10 KN. Determine the strain energy stored in it. Take $E = 2.1 \times 10^5$ N/mm^2 **(10 Marks)**

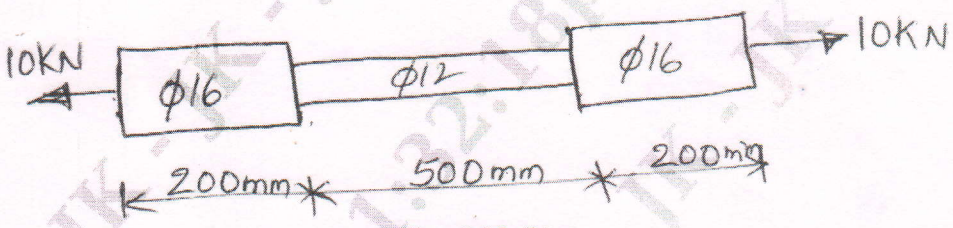


Fig. Q10 (b)

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