CBCS SCHEME

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18AU34

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. List and explain the mechanical properties of Engineering Materials. **(10 Marks)**

b. The stepped bar shown in Fig. Q1(b) is subjected to a pull of 25kN. The bar is made up of two different materials having Young's modulus. $E_1 = 200$ GPa and $E_2 = 100$ GPa. Find the extension of the bar and stress in each materials. **(10 Marks)**

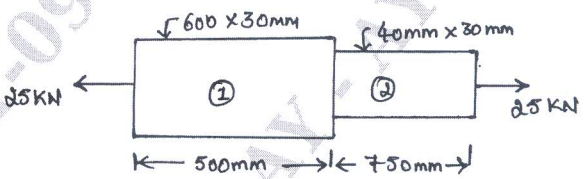

Fig. Q1(b)

2 a. Show the relation between Young's Modulus, Modulus of Rigidity and Bulk Modulus. **(10 Marks)**

b. A compound bar consisting of Steel, Bronze and Aluminum bars connected in series is held between two supports as shown in Fig. Q2(b). When the temperature of the compound bar is increased by 50^0C, determine the stresses induced in each bar. Consider the two cases :
i) Rigid supports and ii) Supports yield by 0.5mm. Take $\alpha_s = 12 \times 10^{-6}/^0$C , $\alpha_B = 19 \times 10^{-6}/^0$C , $\alpha_{Al} = 22 \times 10^{-6}/^0$C , $E_S = 200$ GPa , $E_B = 83$ GPa and $E_{Al} = 70$ GPa **(10 Marks)**

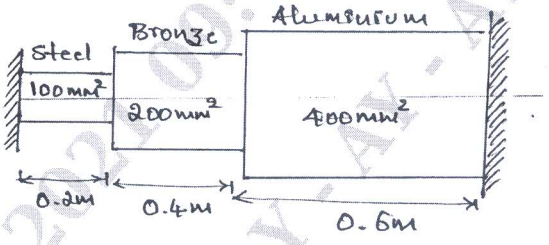

Fig. Q2(b)

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)**

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)**

5 a. Define and explain the following terms : i) Shear force ii) Bending Moment iii) Concentrated load iv) Uniformly distributed load v) Uniformly varying load. **(10 Marks)**

b. A simply supported beam of length 6m, carries point load of 3kN and 6kN at distances of 2m and 4m from the left end. Draw the shear force and bending moment diagrams for the beam. **(10 Marks)**

6 a. What do you mean by 'Simple Bending'? What are the assumptions made in the theory of simple bending? **(08 Marks)**

b. An I – section beam 350mm × 150mm has a web thickness of 10mm and a flange thickness of 20mm. If the shear force acting on the section is 40kN, find the maximum shear stress developed in the I - section. **(12 Marks)**

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 120 rpm. Find the diameter of the shaft, if the shear stress of the material must not exceed 80N/mm^2. The maximum torque 1.25 time 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)**

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. Find the Euler's crippling load for a hollow cylindrical steel column of 40mm external diameter and 4mm thick. The length of the column is 2.5m and is hinged at both ends. Also compute the Rankine's Crippling load using constants 335 MPa and Y_{7500}. Take E = 205 GPa. **(10 Marks)**

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)**

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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