

Homework 2

(Due: March 06, 2026)

Question 1: 10 points.

The cantilevered frame structure carries vertical loads P kN at nodes D, F, H and I. Use the **method of sections** to determine the forces in members a, b and c, as a function of the problem parameters L and P .

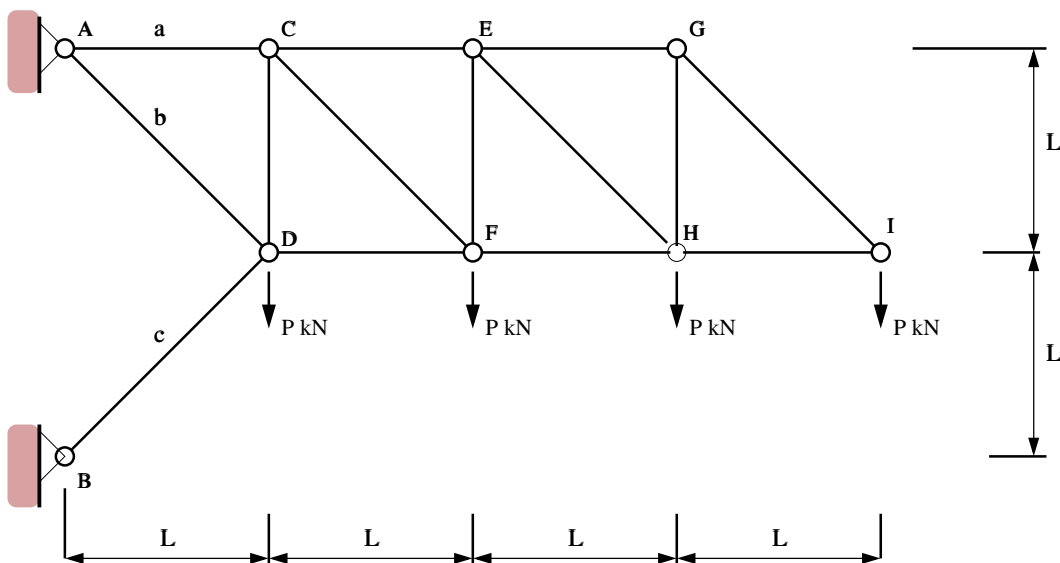


Figure 1: Cantilevered frame structure.

State if the members are in tension or compression. Show all of your working.

Question 2: 10 points.

If the maximum tensile force that any member in Figure 1 can carry is 15 kN, and the maximum compressive force is 10 kN (before buckling), what is the maximum value of loads P that can be carried.

Question 3: 10 points.

Figure 2 shows a cantilevered beam that carries a vertical load P kN at D, and a uniform load W (N/m)

along the segment A-B-C. The total loading on A-B-C will be $2WL$. The two beam segments are connected by a hinge at point B.

Determine the shear and bending moment throughout the beam as a function of P , W and L . Draw the shear and bending moments for the beam. Qualitatively sketch the deflected shape of the beam.

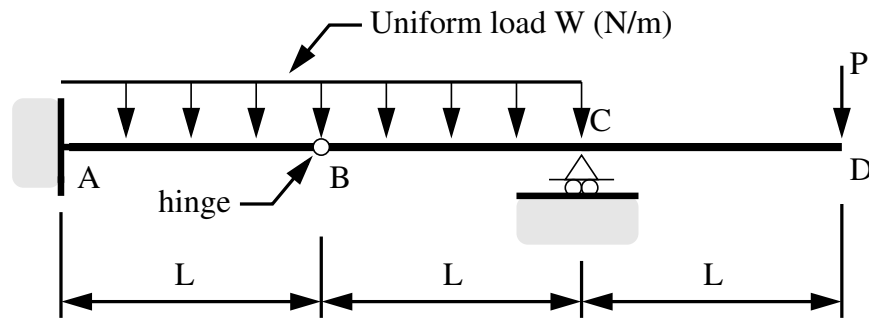


Figure 2: Cantilever beam with hinge connection to supported beam structure.

Question 4: 20 points.

In the design of crane structures, engineers are often required to compute the maximum and minimum member forces and support reactions due to a variety of loading conditions.

Figure 3 shows a nineteen bar pin-jointed truss carrying vertical loads P_1 kN and P_2 kN at joints E and F. The symbols F_1, F_2, \dots, F_{19} represent the axial forces in truss members 1 through 19, and R_{ax}, R_{ay} , and R_{dy} are the horizontal and vertical support reactions at joints A and B.

