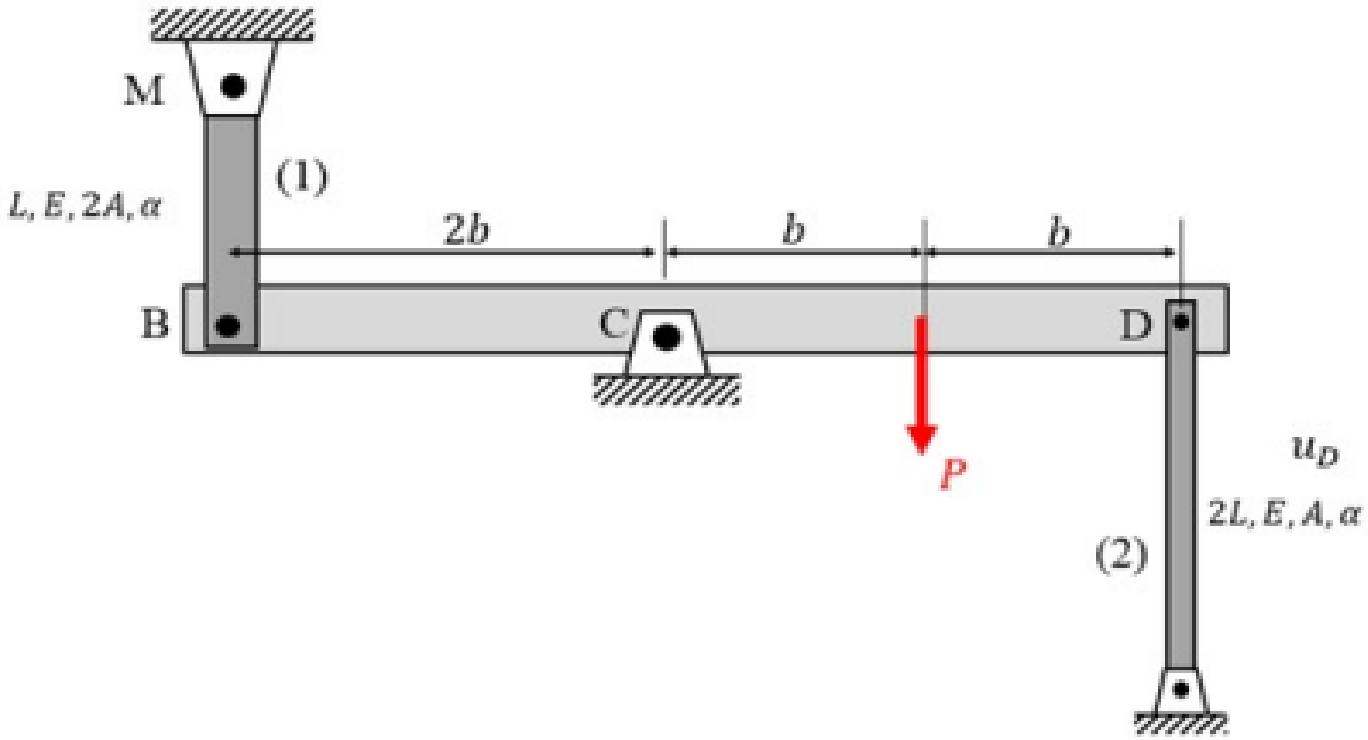
ME 323: Mechanics of Materials **Homework 3**
Fall 2023 **Due Friday, September 15**
Problem 3.1 ***(10 points)***

Rigid bar BD is pinned to ground at its midpoint 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 E 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.

Express your answers in terms of, at most: L, E, A, α, b, P, and ΔT.



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Problem 3.2 ***(10 points)***

