Problem 3.1 *(10 points)*

Consider a three-member truss as shown in Fig.1. Members (1), (2) and (3) are pinned to the wall at H, D, and B, respectively, and pinned to each other at C. The orientations, lengths, Young's modulus, and cross section areas are shown in the figure. A point force P is applied to joint C. It is desired to determine the axial load carried by the three members. Note that all members in the truss are two-force members.

- Write down the equilibrium equations for joint C. Can the axial forces in the members be found from these equilibrium equations alone? Explain your reasoning.
- Write down the force-elongation equations for the three members.
- Write down the compatibility relations between elongation of members (1), (2), (3) and the horizontal and vertical displacements (u_C, v_C) of connector C.
- Calculate the axial loads in the members, and horizontal and vertical displacements (u_C, v_C) of joint C.

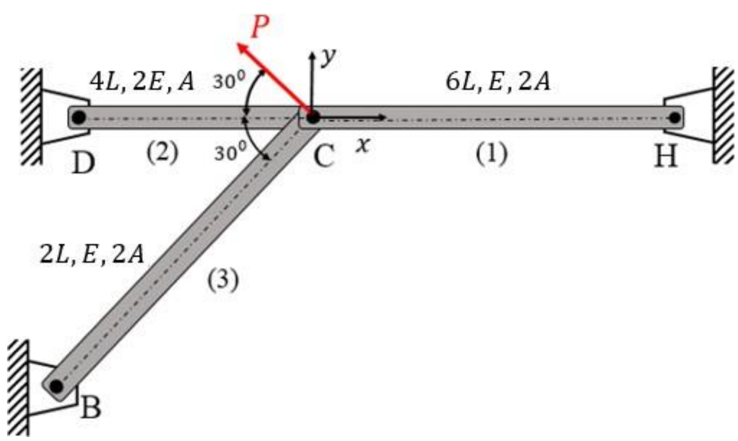
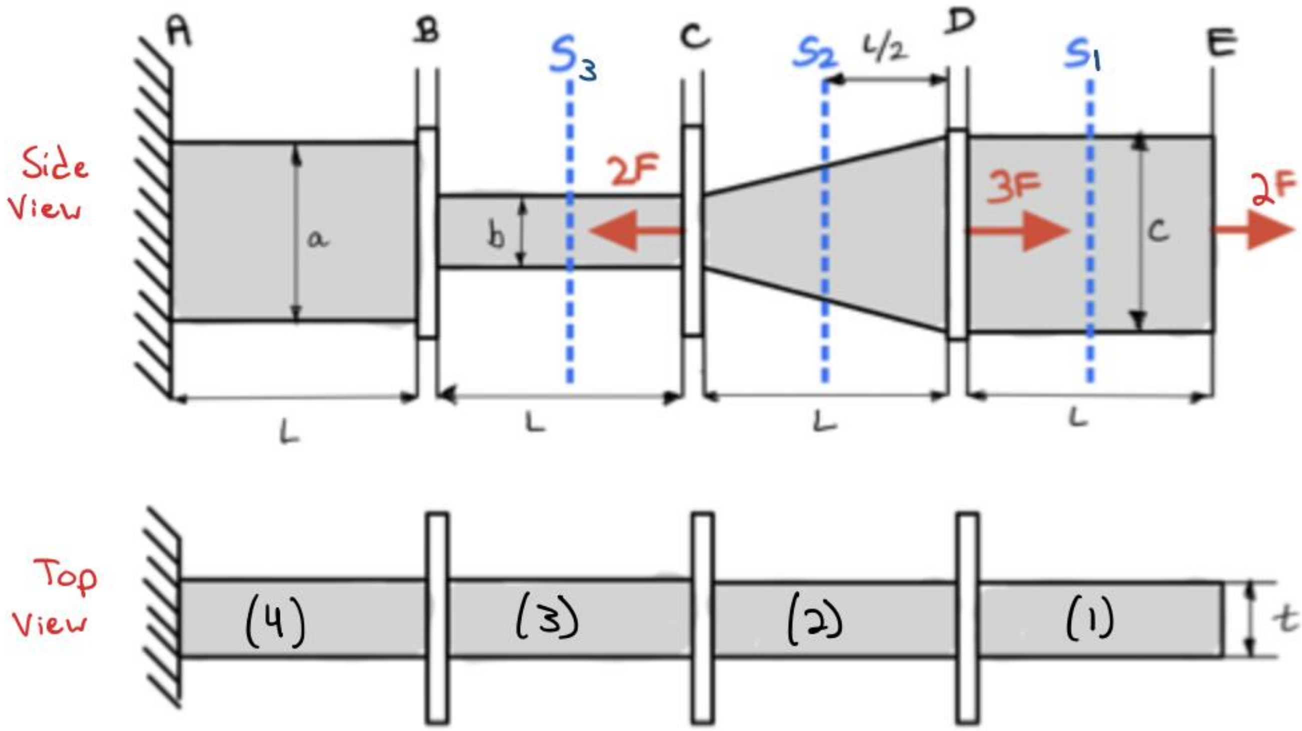