Write down the equations of equilibrium for joints A through K and put the equations in matrix form. Now suppose that the crane supports a variety of payloads:

$$\begin{bmatrix} P_1 \\ P_2 \end{bmatrix} = \begin{bmatrix} 250 \\ 0 \end{bmatrix}, \begin{bmatrix} P_1 \\ P_2 \end{bmatrix} = \begin{bmatrix} 200 \\ 200 \end{bmatrix}, \begin{bmatrix} P_1 \\ P_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 300 \end{bmatrix} \text{ kN.} \quad (1)$$

Develop a Python program that will solve the matrix equations for each of the external load conditions, and compute and print the minimum and maximum support reactions at nodes A and B, and axial forces in each of the truss members.

Getting Started with Python. Download and unpack the file `python-code.zip`. Make sure that your laptop has version 3.X of Python installed. The test program `TestTrussAnalysis01.py` demonstrates the solution procedure (in a simplified way) for analysis of a three-bar truss. Details are covered in the lecture slides. Similarly, `TestTrussAnalysis02.py` demonstrates the solution procedure for analysis of a nine-bar truss. The function `PrintMatrix()` is designed to handle the printing of large matrices by dividing the output into blocks of six columns.

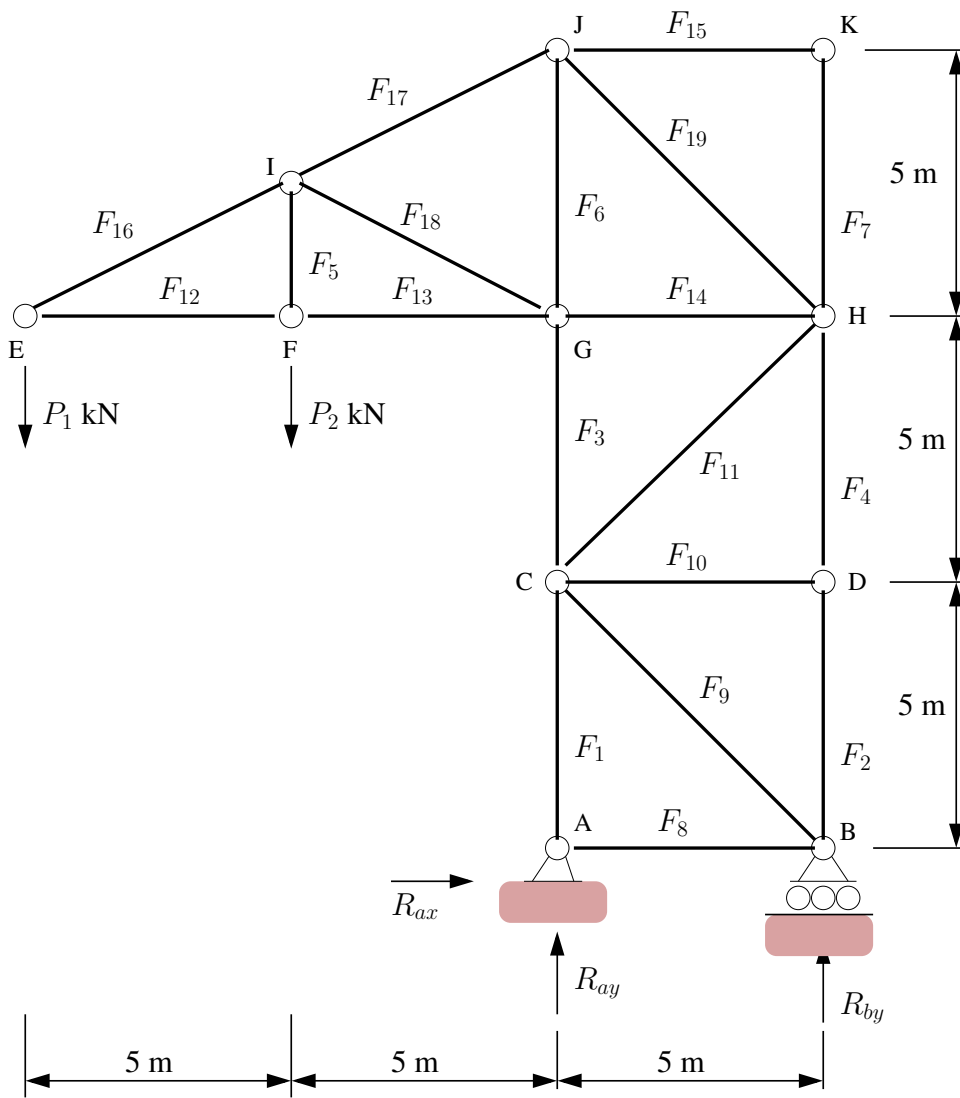


Figure 3: Front elevation of crane tower.