CBCS SCHEME

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

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions.

1 a. Define : (i) Poisson's ratio (ii) Toughness (iii) Resilience (iv) Malleability **(04 Marks)**

b. Derive an expression for extension of uniformly tapering circular bar. **(06 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.

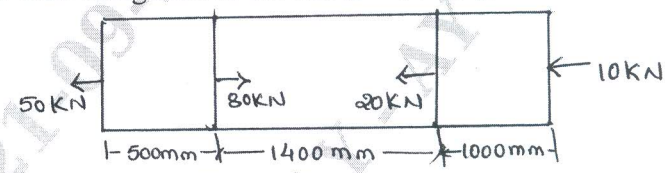

Fig.Q1(c) **(06 Marks)**

2 a. Derive relationship between Modulus of Elasticity and Modulus of Rigidity. **(08 Marks)**

b. A composite bar made up of aluminium and steel is held between two supports as shown in Fig.Q2(b). The bars are stress free at temperature 42°C. What will be the stresses in the two bars with the temperature drops to 24°C if (i) The supports are unyielding (ii) The supports come nearer to each other by 0.1 mm. The cross-sectional area of steel bar is 160 mm^2 and that of aluminium bar is 240 mm^2. $E_A = 0.7 \times 10^5$ N/mm^2, $E_S = 2 \times 10^5$ N/mm^2, $\alpha_A = 24 \times 10^{-6}$ per °C and $\alpha_S = 12 \times 10^{-6}$ per °C.

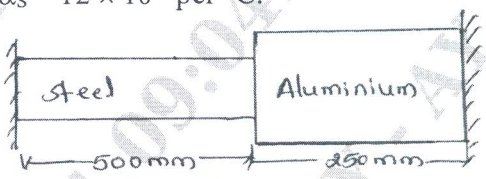

Fig.Q2(b) **(08 Marks)**

3 a. The state of stress in two dimensionally stressed body is shown in Fig.Q3(a). Determine the principal stresses, principal planes, maximum shear stress and their plans.

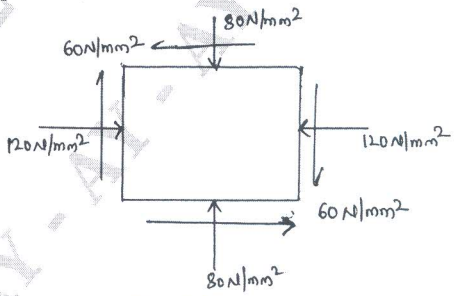

Fig.Q3(a) **(12 Marks)**

b. Define: (i) Principal stress (ii) Principal strain **(04 Marks)**

4 a. Derive Lame's equation for radial and hoop stress in case of thick cylinders. **(10 Marks)**

b. A pipe of 500 mm internal diameter and 75 mm 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. **(06 Marks)**

5 Draw the shear-force and bending moment diagram for a overhanging beam shown in Fig.Q5 and locate the point of contraflexure.

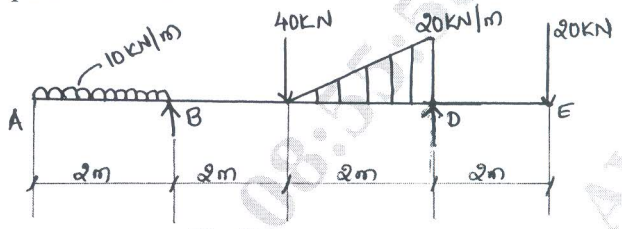

Fig.Q5 **(16 Marks)**

6 a. The T-section shown in Fig.Q6(a) 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.

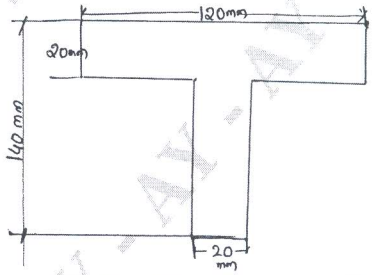

Fig.Q6(a) **(08 Marks)**

b. Prove that in case of a rectangular section of a beam the maximum shear-stress is 1.5 times average shear stress. **(08 Marks)**

7 a. Derive the equation of torsion $\frac{T}{J_p} = \frac{\tau}{r} = \frac{G\theta}{\ell}$ **(10 Marks)**

b. A solid shaft rotating at 1000 rpm transmits 50 KW. Maximum torque 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 twist in the shaft should not exceed 1° in one metre length. Determine the diameter of the shaft. **(06 Marks)**

8 a. Derive an expression for Euler's critical load for a column with both ends are fixed. **(08 Marks)**

b. A 1.5 m long column has a circular cross section of 50 mm diameter. One end of the column is fixed in direction and position and the other end is free. Taking the factor of safety as 3, calculate the safe load using:

(i) Rankine's formula taking yield stress 560 N/mm^2 and $\alpha = 1/1600$.

(ii) Euler's formula, taking $E = 1.2 \times 10^5$ N/mm^2. **(08 Marks)**

9 a. Derive an expression for strain energy for a member subjected to axial load. **(06 Marks)**

b. State Castiglione's theorem I and II. **(04 Marks)**

c. A simply supported beam of span 'ℓ' carries a point lead 'p' at mind-span. Determine the strain energy stored by the beam. Also find the deflection at mid-span. **(06 Marks)**

10 a. Explain Maximum principal stress theory and maximum shear stress theory. **(08 Marks)**

b. A plate of 45C8 steel (σ_{y_t} = 353 MPa) is subjected to the following stresses, $\sigma_x = 150$ N/mm^2, $\sigma_y = 100$ N/mm^2 and $\tau_{xy} = 50$ N/mm^2. Find the factor of safety by:

(i) Maximum principal stress theory

(ii) Maximum shear stress theory. **(08 Marks)**

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