Figure 1

Problem 3.2 *(10 points)*

The axial bar shown in the figure below has four sections. Each section is connected to the neighboring sections by rigid connectors (at B, C and D). 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 width 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 same thickness t. Three loads 2F, 3F, and 2F are applied to the bar as shown in the figure. Assume the Young's Modulus of all the sections is E.

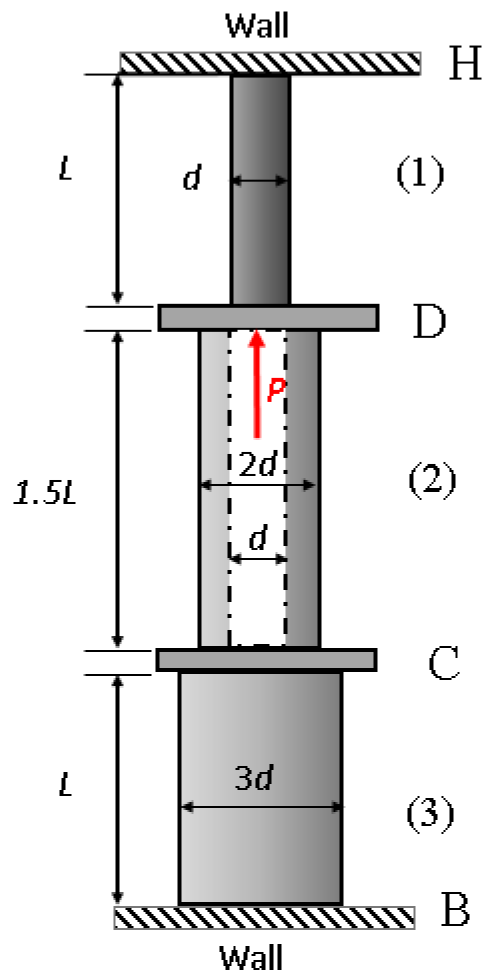
(a) Find expressions for stresses at sections S1, S2 and S3. (S2 is midway of section CD as shown)
(b) Find expressions for displacement at points B, C, and D



Problem 3.3 (10 points)

