CBCS SCHEME

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18ME32

Third Semester B.E. Degree Examination, June/July 2023
Mechanics of Materials

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Explain with neat sketch, stress-strain diagram of mild steel indicating it's salient points. **(06 Marks)**

b. Define : (i) Hooke's law (ii) Modulus of rigidity (iii) Volumetric strain (iv) Poisson's ratio **(04 Marks)**

c. A steel bar ABCD of varying sections is subjected to axial forces as shown in Fig. Q1 (c). Find the value of 'P' necessary for equilibrium. If E = 210 kN/mm^2, determine
  (i) Stress in various segments
  (ii) Total elongation of bar
  (iii) Total strain in the bar.

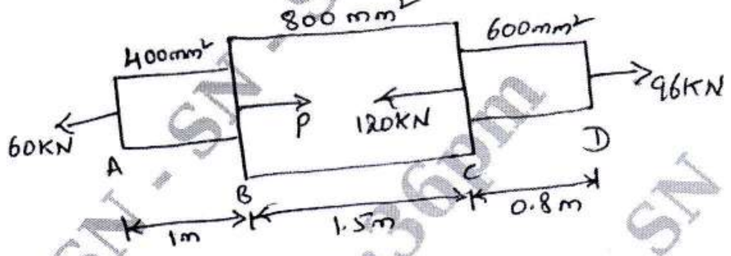

Fig. Q1 (c) **(10 Marks)**

OR

2 a. Derive a relation between young's modulus (E) and modulus of rigidity (G). **(10 Marks)**

b. A composite bar shown in Fig. Q2 (b) is 0.2 mm short a distance between the rigid supports at room temperature. What is maximum temperature rise which will not produce stress in the bar? Find stresses induced when temperature rise is 40°C. Given $\alpha_s = 12\times10^{-6}$ per$^\circ$C, $\alpha_C = 17.5\times10^{-6}$ per$^\circ$C, $E_s = 2\times10^5$ N/mm^2, $E_C = 1.2\times10^5$ N/mm^2, $A_S : A_C = 4 : 3$

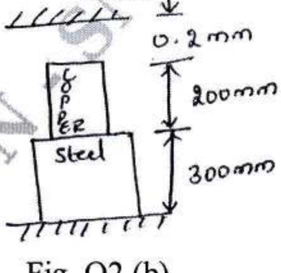

Fig. Q2 (b) **(10 Marks)**

Module-2

3 a. Derive an expression for normal stress, shear stress and resultant stress on an oblique plane inclined at an angle 'θ'. With vertical axis (x-plane) in a bi-axial stress system subjected to σ_1 and σ_2 also find angle of obliquity ϕ. **(10 Marks)**

b. A point in a strained material, the stress on two planes at right angles to each other are 80 N/mm^2(tensile) and 40 N/mm^2 (tensile). Each of above stresses is accompanied by a shear stress of 60 N/mm^2. Determine (i) Normal stress, shear stress and resultant stress on an oblique plane inclined at an angle of 45° to the axis of minor tensile stress. Also find major principal stress , minor principal stress and their location, maximum shear stress and its location.

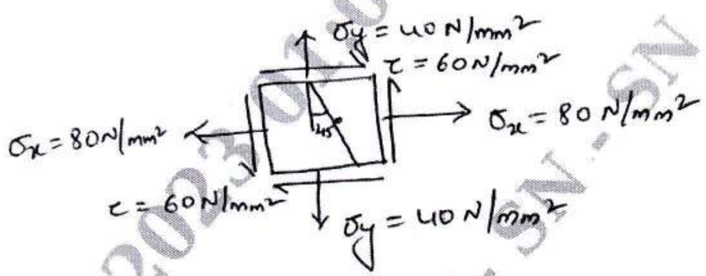

Fig.Q3 (b) **(10 Marks)**

OR

4 a. Derive expression for hoop stress and longitudinal stress for thin cylinder subjected to internal fluid pressure. **(10 Marks)**

b. A thick cylindrical pipe of outside diameter 300 mm and internal diameter 200 mm is subjected to an internal fluid pressure of 20 N/mm^2 and external fluid pressure of 5 N/mm^2. Determine the maximum hoop stress developed. Draw the variation of hoop stress and radial stress across the thickness indicating the values at every 25 mm interval. **(10 Marks)**

Module-3

5 a. Deduce the relationship between relating load (W), Shear Force (F) and Bending moment (M). **(06 Marks)**

b. For the beam shown in Fig. Q5 (b), draw SFD and BMD. Locate the point of contraflexure, if any.

