Homework 1

(Due: February 14, 2025)

Question 1: 20 points.

Consider the combined multi-span beam/truss structure shown in Figure 1.

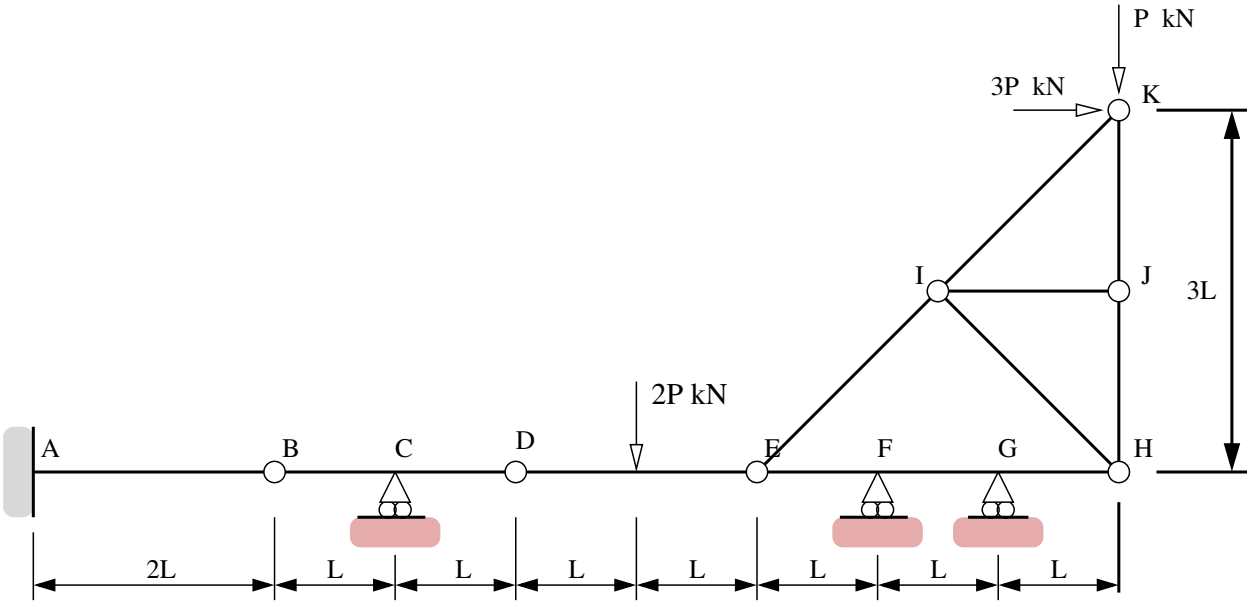

Figure 1: Front elevation view of multi-span beam structure.

The cantilever is fully-fixed to the wall at Point A. Points B, D, E and H are hinges. Horizontal and vertical point loads **3P** (kN) and **P** (kN) are applied to the truss as shown in Figure 1.

[1a] Compute the degree of indeterminacy for the articulated beam structure (A-B-C-D-E-F-G-H).

[1b] Identify the zero-force members in the truss structure. You can simply mark them up on Figure 1.

[1c] Compute the distribution of forces throughout the truss structure. Draw a diagram summarizing your results.

[1d] Compute the vertical reaction forces at nodes F and G.

[1e] Draw and label diagrams showing how the **bending moment** and **axial force** vary along the beam, nodes A through H. Clearly indicate on your bending moment diagram, regions that are in tension/compression.

Question 2: 10 points.

Classifiy each of the structures in Figure 2 as statically determinate, statically indeterminate, stable or unstable. For those structures that are indeterminate, specify the degree of indeterminancy.

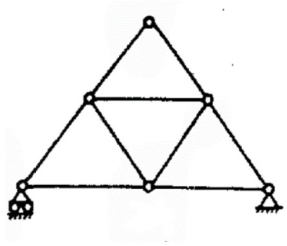

Figure 1:

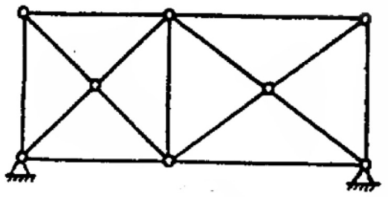

Figure 2:

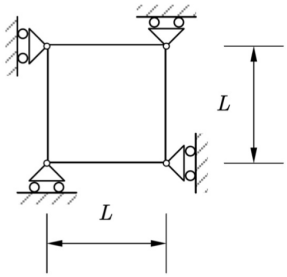

Figure 3:

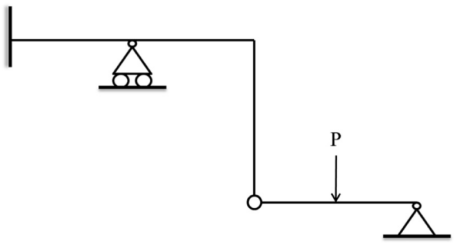

Figure 4:

Figure 2: Assortment of statically determinate and indeterminate frame structures.

