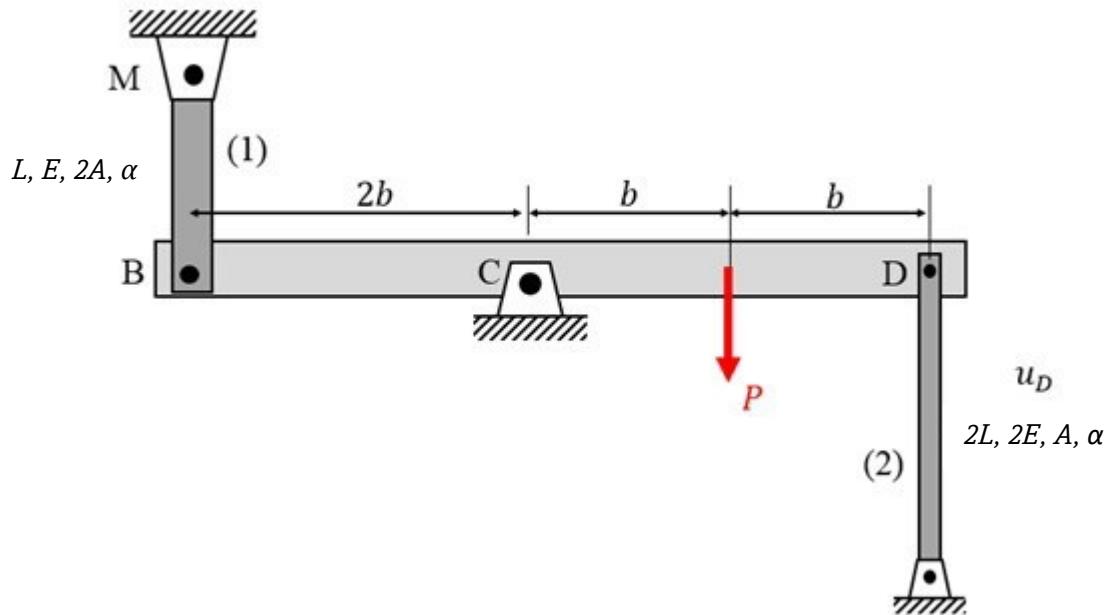


Problem 3.1 (10 points)

Rigid bar BD is pinned to ground at end C. The bar is supported by thin rods (1) and (2), where rod (1) has a Young's modulus of E and a cross-sectional area of $2A$ and rod (2) has a Young's modulus of $2E$ and a cross-sectional area of A . Each rod possesses a coefficient of thermal expansion α . A load P acts midway between pins C and D on the bar. Assume that the angle of rotation of the bar as a result of the applied load is small and the temperature of both rods is simultaneously increased by ΔT . Ignore the weight of all components of the structure.

- (a) Determine the stress in rods (1) and (2).
- (b) Determine the angle of rotation of bar BD.



Problem 3.2 (10 points) A rod is made up of elements (1), (2) and (3), as shown below. Element (2) is hollow with outer and inner diameters of $2d$ and d , respectively, whereas elements (1) and (3) are solid with diameters of d and $3d$, respectively. Elements (1) and (2) are joined by rigid connector D, elements (2) and (3) are joined by rigid connector C, and elements (1) and (3) are connected to ground at ends H and B, respectively. The modulus of elasticity for all three elements is E . The weights of connectors D and C are $2W$ and $3W$, respectively, whereas the weights of the rod elements (1), (2) and (3) are to be considered negligible.

- Determine the stress in element (3) resulting only from the weights of the connectors (refer to Fig A).
- Suppose that an axial load P is applied to connector D in a way that the magnitude of the stress in element (3) is reduced (refer to Fig B). Determine the load value for P such that the magnitude of the compressive stress in (3) reduced by 50 percent from that found in (a).

