CBCS SCHEME

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18AU34

Third Semester B.E. Degree Examination, Dec.2024/Jan.2025
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. Explain the stress-strain diagram for mild steel depicting all the salient points in it. **(10 Marks)**

b. A stepped bar is subjected to an external loading as shown in Fig.Q1(b). Calculate the change in the length of bar. Take E = 200GPa for steel. E = 70GPa for Aluminum and E = 100GPa for Copper. **(10 Marks)**

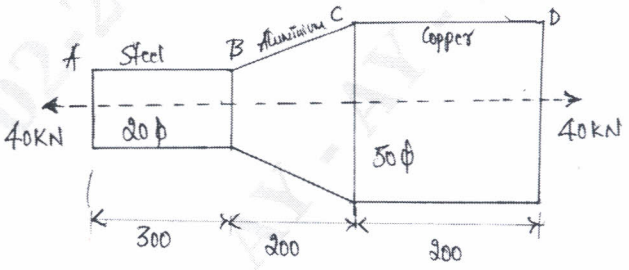

Fig.Q1(b)

OR

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

b. A steel bar is placed between two copper bars, each having the same area and of length 'L' as the steel bar at 15°C. At this stage, they are rigidity connected together at the both ends. The length of composite bar is also L. When the temperature is raised to 315°C, the length of the bar increase by 1.5mm. Determine the original length and find the stresses in th bars. Take : $E_S = 2.1 \times 10^5 N/mm^2$, $E_C = 1 \times 10^5 N/mm^2$,
$\alpha_S = 0.000012$ per °C, $\alpha_C = 0.00001 + 5$ per °C. **(10 Marks)**

Module-2

3 a. Show that the sum of the normal stresses on any two planes at right angles in a general two dimensional stress system is constant. **(10 Marks)**

b. A point in a beam is subjected to maximum tensile stress 110 MPa and shear stress 30 MPa. Find the magnitude and directions of principal stresses. If the point in the beam is in the compression zone under the same magnitude of bending stress and shear stress. Find the magnitudes of principal stresses and their directions. **(10 Marks)**

OR

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

b. A cylindrical pressure of 1 meter inner diameter and 1.5 meters long is subjected to an internal pressure P_1 thickness of the cylinder wall is 15mm. Taking allowable stress for cylinder materials as 90 MPa. Determine i) Magnitude of maximum internal pressure 'P' that the pressure vessel can withstand and ii) Change in dimensions.
Take E = 200 GPa and r = 0.3. **(10 Marks)**

Module-3

5 a. Explain the types of Beam, loads and supports. **(10 Marks)**

b. A simply supported beam of 6m long is subjected to loads 2kN, 5kN, and 4kN at distances 1.5m, 3m and 4.5m from the left support. Draw the shear force and Bending moment diagram. **(10 Marks)**

OR

6 a. What are the assumptions made in theory of simple bending? **(08 Marks)**

b. The cross-section of a beam is shown in Fig Q6(b). If permissible stress is 150N/mm^2. Find its moment of inertia. Compare it with equivalent section of the same area for a square section.

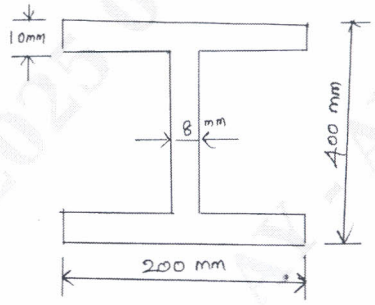

Fig Q6(b) **(12 Marks)**

Module-4

7 a. Derive the relation for a circular shaft when subjected to torsion as given by $\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{L}$. **(10 Marks)**

b. A solid circular shaft has to transmit a power of 1000 KW at 120rpm. Find the diameter of the shaft, if the shear stress of the material must not exceed 80N/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 hollow one whose internal diameter is 0.6 times its external diameter, the length, material and maximum shear stress being same? **(10 Marks)**

OR

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

b. A Hollow CI column whose outside diameter is 200mm has a thickness of 20mm. It is 4.5m long and is fixed at both ends. Calculate the safe load by Rankine's formula using a factor of safety of 4. Calculate the slenderness ratio and the ratio of Euler's and Rankine's critical loads. Take $f_c = 550$ N/mm^2, $\alpha = \frac{1}{1600}$ in Rankine's formula and $E = 9.4 \times 10^4$ N/mm^2. **(10 Marks)**

Module-5

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

b. Write short notes on :

i) Castigliano's theorem I & II ii) Modulus of resilience of strain energy. **(10 Marks)**

OR

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

b. Determine the strain energy and hence the deflection at the free end of a cantilever beams of length 'L' carrying a point load 'W' at its free end. **(10 Marks)**

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