

Homework 5
(Due: May 7, 2021)

Question 1: 10 points

The cantilevered beam structure shown in Figure 1 supports a uniformly distributed load w (N/m) between points C and D.

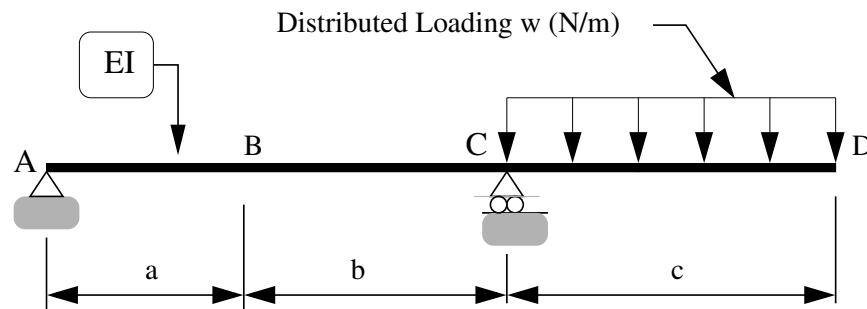


Figure 1: Front elevation view of a simple beam structure.

[1a] (4 pts) Use the method of **virtual displacements** to compute formulae for the vertical reactions at A and C. Show all of your working.

[1b] (6 pts) Use the method of **virtual displacements** to compute a formula for the bending moment at B. Show all of your working.

Question 2: 10 points

Figure 2 is a front elevation view of a bent cantilever beam carrying two external loads P . The flexural stiffness EI is constant along the beam. The axial stiffness EA is very high and, as such, axial displacements can be ignored in the analysis.

[2a] (5 pts) Use the method of **virtual forces** to compute the vertical displacement at C.

[2b] (5 pts) Use the method of **virtual forces** to compute clockwise rotation of the beam at point C.

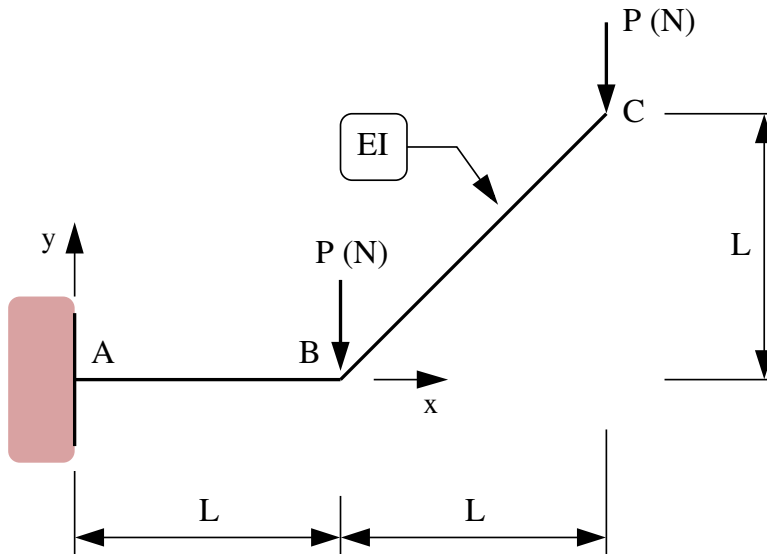


Figure 2: Cantilever beam carrying two applied loads P (N).

Question 3: 10 points

Figure 3 is a front elevation view of a simple truss that supports vertical loads at nodes C and D. All of the truss members have cross section properties AE .

[3a] (5 pts). Compute the support reactions and distribution of forces throughout the structure.