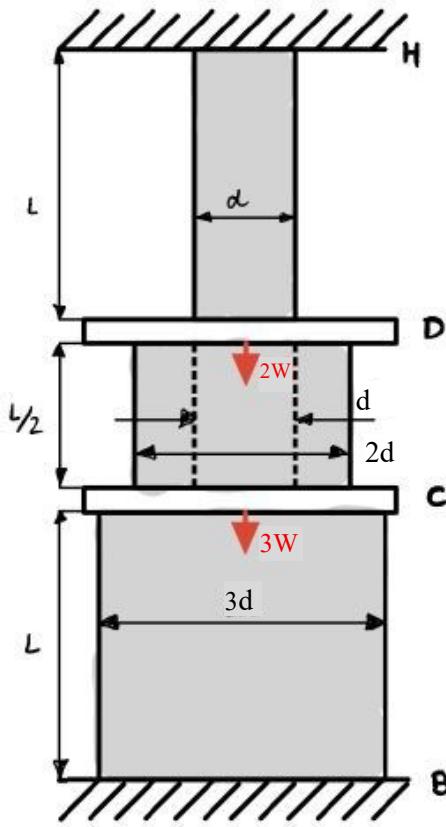


Fig A

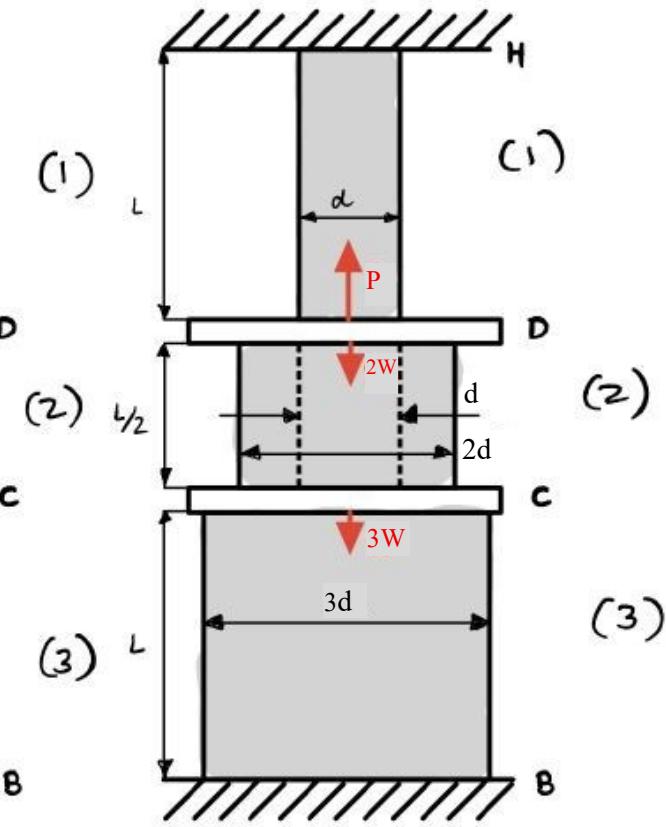
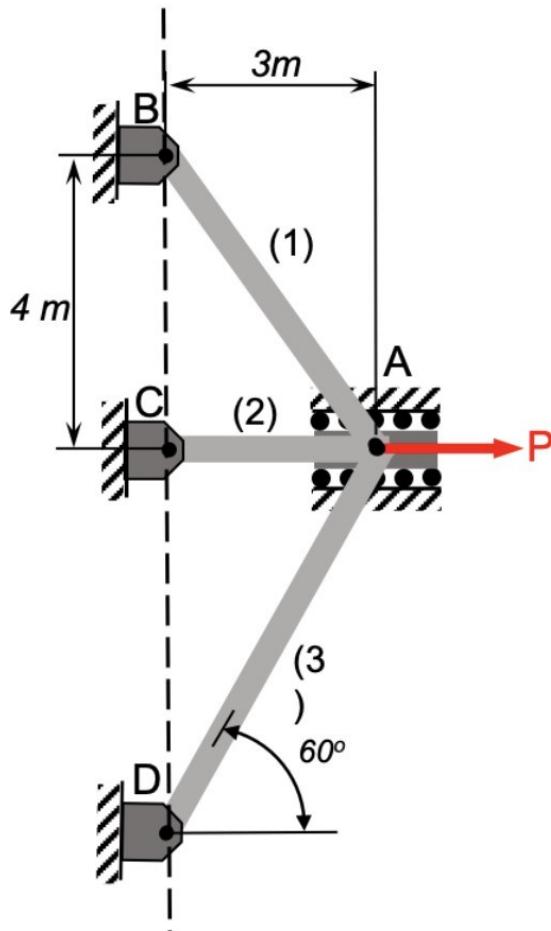


