CBCS SCHEME

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21ME44

Fourth Semester B.E. Degree Examination, June/July 2023
Mechanics and 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) Elasticity ii) Stress iii) Strain iv) Young's modulus v) Poison's ratio. **(05 Marks)**

b. Derive an expression for extension of the uniformly tapered circular bar subjected to an axial load. **(05 Marks)**

c. A member ABCD is subjected to point loads P_1, P_2, P_3 and P_4 as shown in Fig.Q1(c). Calculate the force P_2 necessary for equilibrium if $P_1 = 45kN$, $P_3 = 450kN$ and $P_4 = 130kN$. Determine stresses in each member and also determine the total elongation of the member assuming the $E = 2.1 \times 10^5 N/mm^2$.

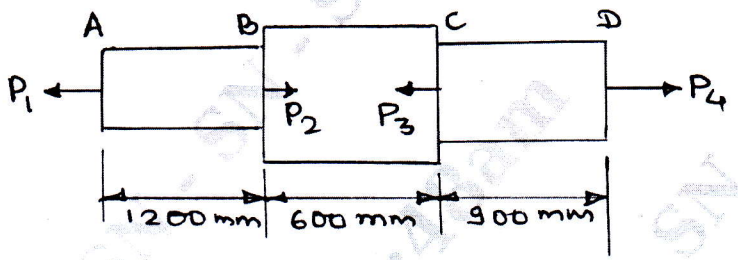

Fig.Q1(c) **(10 Marks)**

OR

2 a. Derive relationship between modulus of elasticity and modulus of rigidity. **(10 Marks)**

b. A compound bar is made up of a central steel plate 50mm wide and 10mm thick to which copper plate 50mm wide and 5mm thick are connected rigidly on each side. The length of the compound bar at room temperature is 1000mm. If the temperature is raised by 100°C, determine the stress in each material and change in length of the compound bar. Assume $E_{st} = 200GPa$, $E_{CO} = 100GPa$. **(10 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. **(10 Marks)**

b. An element with the stresses acting on it as shown in Fig.Q3(b). Determine :
i) Principal stresses and its locations
ii) Maximum shear stresses and its locations.

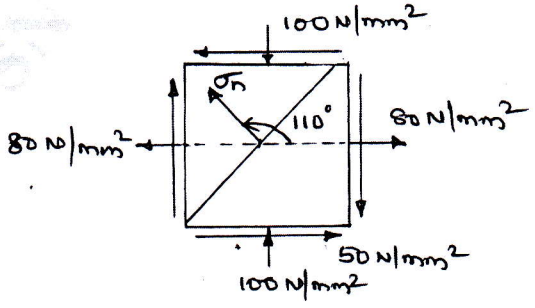

Fig.Q3(b) **(10 Marks)**

OR

4 The state of stress at a point in a strained material is shown in Fig.Q4. Determine :

a. Stresses on a plane whose normal is at an angle of 45° with reference to 80N/mm^2 stress direction

b. Magnitude of principal stresses and their location

c. Maximum and minimum shear stress and their location

d. Draw Mohr's circle and verify the results obtained analytically.

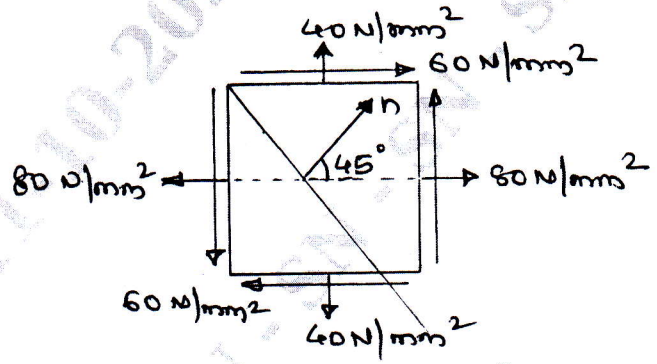

Fig.Q4 **(20 Marks)**

Module-3

5 a. Obtain expressions relating load, shear force and bending moment. **(05 Marks)**

b. Draw the shear force and bending moment diagram for the beam shown in Fig.Q5(b).

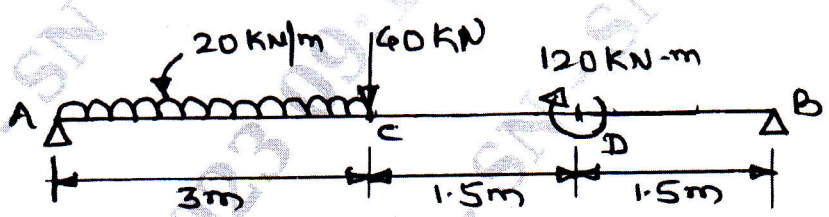

Fig.Q5(b) **(15 Marks)**

OR

6 a. Derive the equation $\frac{M}{I} = \frac{\sigma_b}{Y} = \frac{E}{R}$ with usual notations. State the assumptions in the derivation. **(10 Marks)**

b. A beam having T-section with its flanges of 180mm × 10mm and web of 220mm × 10mm is subjected to sagging bending moment 15kN-m. Determine the maximum tensile stress and maximum compressive stress, and their location in the section. **(10 Marks)**

Module-4

7 a. Derive differential equation for deflection of beam. **(10 Marks)**

b. Determine slope and deflection for a cantilever beam of length L and subjected to UDL W/unit length. **(10 Marks)**

OR

8 a. State assumptions and derive the torsional equation $\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{L}$. **(10 Marks)**

b. A hollow shaft of diameter ratio 3/8 is required to transmit 588kW at 110rpm, the maximum torque being 120% of the mean. Shear stress is not exceed 63N/mm^2 and twist in a length of 3m not to exceed 1.4° calculate external diameter of shaft which would satisfy these conditions. Take modulus of rigidity as 84GPa. **(10 Marks)**

Module-5

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

b. Derive an expression for strain energy for a member subjected to axial load. **(05 Marks)**

c. A steel bar 15mm diameter is pulled axially by a force of 10kN. If the bar is 250mm long, calculate the strain energy stored per unit volume of the bar and total strain energy stored by the bar. Take $E = 2 \times 10^5$ N/mm^2. **(05 Marks)**

OR

10 a. Obtain the expression for Euler's critical load for a long column with both ends hinged. Also state assumptions made. **(10 Marks)**

b. A thick cylinder with internal diameter 80mm and external diameter 120mm is subjected to an external pressure of 40N/mm^2 when the internal pressure is 120N/mm^2. Plot the variation of circumferential stress and radial pressure on the thickness of the cylinder. **(10 Marks)**

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