Question 3: 10 points.

Consider the crane tower structure shown in Figure 3. A single point load **P** (kN) is applied at node I as shown in the figure.

[3a] Compute the support reactions at A and B.

[3b] Identify all of the zero-force members. If you wish, you can simply copy and annotate Figure 3.

[3c] Using the method of joints (or otherwise) compute the distribution of tension and compression forces throughout the crane structure. Draw and label a diagram showing the distribution of forces in the simplified crane tower structure.

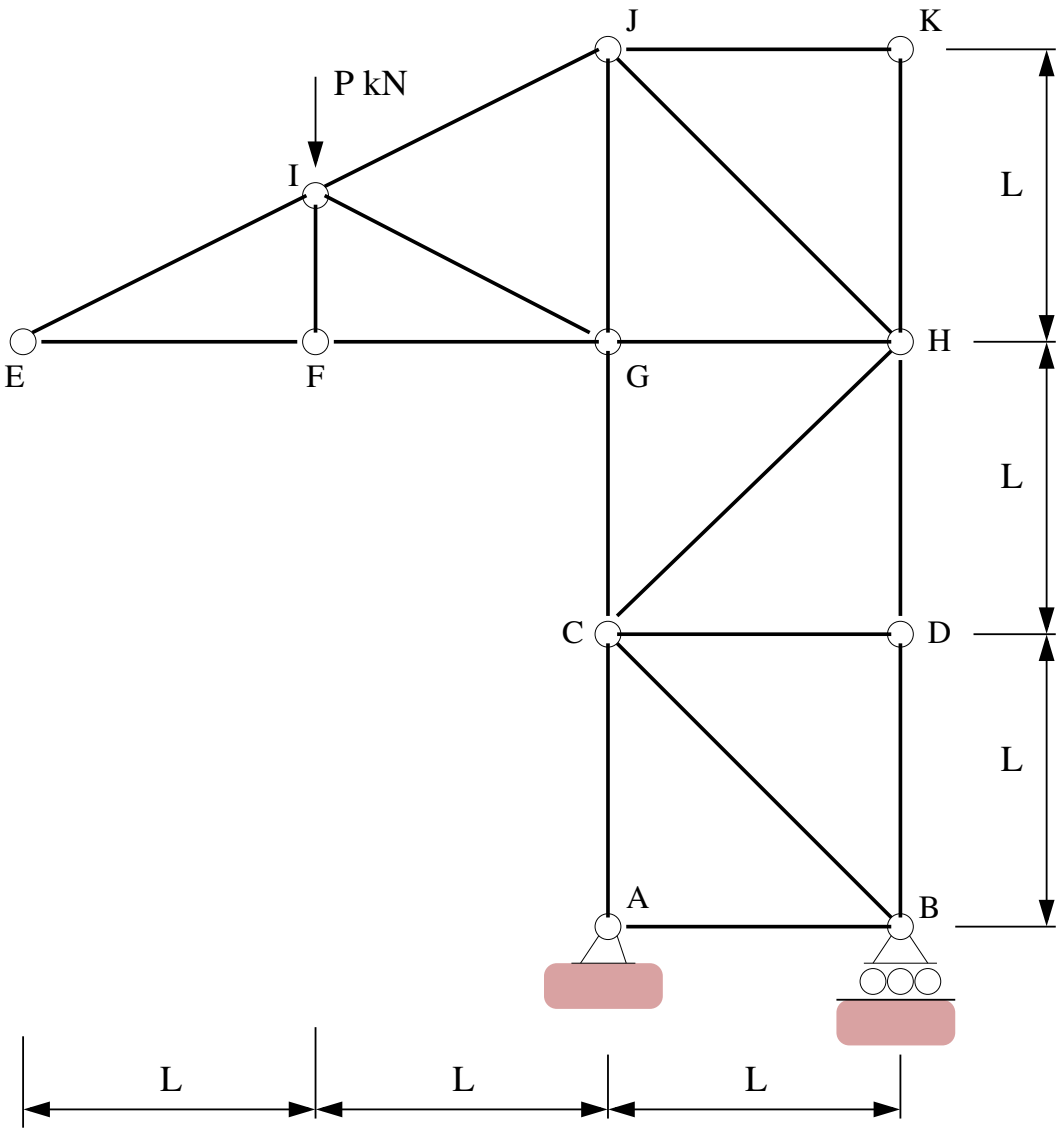

Figure 3: Elevation view of a simple crane tower.