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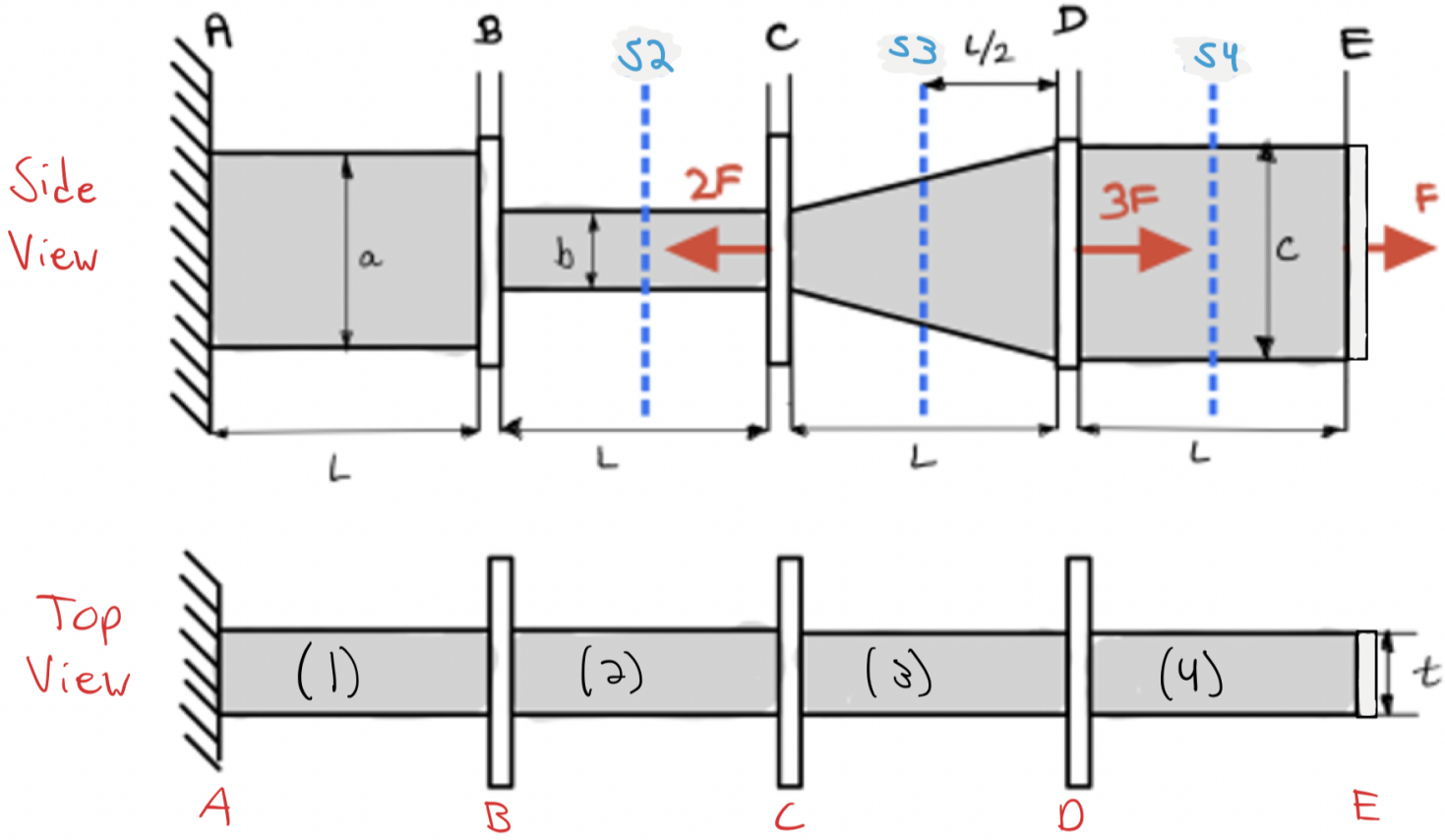
The axial bar shown below has four sections. Each section is connected to the neighboring sections by rigid connectors (at B, C, D, and E). The size of the rigid connectors is negligible. The first section AB, second section BC and the last section DE have uniform rectangular cross sections with widths a, b, and c, respectively. The section CD has width varying linearly from b to c. The length of each section is L. All the sections have the same thickness t. Three loads F, 3F and 2F are applied to the connectors as shown in the figure. Assume the Young's Modulus of all the sections is E.

(a) Find expressions for stresses at sections S2, S3 and S4. (S3 is midway of section CD as shown.)

(b) Find expressions for the displacement of connectors B and C.

Express your answers in terms of, at most: a, b, c, t, L, F, and E.



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Problem 3.3 ***(10 points)***

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A rod is made up of circular cross-sectioned 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 W, respectively, whereas the weights of the rod elements (1), (2) and (3) are to be considered negligible.

(a) Determine the stress in element (3) resulting only from the weights of the connectors (refer to Fig A).
(b) 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).

Express your answers in terms of, at most: L, d, E, and W.

