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10CV/EV/CT33

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

Time: 3 hrs.

Max. Marks:100

Note: Answer any FIVE full questions.

- 1 a. Draw the stress-strain diagram for ductile specimen under axial tensile force. Mark the salient points on the diagram and name them. **(06 Marks)**
- b. Find the maximum and minimum stresses produced in the stepped bar shown in Fig.Q1(b) due to an axially applied compressive load of 12 kN.

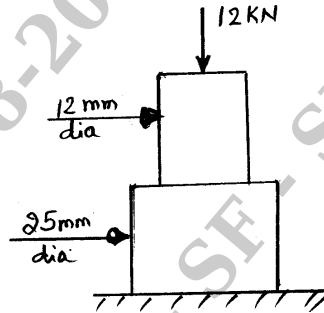


Fig.Q1(b)

(04 Marks)

- c. A 2 meter long steel bar has a uniform diameter of 40 mm for a length of 1 m from one end. For the next 0.5 m length the diameter decreases uniformly to "d". For the remaining 0.5 m length it has a uniform diameter of "d" mm. When a load of 150 kN is applied, the observed extension is 2.40 mm. Determine the diameter "d". Take modulus of elasticity for steel as 200 GPa. [Refer Fig.Q1(c)]

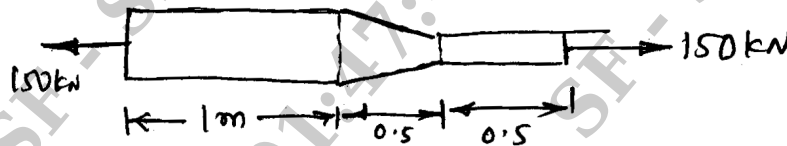


Fig.Q1(c)

(10 Marks)

- 2 a. Define: (i) Lateral strain, (ii) Bulk modulus. **(04 Marks)**
- b. Derive the relationship between Young's modulus and shear modulus. **(06 Marks)**
- c. A steel bar 25 mm in diameter is enclosed in a brass tube 25 mm internal diameter and 50 mm external diameter. Both the bars are of length 1m and rigidly fixed to each other. The composite bar is subjected to rise in temperature of 60°C. Determine the stresses due to temperature change.

If in addition to temperature change the bar is subjected to a pull of 60 kN, determine resultant stresses $E_B = 100 \text{ kN/mm}^2$, $E_S = 200 \text{ kN/mm}^2$, $\alpha_s = 12 \times 10^{-6}/^\circ\text{C}$, $\alpha_B = 18 \times 10^{-6}/^\circ\text{C}$.

(10 Marks)

- 3 a. At a certain point in a strained material the intensities of normal stresses on two planes at right angles to each other are 20 N/mm² and 10 N/mm² both tensile. They are accompanied by shear stress of 10 N/mm². Find the principal planes and principal stresses. Also find the maximum shear stress. **(10 Marks)**
- b. The principal stresses at a point in a bar are 200 N/mm² (tensile) and 100 N/mm² (compressive). Determine the resultant stress in magnitude and direction on a plane inclined at 60° to the axis of the major principal stress. Also determine the maximum intensity of shear stress in the material at the point. **(10 Marks)**

- 4 a. Define:
- i) Hogging bending moment
 - ii) Sagging bending moment
 - iii) Point of contraflexure.
- (06 Marks)
- b. Draw SFD and BMD for the beam shown in Fig.Q4(b) showing salient features.

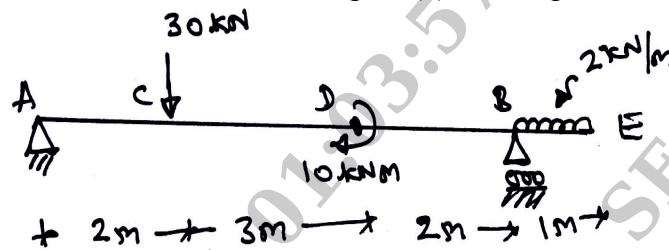


Fig.Q4(b)

(14 Marks)

- 5 a. Show that for a rectangular cross section shear stress distribution varies parabolically across the depth. Further show that maximum shear stress is 1.5 times average shear stress. (06 Marks)
- b. A cantilever beam 3m long is subjected to a udl of 30kN/m over the entire span. The allowable working stress in compression and tension is 150MPa. If the cross section is to be of rectangular, determine the dimensions. Take the depth of the c/s as twice the width. (14 Marks)

- 6 a. Derive $EI \frac{d^2y}{dx^2} = +M$ with usual notations. (08 Marks)

- b. A simply supported beam 'AB' of span $\frac{2L}{3}$ has an overhang BC of length $\frac{L}{3}$. The beam supports a uniform load of intensity 'q' per meter run over (Refer Fig.Q.6(b)).

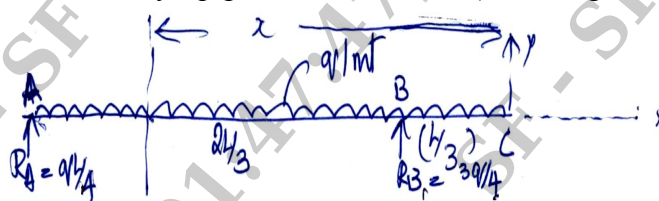


Fig.Q.6(b)

Its entire length. Determine deflection and slope at free and 'C'.

(12 Marks)

- 7 a. Prove that a hollow shaft is stronger and stiffer than the solid shaft of same material, length and weight. (08 Marks)
- b. Determine the diameter of the solid shaft transmitting 120 kW at 120 rpm if the permissible shear stress is 80 N/mm². What would be the diameter of a hollow shaft of same length having external diameter twice the internal diameter to transmit same power at same rate of revolution. What is the percentage saving in weight by changing over to hollow shaft? (12 Marks)

- 8 a. Derive an expression for the Euler's crippling load for slender column having both ends of the column hinged. (06 Marks)
- b. Find Euler's critical load for a hollow cylindrical cast iron column 200 mm external diameter and 25 mm thick, if it is 6 meters long and hinged at both ends. Take $E = 8 \times 10^4 \text{ N/mm}^2$. Compare Euler's critical load with the Rankine's critical load taking $f_c = 550 \text{ N/mm}^2$ and $a = 1/1600$. For what length of the column would the critical loads by Euler's and Rankine's formula will be equal? (14 Marks)