[3d] If the maximum force any member can support is 10 kN in tension and 7 kN in compression, determine the maximum value of P that the crane tower can safely carry.

Question 4: 20 points.

Consider the leaning tower structure shown in Figure 4.

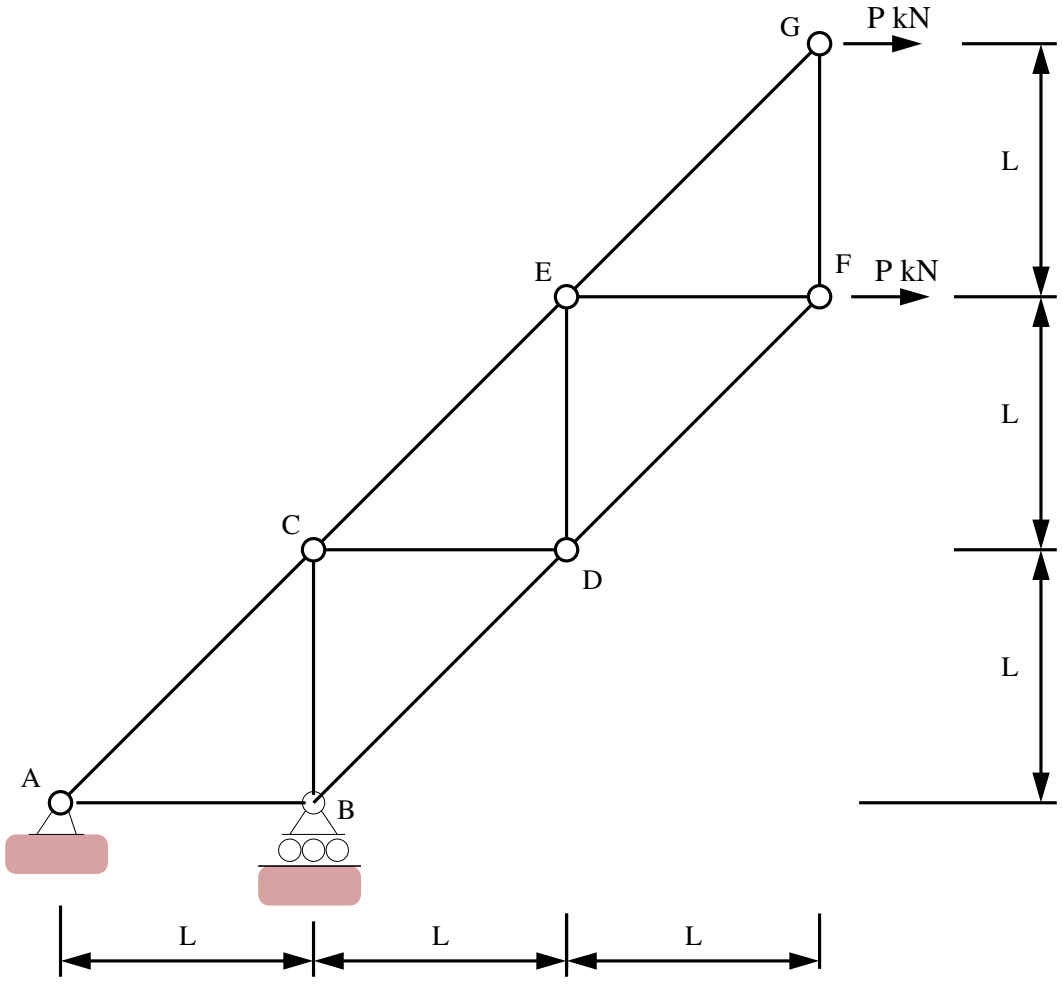

Figure 4: Elevation view of a leaning tower structure.

Horizontal loads **P** (kN) are applied at nodes F and G as shown in the figure.

[4a] Compute the **total support reactions** at A and B.

[4b] Using the method of joints (or otherwise) compute the distribution of tension and compression forces throughout the structure. Show all of your working.

[4c] Now suppose that the maximum tensile force any member can support is 10 kN, and that the maximum allowable compressive force is:

$$P_{ci} = 8\left(\frac{L}{L_i}\right)^2 kN, \tag{1}$$

where L_i is the length of the i-th element, and P_{ci} is the maximum allowable compressive force of the i-th element before buckling.

Determine the maximum value of P (kN) that the leaning tower can safely carry.