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06ME34

Third Semester B.E Degree Examination, Dec. 07 / Jan. 08

Mechanics of Materials

Time: 3 hrs. Max. Marks:100

Note : ***1. Answer any FIVE full questions.***
2. Missing data, if any may suitably be assumed.

1 a. Explain clearly with neat sketches, if any, the following i) Proof stress ii) Secant Modulus iii) Elasticity iv) Strain Hardening. **(08 Marks)**

b. A stepped bar is subjected to an external loading as shown in fig. 1(b). Calculate the change in the length of the bar. Take E = 200 GPa for steel, E = 70 MPa for Aluminum and E = 100 GPa for Copper. **(08 Marks)**

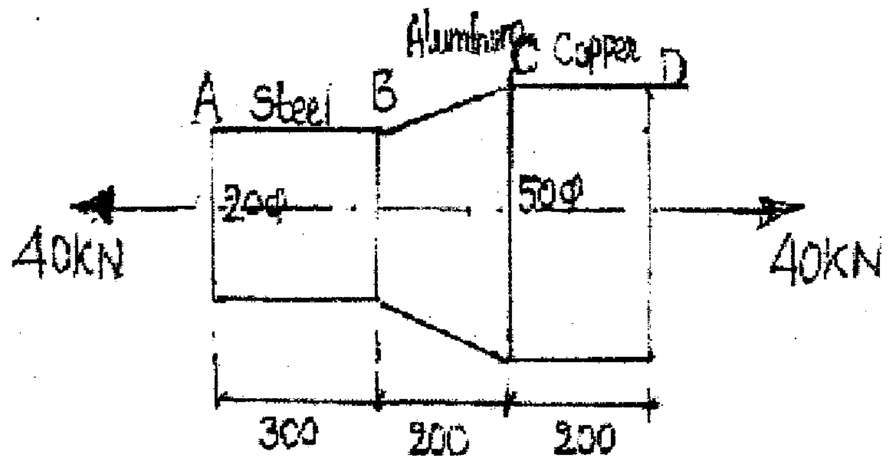


Fig. 1(b)

c. Explain briefly the Principle of Super position. **(04 Marks)**

2 a. Prove that volumetric strain is equal to sum of the three principal strains $\epsilon_v = \epsilon_x + \epsilon_y + \epsilon_z$. **(05 Marks)**

b. A cube of 100mm side is subjected to 10N/mm^2 (Tensile) 8N/mm^2 (compressive) and 6N/mm^2 (Tensile) acting along X, Y and Z planes respectively. Determine the strains along the three directions and the change in volume. Take Poissons ratio = 0.25 and $E = 2 \times 10^5$ N/mm^2. **(05 Marks)**

c. A steel tube of 25mm external diameter and 18mm internal diameter encloses a copper rod of 15mm diameter. The ends are rigidly fastened to each other. Calculate the stress in the rod and the tube when the temperature is raised from 15^0 to 200^0C. Take $\alpha_{st} = 11 \times 10^{-6}/\ ^0$C, $\alpha_{cu} = 18 \times 10^{-6}/\ ^0$C , $E_{st} = 200$ GPa, $E_{cu} = 100$ GPa. **(10 Marks)**

3 a. Derive expressions for Normal stress and shear stress on a plane inclined at θ to the vertical axis in a biaxial stress system with shear stress as shown in fig.3(a). Hence, prove that the sum of Normal stresses on any two mutually perpendicular planes are always constant. **(10 Marks)**

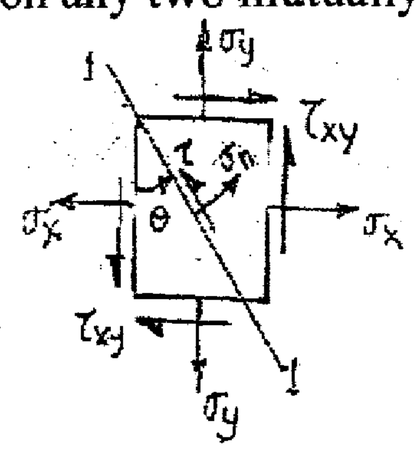


Fig.3(a)

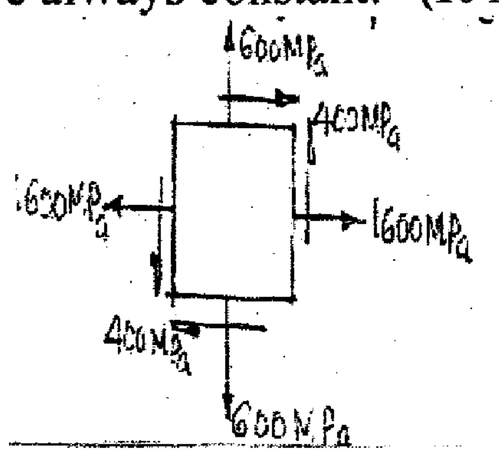


Fig. 3(b)

b. Using Mohr's circle, determine the principle stresses and the planes, Max. shear stress and the planes. Show the same on the elements separately. Refer fig.3(b). **(10 Marks)**

