CBCS SCHEME

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17ME34

Third Semester B.E. Degree Examination, Jan./Feb. 2021

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) Hook's law (ii) Poisson's ratio (iii) Modulus of rigidity (iv) Modulus of elasticity (v) Bulk modulus. **(05 Marks)**

b. Draw stress-strain diagram of a mild steel and name the salient points. **(05 Marks)**

c. A brass bar having cross-sectional area 300 mm^2 is subjected to axial forces as shown in Fig.Q1(c). Find the total elongation of the bar. E = 84 GPa. **(10 Marks)**

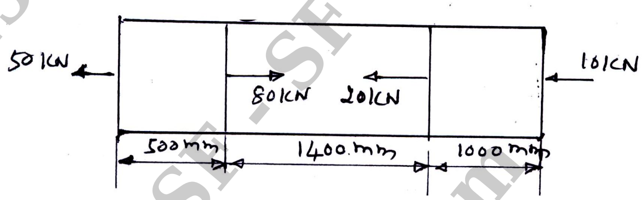

Fig.Q1(c)

OR

2 a. Define :
(i) Elasticity (ii) Plasticity (iii) Stiffness (iv) Resilience (v) Toughness **(05 Marks)**

b. Derive a relation between modulus of elasticity, modulus of rigidity and bulk modulus. **(05 Marks)**

c. At room temperature the gap between two bars as shown in Fig.Q2(c) is 0.25 mm. What are the stresses induced in the bars, if temperature rise is 35°C. Given $A_A = 1000$ mm^2, $A_B = 800$ mm^2, $E_A = 2\times10^5$ MPa, $E_B = 1\times10^5$ MPa, $\alpha_A = 12\times10^{-6}$ per °C, $\alpha_B = 23\times10^{-6}$ per °C.

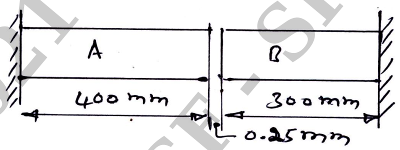

Fig.Q2(c) **(10 Marks)**

Module-2

3 a. Define principal plane and principal stress. **(02 Marks)**

b. Derive an expression for hoop stress and longitudinal stress for thin cylinder. **(06 Marks)**

c. At a point in a strained material the stress condition shown in Fig.Q3(c). Find
(i) Normal and shear stresses on the inclined plane AB.
(ii) Principal stress and principal planes
(iii) Maximum shear stress. **(12 Marks)**

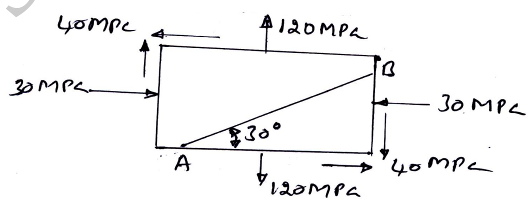

Fig.Q3(c)

OR

4 a. Derive Lame's equation for thick cylinder. **(08 Marks)**

b. A pipe of 500 mm internal diameter and 75mm thick is 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. **(12 Marks)**

Module-3

5 a. Derive the relations between intensity of load 'W', shear force 'F' and bending moment 'M' in the beam. **(06 Marks)**

b. Draw bending moment and shear force diagram for the beam shown in Fig.Q5(b). Clearly indicate the point of contraflexure. **(14 Marks)**

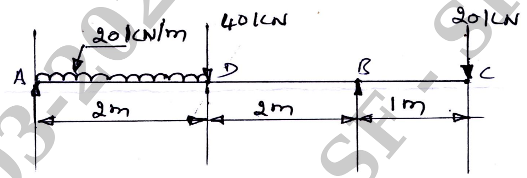

Fig.Q5(b)

OR

6 a. Derive the relationship between bending stress and radius of curvature. **(06 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. **(14 Marks)**

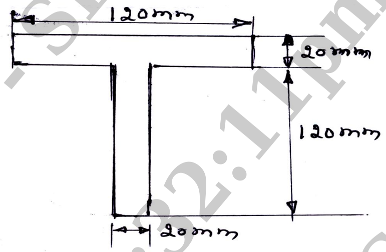

Fig.Q6(b)

Module-4

7 a. Derive the torsional equation. **(10 Marks)**

b. A solid shaft rotating at 1000 rpm transmits 50 kW. Maximum torque is more than 20% of mean torque. Material of the shaft had the allowable shear stress of 50 MPa and G = 80 GPa. Angle of twist in the shaft should not exceed 1° per meter length. Determine the diameter of the shaft. **(10 Marks)**

OR

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

b. Determine the crippling load for a T-section of dimensions 100mm × 100mm × 20mm and length of column 12m with both ends fixed. Take E = 210 GPa. **(10 Marks)**

Module-5

9 a. Explain : (i) Castigliano's first theorem (ii) Castigliano's second theorem **(10 Marks)**

b. A cantilever beam of uniform cross-section carries a point load at the free end. Determine strain energy and deflection at the free end, if F = 200 kN, E = 200 GPa, L = 3 mt and $I = 10^{-4}\ m^4$. **(10 Marks)**

OR

10 a. Explain maximum normal stress theory and maximum shear stress theory. **(10 Marks)**

b. A machine member made of C40 steel having the yield stress of 328.6 MPa is loaded as follows. $\sigma_x = 60$ MPa, $\sigma_y = -20$ MPa and $\tau_{xy} = 30$ MPa. Determine the factor of safety by (i) Maximum normal stress theory (ii) Maximum shear stress theory. **(10 Marks)**