

**Homework 5**  
(Due: December 10, 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.

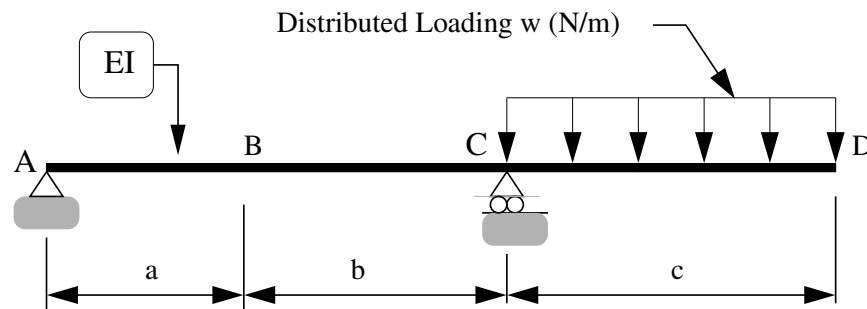


Figure 1: Front elevation view of a simple beam structure.

**[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.

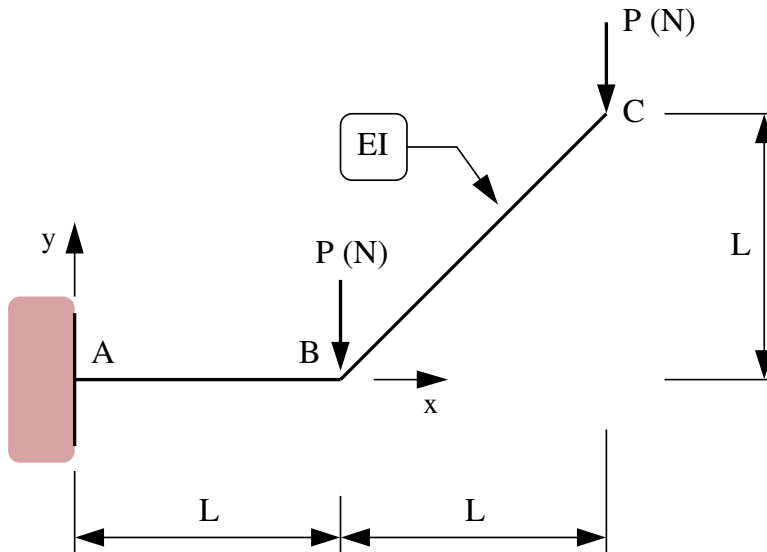


Figure 2: Cantilever beam carrying two applied loads  $P$  (N).

**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.,

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

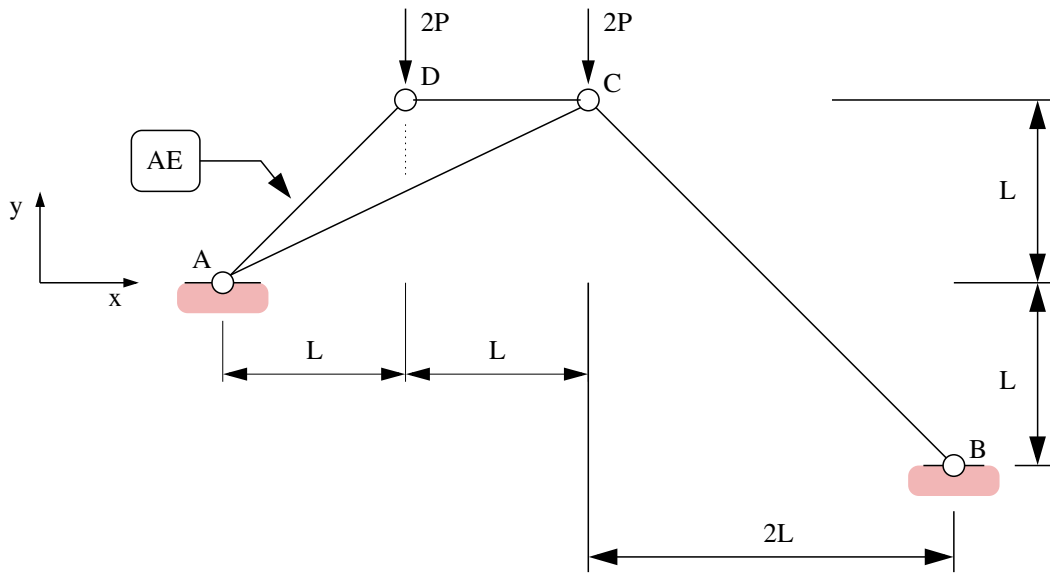


Figure 3: Front elevation view of a simple truss.

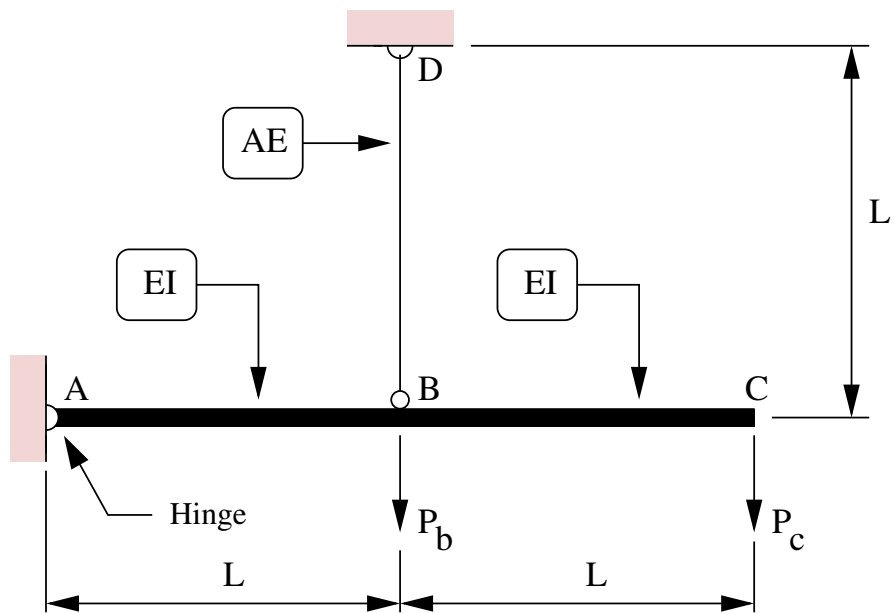


Figure 4: Front elevation view of a supported cantilevered beam structure.