4 a. Prove that the volumetric strain in a thin cylinder is given by $\epsilon_V = (2.\epsilon_C + \epsilon_L)$ Where ϵ_C = hoop strain , ϵ_L = long strain and express the same in terms of diameter of the cylinder (D), thickness (t), Youngs modulus (E), internal pressure (P) and Poisson's ratio (μ). **(10 Marks)**

b. A thick cylinder with Internal diameter 80mm and External diameter 120mm is subjected to an external pressure of 40 kN/m^2, when the internal pressure is 120 kN/m^2. Calculate the circumferential stress at external and internal surfaces of the cylinder. Plot the variation of circumferential stress and Radial pressure on the thickness of the cylinder. **(10 Marks)**

5 a. Briefly explain different types of beam supports. **(03 Marks)**

b. Derive expressions relating Load, Shear Force and Bending Moment (M) with usual notations. **(05 Marks)**

c. Draw SF and BM diagrams for the loading pattern on the beam shown in fig.5(c). Indicate where the Inflexion and contraflexure points are located. Also locate the maximum BM with its magnitude. **(12 Marks)**

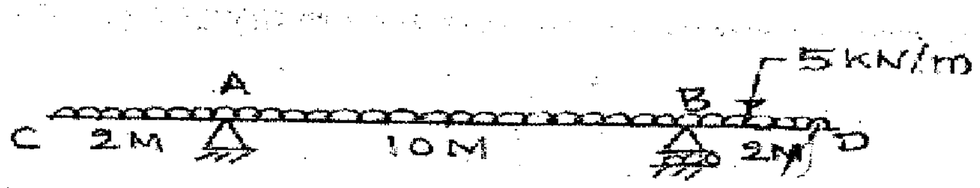


Fig. 5(c)

6 a. Prove that the maximum transverse shear stress is 1.5 times the average shear stress in a beam of a rectangular cross section. Plot the shear stress distribution. What assumptions are made in the above? **(10 Marks)**

b. A beam of T section has a length of 2.5m and is subjected to a point load as shown in the fig.6(b). Calculate the compressive bending stress and plot the stress distribution across the cross section of the beam. The maximum tensile stress is limited to 300 MPa. Calculate the value of W. **(10 Marks)**

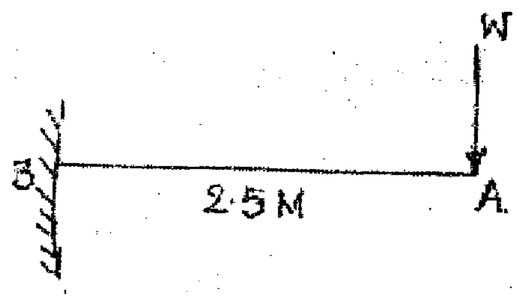
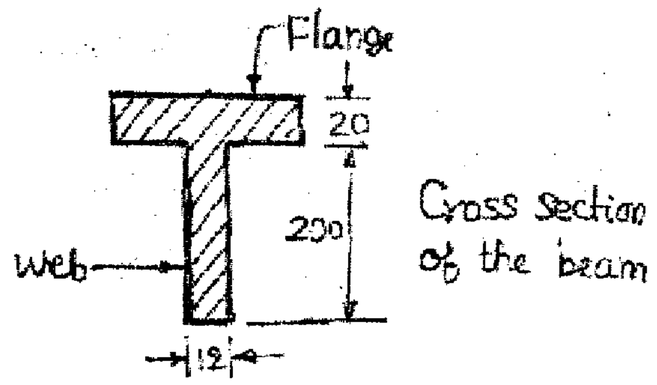


Fig. 6(b)



All dimensions are in mm.

7 a. A beam of length 4m is simply supported at the ends and carries two concentrated loads of 20kN and 30kN at distance 1.5m and 2.5m from left end. Refer fig.7(a). Find the deflection at mid span. Take E = 200 GPa and Moment of Inertial I = 3×10^8 mm^4 of the cross section. **(10 Marks)**

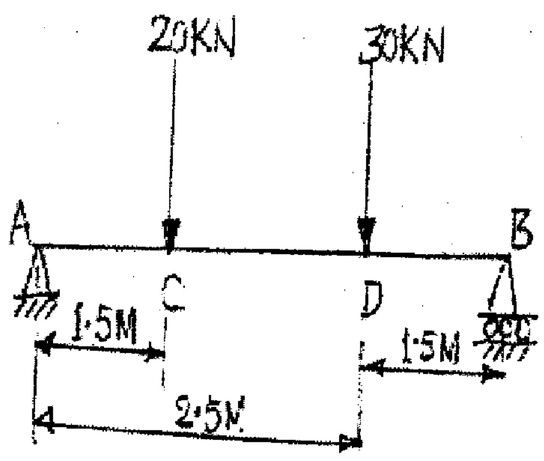


Fig. 7(a)

b. Derive an expression relating slope, deflection and radius of curvature in a beam from first principle in terms E, I and M, with usual notations. **(07 Marks)**

c. Explain how the deflection in beams can be reduced. **(03 Marks)**

8 a. Derive an expression for the critical load in a column subjected to compressive load, when one end is fixed and the other end free. **(10 Marks)**

b. Find the diameter of the shaft required to transmit 60kW at 150 rpm if the maximum torque is 25% of the mean torque for a maximum permissible shear stress of 60 MN/m^2. Find also the angle of twist for a length of 4m. Take G = 80 GPa. **(10 Marks)**

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