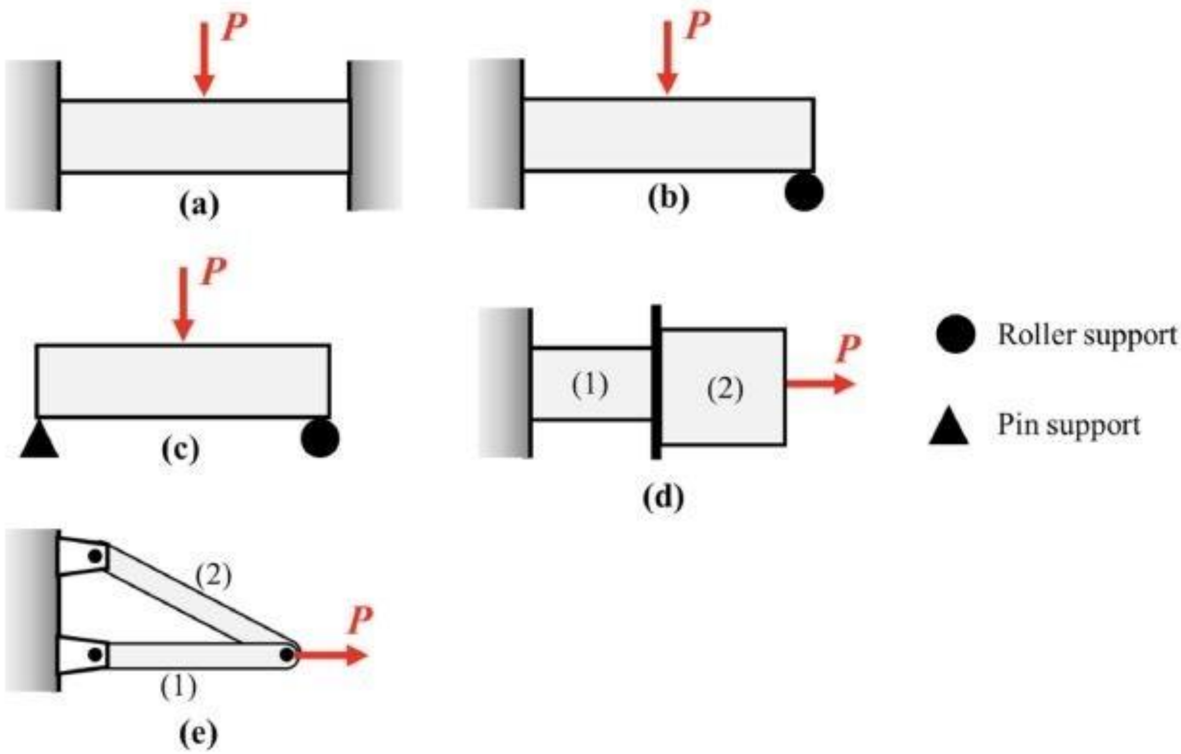
A rod is made up of elements (1), (2) and (3), as shown below. Element (2) is hollow with outer and inner diameters of 2d and d, respectively, whereas elements (1) and (3) are solid with diameters of d and 3d, respectively. Elements (1) and (2) are joined by rigid connector D, elements (2) and (3) are 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 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 (WITHOUT axial load P).
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. Determine the load value for P such that the magnitude of the compressive stress in (3) reduced by 50% from that found in part a).



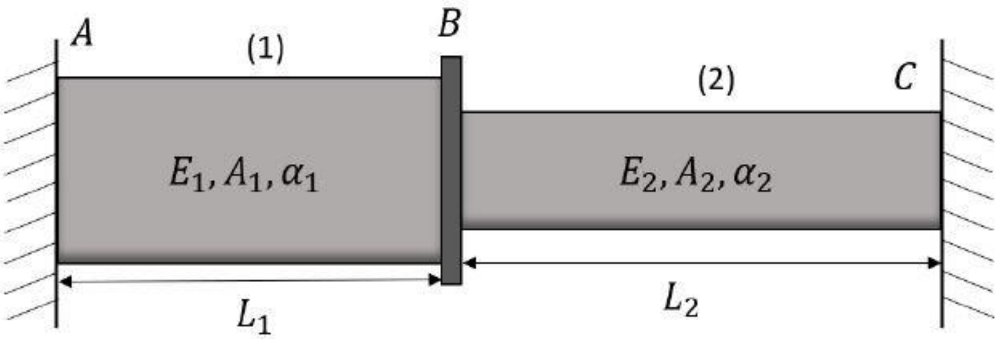
Problem 3.4 *(2.5 + 2.5 points)*

1. Match the following six structures (a)-(e) with correct option given in i-iii.



i. Statically indeterminate structure
ii. Statically determinate structure
iii. Insufficient information

2. Consider a bar made of two sections fixed at both ends. For section (1) let the length be L_1, area A_1, Young's modulus E_1 and coefficient of thermal expansion α_1. The corresponding values for section (2) are L_2, A_2, E_2 and α_2. It is known that $L_1 < L_2$, $E_1 > E_2$, $A_1 > A_2$ and $\alpha_1 > \alpha_2$. The bar is free of stress at temperature T_1. Let σ_1 and σ_2 represent the axial stresses in section 1 and 2, respectively, after the rise in temperature. The temperature is raised from T_1 to T_2 ($T_2 > T_1$).



If δ_1 is the change in length of section 1 and δ_2 is the change in length of section 2, which of the following statements is true?

(a) $\delta_1 = \delta_2 = 0$
(b) $\delta_1 + \delta_2 = 0$
(c) $\delta_1 = \delta_2 \neq 0$
(d) $\delta_1 = \frac{E_1}{E_2}\delta_2$