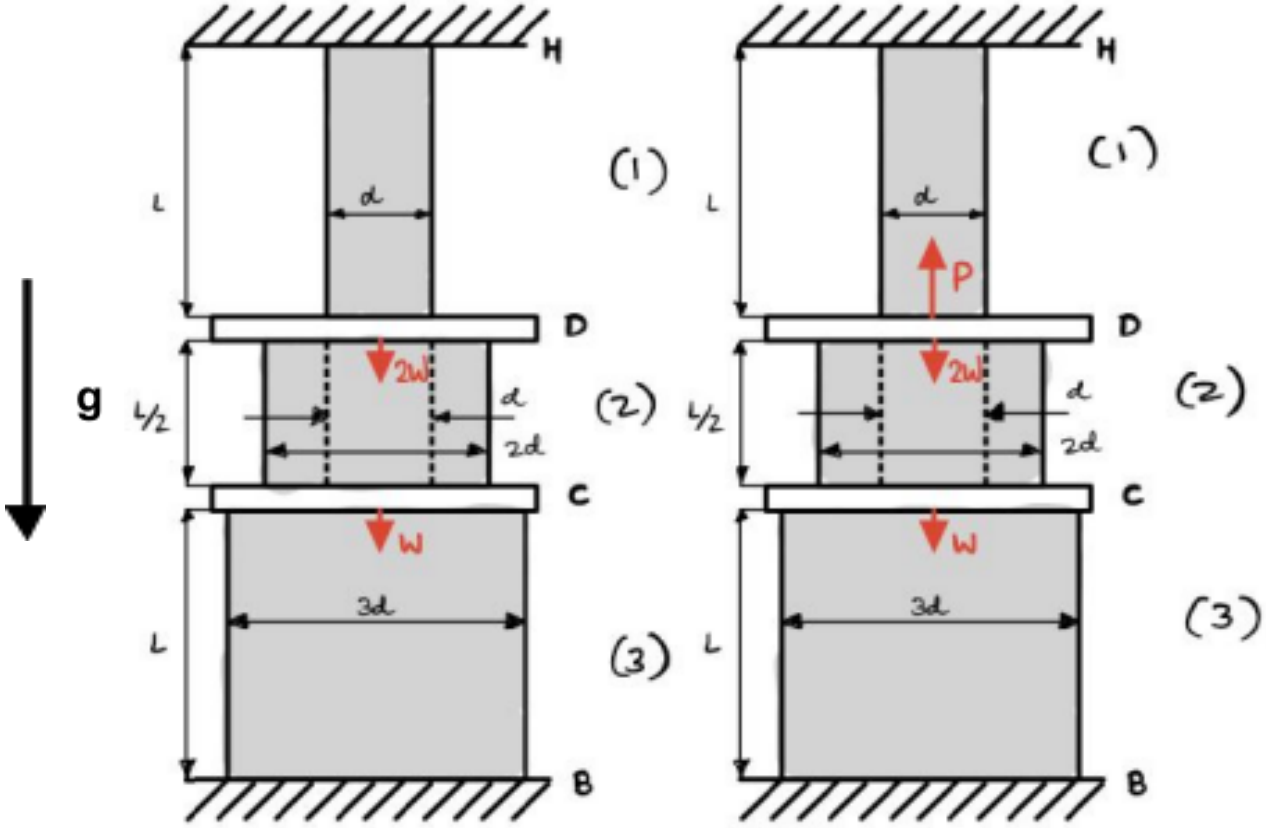

Fig A

Fig B

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Problem 3.4 (2.5+2.5 points)

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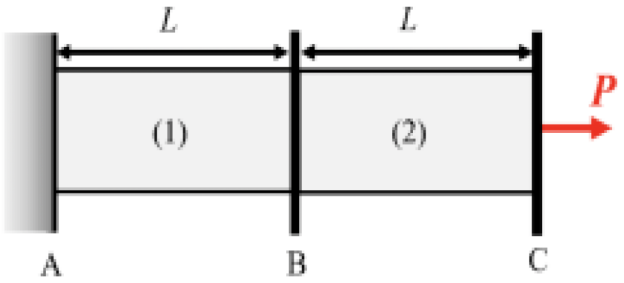
a) The rod consists of elements (1) and (2) and rigid connectors B and C. Both elements have length L and cross-sectional area A. Element (1) has Young's modulus E_1, and element (2) has Young's modulus E_2, with $E_1 < E_2$.



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

- $F_1 > F_2$
- $F_1 = F_2$
- $F_1 < F_2$
- Insufficient information

b) For the configuration in a), let δ_1 and δ_2 be the axial elongations of members (1) and (2), respectively. Choose the correct option:

- $\delta_1 > \delta_2$
- $\delta_1 = \delta_2$
- $\delta_1 < \delta_2$
- Insufficient information