[3b] (5 pts). Use the method of **virtual forces** to show that the total deflection at node C is:

$$\Delta = \frac{PL}{AE} \left[\frac{8\sqrt{10}}{3} \right]. \quad (1)$$

Question 4: 10 points

Consider the supported cantilevered beam structure shown in Figure 4. Use the principle of **virtual forces** to compute the two-by-two flexibility matrix connecting displacements at points B and C to applied loads P_b and P_c , i.e.,

$$\begin{bmatrix} \Delta_b \\ \Delta_c \end{bmatrix} = \begin{bmatrix} f_{11} & f_{12} \\ f_{21} & f_{22} \end{bmatrix} \begin{bmatrix} P_b \\ P_c \end{bmatrix}. \quad (2)$$

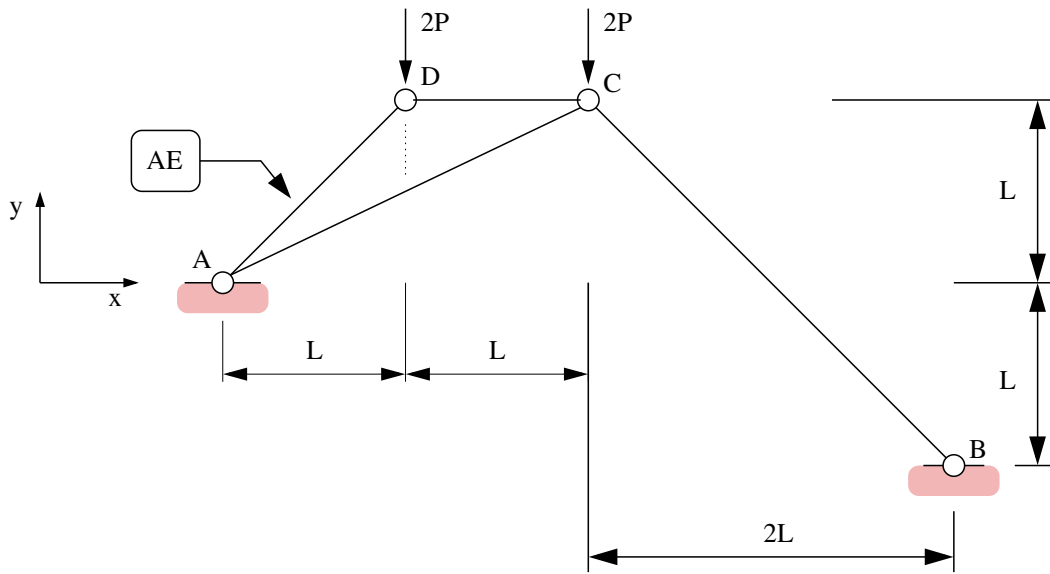


Figure 3: Front elevation view of a simple truss.

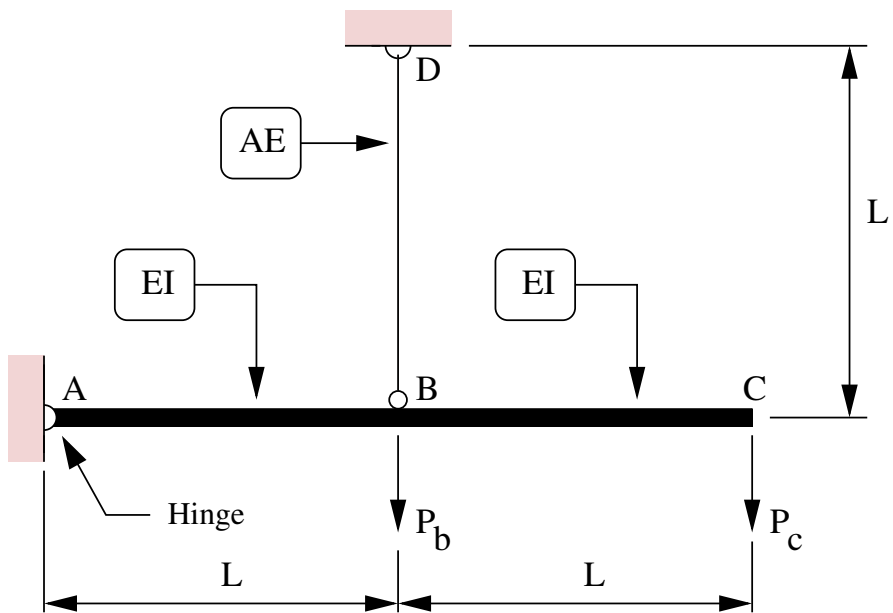


Figure 4: Front elevation view of a supported cantilevered beam structure.