Fig B

Problem 3.3 (10 points)

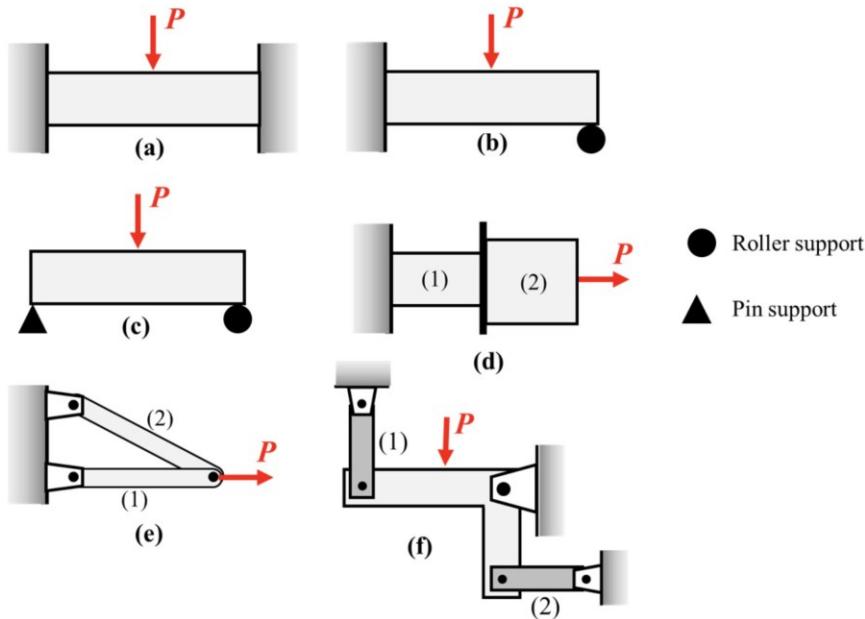
Three elastic members form the pin-jointed truss in the figure below. The joint at A is constrained by a slider block to move only in the horizontal direction (i.e., $v_A = 0$). All members have the same cross-sectional area $A = 400 \text{ mm}^2$ and a modulus of elasticity $E = 150 \text{ GPa}$. The pin-joints B, C and D are colinear.

- Determine the member forces F_1 , F_2 and F_3 which result in moving the joint A to the right by 15 mm (i.e., $u_A = 15 \text{ mm}$).
- Determine the horizontal load P .
- Determine the vertical reaction between the slider block at A and the track.

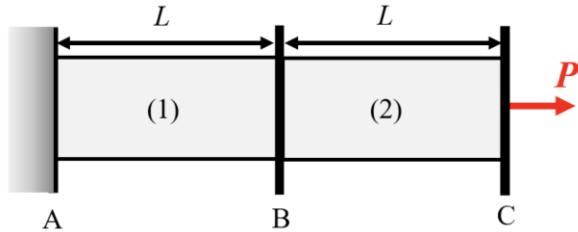


Problem 3.4 Conceptual (2.5+2.5 points)

(a) Out of the six structures (a)-(f) below, how many are statically indeterminate? Circle them and briefly justify your position.



(b) The rod consists of elements (1) and (2) and rigid connectors B and C. Both elements have length L and cross-sectional area A. Element (1) has Young's modulus E_1 , and element (2) has Young's modulus E_2 , with $E_1 < E_2$.



Let F_1 and F_2 represent the axial forces in members (1) and (2). Choose the correct option and explain why.

- (a) $F_1 > F_2$
- (b) $F_1 = F_2$
- (c) $F_1 < F_2$
- (d) Insufficient information