

ME1105: Strength of Materials and Analysis

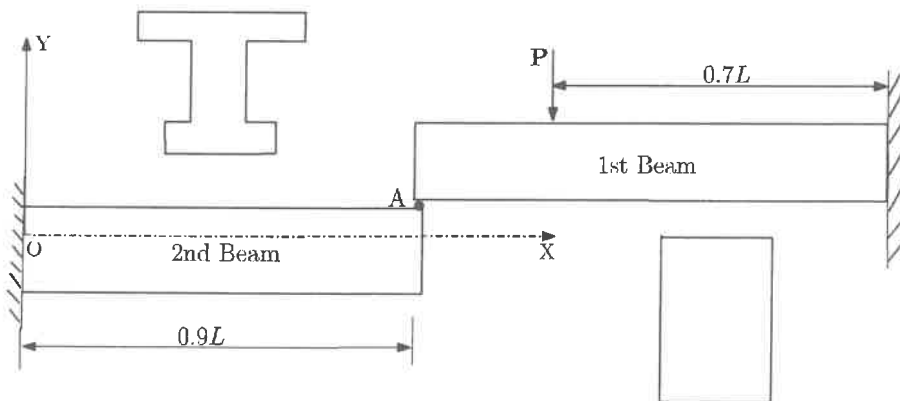
2020-24 IV Semester, End-Semester Examination
Institute of Engineering Technology
JK Lakshmipat University, Jaipur, Rajasthan, India

Duration: 3 Hours, Full Marks: 100

NOTE: Students can use any resource e.g., class notes, books, laptop (with internet connection) but NOT Cellphone

Problem 1. As shown in figure, two cantilever beams of different cross section are designed for some special purpose. Length of first beam is $L = 500 \text{ mm}$. Maximum allowable tensile stress $\sigma_{yt} = 500 \text{ MPa}$ and compressive stress $\sigma_{yc} = 400 \text{ MPa}$ for both beam. (20 Marks) (CO₂)

- find the minimum value of P at which second beam will fail.
- Find the location at which failure will start in second beam as per given coordinate in figure, assume x-axis is coinciding with neutral axis of the second beam.
- Find the vertical deflection of point 'A' as shown in figure just before failure of second beam.
- Find the maximum bending stress in first beam at the time of failure of second beam and also comment on the failure of first beam.

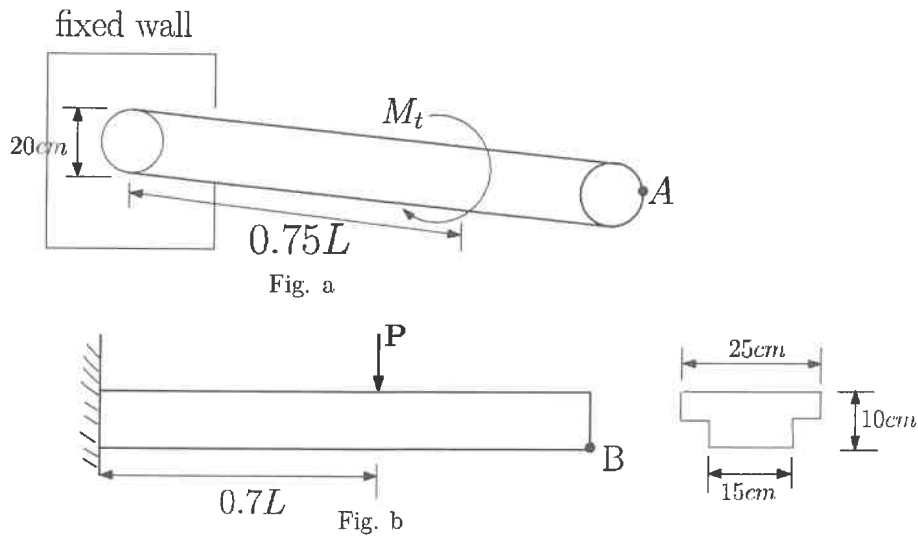


Problem 2. As shown in figure,

(10 Marks) (CO₃)

- Find total angle of twist of point 'A' (as shown in Fig. a) with respect to fixed wall, when twisting moment $M_t = 500 \text{ KNm}$.
- Find slope and vertical deflection of beam at the point 'B' (as shown in Fig. b), when applied load $P = 100 \text{ KN}$.

Assume material for both shaft and beam is steel, Young's Modulus of elasticity for steel $E_s = 200 \text{ GPa}$ and Poisson's ratio is $\nu = 0.3$ and length for both shaft and beam is same i.e. $L = 500 \text{ mm}$.



