CIV102F Assignment # 7 – October 25-27, 2022

Due November 1-3, (before assigned tutorial), 2022

General Instructions

- There are four questions on this assignment. All questions must be attempted; however, only one question will be graded.
- Submissions which are incomplete and do not contain a serious attempt to solve each question will receive a grade of 0.
- Intermediate steps must be provided to explain how you arrived at your final answer. Receiving full marks requires both the correct process and answer.
- All final answers must be reported using slide-rule precision (ie, four significant figures if the first digit is a “1”, three otherwise), and engineering notation for very large or very small quantities.
- Submissions must be prepared neatly and be formatted using the requirements discussed in the course syllabus. Marks will be deducted for poor presentation of work.

Assignment-Specific Instructions

- For all bending moment diagrams and shear force diagrams, label key values (i.e. local minima/maxima)

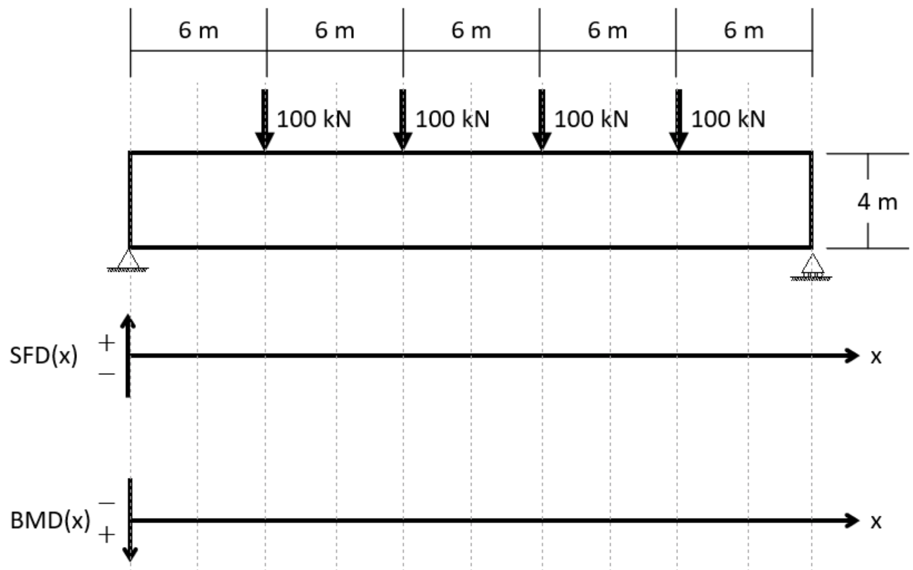
1. For the 30 m long beam shown below, first calculate the reaction forces. Then:

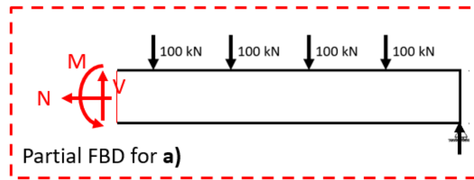
a) Draw a partial FBD of the beam from x = 3m to the right end of the beam (shown below).
At the cut surface at x = 3m, three unknown **internal forces** are exposed:
- Axial Force N (perpendicular to the cut surface, this is the same as tension/compression forces)
- Shear Force V (parallel to the cut surface)
- Bending Moment M

Use equations of equilibrium to solve for these unknown internal forces, N, V, M, at x = 3m. Plot the value V(at x = 3m) on the shear force diagram (SFD) at x = 3m and M(x = 3m) on the bending moment diagram (BMD).
The sign convention for internal bending moments is *<u>not based on clockwise or counter-clockwise</u>* *but whether the bending will cause the bottom of a member to be in tension (+, "smiling 😊") or the top of a member to be in tension (−, "frowning ☹"). Check in a mirror if either facial feature is unfamiliar.*

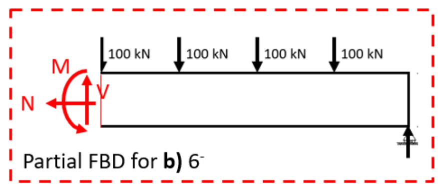
b) Consider another cut at x = 6m and similarly solve and plot the shear force value V on the SFD and bending moment M on the BMD. For the SFD, consider two points as $x \to 6^-$ and $x \to 6^+$.

c) Fill out the remaining points on the SFD and BMD using any method you prefer.

