CBCS SCHEME

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21MR53

Fifth 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: (i) Plasticity (ii) Brittleness (iii) Toughness (iv) Young's modulus (v) Poisson's ratio **(10 Marks)**

b. A brass bar having cross sectional area 300 mm^2 is subjected to axial forces as shown in Fig.Q1(b). Find the total elongation of the bar E = 84 GPa.

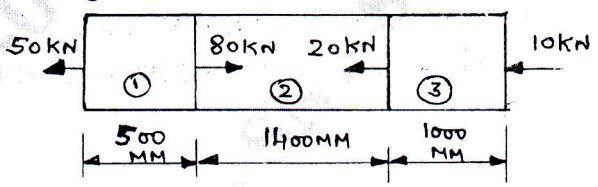

Fig.Q1(b) **(10 Marks)**

OR

2 a. Derive expression for relation between modulus of elasticity and modulus of rigidity. **(10 Marks)**

b. A cube of 100 mm side is subjected to 10 N/mm^2 (tensile), 8 N/mm^2 (compression) and 6 N/mm^2 (Tensile) acting along x, y and z planes respectively. Determine the strains along the three directions and change in volume. The Poisson's ratio = 0.25 and $E = 2 \times 10^5$ N/mm^2. **(10 Marks)**

Module-2

3 a. Show that the sum of the normal stresses on any two planes at right angles in a general two dimensional stress system is constant. **(10 Marks)**

b. At a certain point in a strained material the values of normal stresses across two planes at right angles to each other are 80 MPa and 32 MPa, both tensile and there is a shear stress of 32 MPa. CW on the plane carrying 80 MPa stresses across the planes as shown in Fig.Q3(b), determine:

(i) Maximum and minimum normal stresses and locate their planes.

(ii) Maximum shear stress and specify its plane

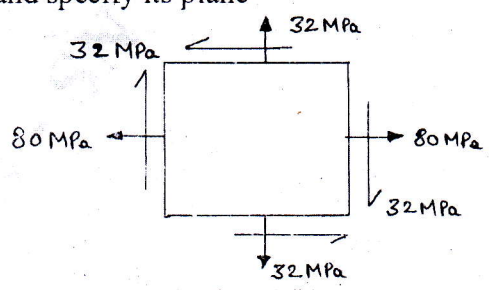

Fig.Q3(b) **(10 Marks)**

OR

4 a. Explain construction of Mohr's circles for stresses. **(10 Marks)**

b. Derive expression for normal stress and tangential stress in member subjected to direct stresses on two material perpendicular directions. **(10 Marks)**

Module-3

5 a. Derive an expression for load, shear force and bending moment. **(10 Marks)**

b. Draw SFD and BMD for a simply supported beam loaded as shown in Fig.Q5(b).

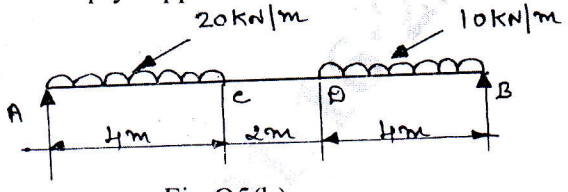

Fig.Q5(b) **(10 Marks)**

OR

6 a. Write the assumptions made in theory of simple bending and derive an expression for relationship between bending stress and radius of curvature. **(10 Marks)**

b. The T-section shown in Fig.Q6(b) is used as a simply supported beam over a span of 4 meters, it carries an uniformly distributed load of 8 kN/m over its entire span. Calculate the maximum tensile and compressive stresses occurring in the section.

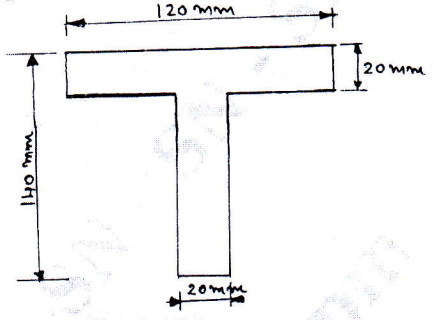

Fig.Q6(b) **(10 Marks)**

Module-4

7 a. Derive Euler's Bernoulli's equation for deflection. **(10 Marks)**

b. A cantilever beam 2m long is carrying a load of 20 kN at its free end and 30 kN at a distance of 1m from the free end. Find the slope and deflection at the free end. Take $I = 15 \times 10^7$ mm^4, $E = 2 \times 10^5$ N/mm^2. **(10 Marks)**

OR

8 a. Derive Torsion equation and list out assumptions made in torsion. **(10 Marks)**

b. A solid shaft rotation at 1000 rpm transmits 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 the twist in the shaft should not exceed 1° in 1m length. Determine the diameter of the shaft. **(10 Marks)**

Module-5

9 a. Define thin cylinder. Derive an expression for circumferential stress and longitudinal stress. **(10 Marks)**

b. A pipe of 500 mm internal diameter and 75 mm thick filled with a fluid at a pressure of 6 N/mm^2. Find the maximum and minimum hoop stress across the cross section of the cylinder. Also sketch the radial pressure and hoop stress distribution across the section. **(10 Marks)**

OR

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

b. Design the section of a circular cast iron column that can safely carry a load of 1000 kN. The length of the column is 6 meters. Rankine's constant $\frac{1}{1600}$, factor of safety is 3. One end of the column is fixed and other end is free. Critical stress is 560 MPa. **(10 Marks)**