CBCS SCHEME

USN

17ME34

Third Semester B.E. Degree Examination, July/August 2021

Mechanics of Materials

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions.

1 a. Define the following:
(i) Elasticity (ii) Ductility (iii) Poison's ratio
(iv) Shear stress (v) Hooks law **(10 Marks)**

b. Derive an expression for the extension of a tapering bar whose diameter D_1 at one end tapers linearly to a diameter D_2 in a length L, under an-axial pull 'P' and Young's modulus E. **(06 Marks)**

c. A 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. Take E = 84 GPa.

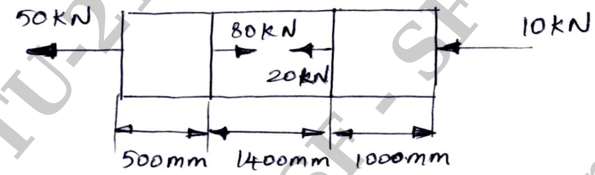

Fig.Q1(c) **(04 Marks)**

2 a. Derive a relation between Young's modulus and Modulus of rigidity. **(10 Marks)**

b. A copper bar of length 160 mm is placed on a rigid support in vertical position. Clearance between the upper support and top surface of the member is 0.1 mm as shown in the Fig.Q2(b). Determine:
(i) Increase in temperature required for the bar to touch the upper support.
(ii) Temperature rise required to induced compressive stress of 100 MPa.
(iii) Stress induced in the bar when its temperature is increased by 90°C and the upper support yields by 0.12 mm.
(iv) Stress induced in the bar when the temperature is increased by 30°C, assume that there is no clearance between upper support and top surface of the bar. Take E_c = 120 GPa and $\alpha_c = 18 \times 10^{-6}/°C$.

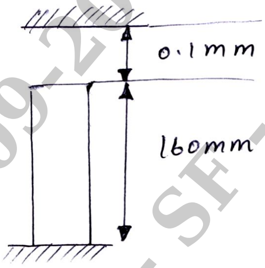

Fig.Q2(b) **(10 Marks)**

3 a. Derive an expression for normal stress and shear stress acting on a inclined plane. **(10 Marks)**

b. A point in a strained member is subjected to tensile stresses 100 MPa and 70 MPa along two mutually perpendicular directions. The point is also subjected to a shear stress 50 MPa such that shear force on vertical face give rise to anticlockwise couple. Determine:
(i) Stresses acting on a plane whose normal is at an angle of 120° with the reference to the 100 MPa stress plane.
(ii) Magnitude of principal stresses and maximum shear stresses
(iii) Orientations of the principal plane and maximum and minimum shear stress planes. Solve the problem using Mohr's circle method. **(10 Marks)**

4 a. Derive an expression for Hoop stress and longitudinal stress for thin cylinder. **(08 Marks)**

b. A thin cylindrical vessel of 1000 mm diameter and 3000 mm length has a metal wall of thickness 10 mm. It is subjected to an internal fluid pressure of 3 N/mm^2. Find the circumferential and longitudinal stresses in the wall. Determine the change in the length, diameter and volume of the cylinder. Assume $E = 2.1 \times 10^5$ N/mm^2 and Poisson's ratio = 0.3. **(12 Marks)**

5 For the beam shown in the Fig.Q5, draw shear force and bending moment diagrams. Locate the point of contraflexure, if any.

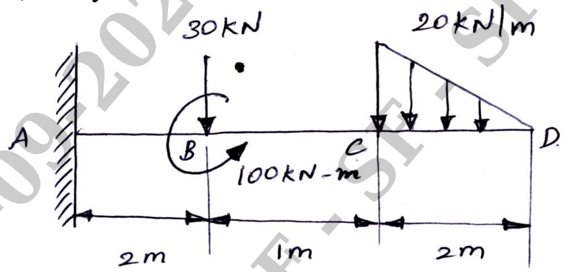

Fig.Q5 **(20 Marks)**

6 a. Derive the deflection equation, $EI\frac{d^2y}{dx^2} = M$. **(06 Marks)**

b. A T section of flange 120 × 12 mm and overall depth is 200 mm with 12 mm web thickness is loaded, such that, at a section it has a moment of 20 kN-m and shear force of 120 kN. Sketch the bending and shear force distribution diagram. **(14 Marks)**

7 a. Derive an expression for torque and shear stress of a shaft. **(08 Marks)**

b. A 2m long hollow cylinder shaft has 80 mm outer diameter and 10 mm wall thickness. When the torsional load on the shaft is 6 kN-m, determine:
(i) Maximum shear stress induced
(ii) Angle of twist
(iii) Also draw the distribution of shear stress in the wall of the shaft. Take G = 80 GPa. **(12 Marks)**

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

b. A 2m long column has a square cross-section of side 40 mm. Taking FOS = 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.
Take E = 210 GPa. **(10 Marks)**

9 a. Derive an expression for strain energy due to shear stresses. **(10 Marks)**

b. Explain:
(i) Maximum principal stress theory
(ii) Maximum shear stress theory **(10 Marks)**

10 a. Derive an expression for the strain energy in bending and strain energy in torsion. **(16 Marks)**

b. A solid circular shaft is 4 m long has a diameter of 80 mm. Find the torsional strain energy stored in it when it is subjected to a torque of 200 N-m. Take G = 80 GPa. **(04 Marks)**

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