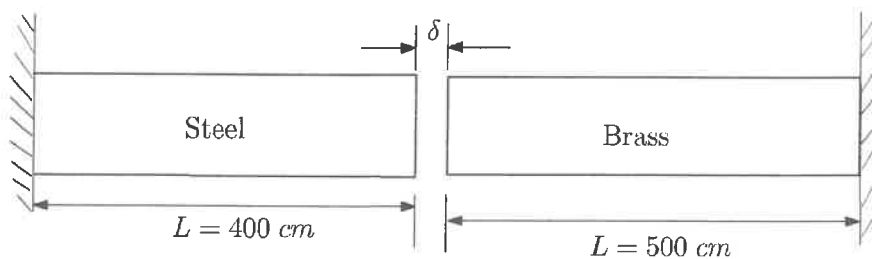
Problem 3. Two rods, one is made of steel and other is of brass are kept as shown in figure. Cross-sectional area is same for both rods, $A_o = 250 \text{ mm}^2$. If temperature is increased to 125°C , then find the strain and stress developed in both rods. The gap between two rods, as shown in Fig.??, is given $\delta = 7.5 \times 10^{-4} \text{ m}$. Initially both rods are stress free and are at temperature 25°C . Material properties are given,
for steel

$$E_s = 210 \text{ GN/m}^2, \alpha_s = 10 \times 10^{-6} / ^\circ\text{C},$$

for brass

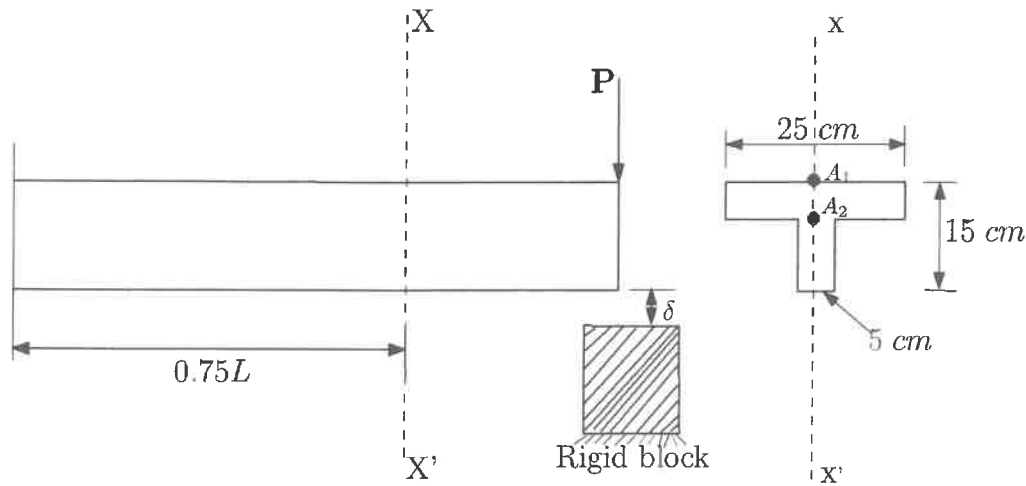
$$E_b = 105 \text{ GN/m}^2, \alpha_b = 20 \times 10^{-6} / ^\circ\text{C}.$$

(15 Marks) (CO₄)



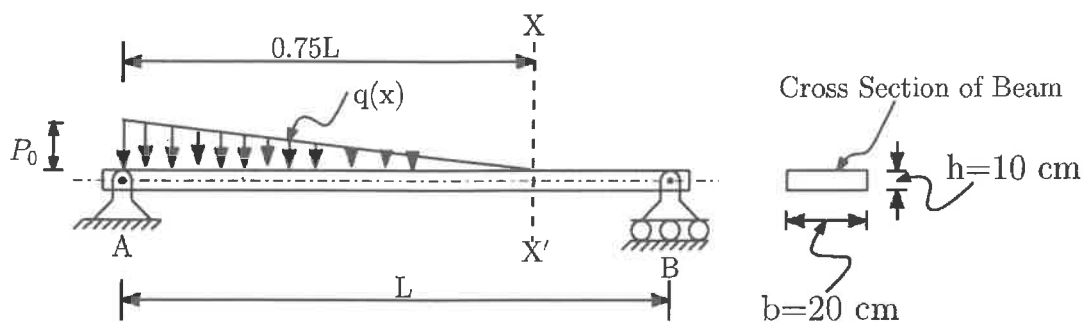
Problem 4. Consider the situation as shown in figure, there is a cantilever beam of length $L = 750 \text{ mm}$ with concentrated load P is applied at the end. Rigid block prevents the further deflection of beam. Here initial gap between beam's end and rigid block is $\delta = 2.5 \times 10^{-3} \text{ m}$. If applied load $P = 50 \text{ kN}$, then (20 Marks) (CO₅)

- find the principal stress and draw the Mohr's circle of the state of stress at points A_1 and A_2 , as shown in figure.
- Also find the principal stress and draw Mohr's circle for the state of stress at the point of intersection between neutral axis and X-X' section.



Problem 5. A simply-supported beam is subjected to a distributed load as shown in figure. Assume $P_0 = 100 \text{ kN/m}$, $L = 5 \text{ m}$. Beam has a I-cross-sectional area as shown in figure. (25 Marks) (CO₅)

- Find distributed load function $q(x)$.
- Derive the expressions for transverse deflection and slope.
- Draw shear force and bending moment diagram.
- Find slope at A and B.
- Find shear stress distribution across the section X-X' as shown in figure.
- Find the location of cross section along the length across which shear stress is constant throughout the section.
- Find maximum bending stress and its position along the length of the beam.



Problem 6. Find the vertical and horizontal displacement of point 'B', as shown in figure, Using Castigliano's theorem, estimate the reaction moment and the reaction forces at built in end. A_{AB} and A_{BC} are the cross sectional area and I_{AB} and I_{BC} are second moment of inertia of cross-section of AB and BC members respectively. (10 Marks) (CO₁)