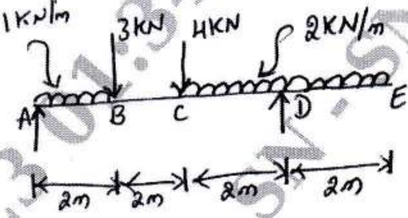

Fig. Q5 (b) **(14 Marks)**

OR

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

b. A beam of an I-section consists of 180mm $\times$ 15mm flanges and a web of 280 mm depth $\times$ 15 mm thickness.
It is subjected to a bending moment of 120 kN-m and a shear force of 60 kN. Sketch the bending and shear stress distributions along the depth of the section.

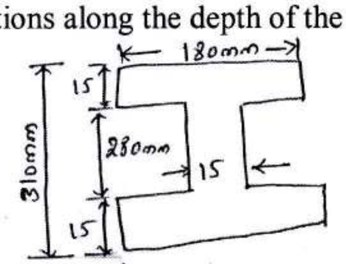

Fig. Q6 (b) **(12 Marks)**

Module-4

7 a. Write a note on the following :

(i) The maximum principal stress theory.

(ii) The maximum shear stress theory. **(08 Marks)**

b. A solid circular shaft is subjected to a bending moment of 9000 Nm and a twisted moment of 12000 Nm. In a simple uniaxial tensile test of the same material, it gives the following particulars. Stress at yield point 300 N/mm^2. Assume factor of safety = 3. Estimate the least diameter required using, (i) Maximum principal stress theory

(ii) Maximum shear stress theory. **(12 Marks)**

OR

8 a. Derive the torsion equation with usual notation $\frac{T}{J} = \frac{G\theta}{L} = \frac{\tau}{R}$. State the assumption made in the derivation. **(10 Marks)**

b. A solid circular shaft has to transmit a power of 1000 kW at 120 rpm. Find the diameter of the shaft, if the shear stress of the material must not exceed 80 N/mm^2. The maximum torque 1.25 times of its mean. What percentage of saving in material would be obtained, if the shaft is replaced by a hollow one whose internal diameter is 0.6 times its external diameter, the length, material and maximum shear stress being same? **(10 Marks)**

Module-5

9 a. State the assumption made while deriving Euler's column formula. Also derive Euler's expression of buckling load, for column with both ends fixed. **(10 Marks)**

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

(i) Rankine's formula, take yield stress $\sigma_C = 560$ N/mm^2 and $\alpha = \frac{1}{1600}$ for pinned ends.

(ii) Euler's formula, young's modulus for CI = 1.2×10^5 N/mm^2 **(10 Marks)**

OR

10 a. Explain the following :

(i) Castigliano's I[st] and II[nd] theorem.

(ii) Strain energy due to bending and torsion

(iii) Strain energy due to shear. **(15 Marks)**

b. The bar with circular cross section as shown in Fig. Q10 (b) is subjected to a load of 10 kN. Determine the strain energy stored in it. Take $E = 2.1\times10^5$ N/mm^2.

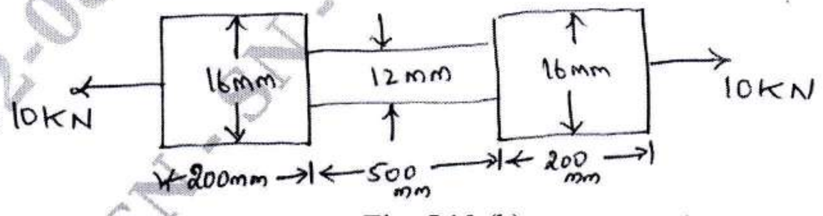

Fig. Q10 (b) **(05 Marks)**

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