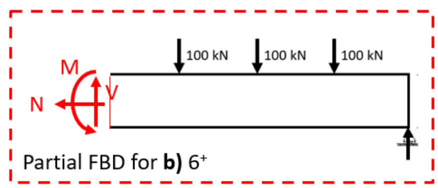




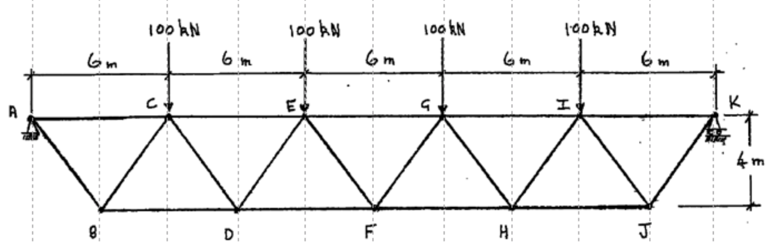
Partial FBD for **a)**



Partial FBD for **b)** 6^-



Partial FBD for **b)** 6^+



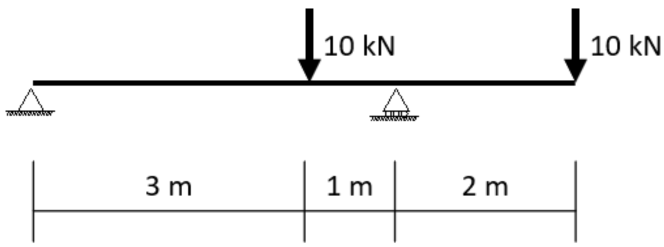
2 (OPTIONAL). For the 30 m long truss shown above, first calculate the reaction forces. Then:

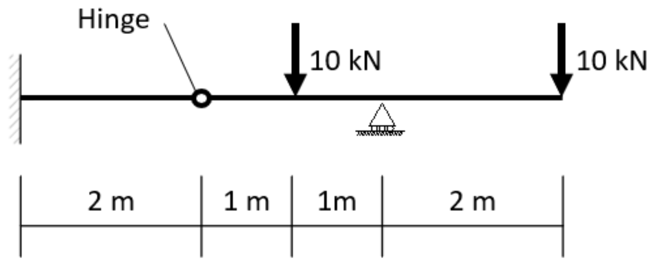
a) Use the method of sections to calculate the vertical component of the forces in members AB, BC, and CD. Compare your results to the SFD in Q1. For the remaining vertical truss members, fill out their vertical components by reading off of the SFD in Q1.

b) Use the method of sections at a cut at x = 3m and calculate the force in member AC. Repeat at x = 6m for member BD and x = 9m for member CE. Compare your member forces with the BMD at x = 3, 6, 9 in Q1. For the remaining horizontal truss members, fill out their member forces by reading off of the BMD in Q1 and dividing by the distance between the top and bottom members.

c) Verify that this new method of truss analysis is correct.

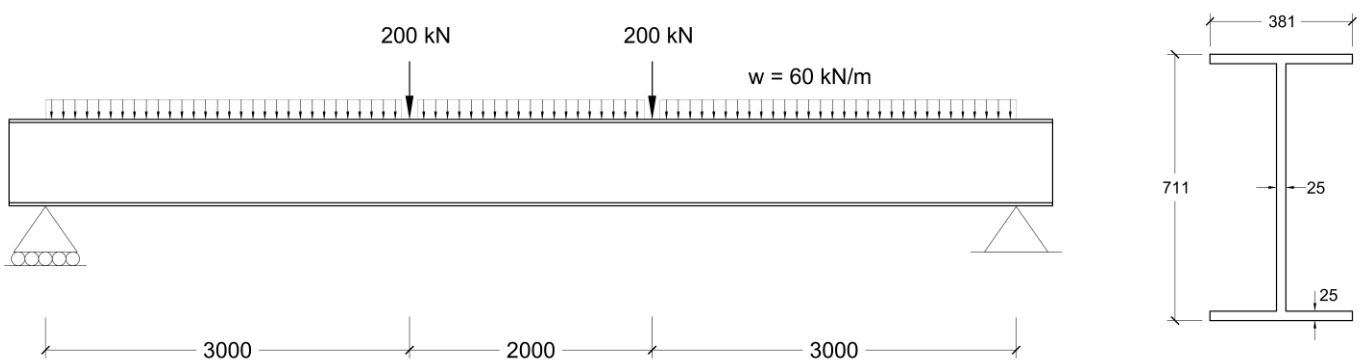
3. For the following structures, calculate the reaction forces and draw the SFD and BMD.



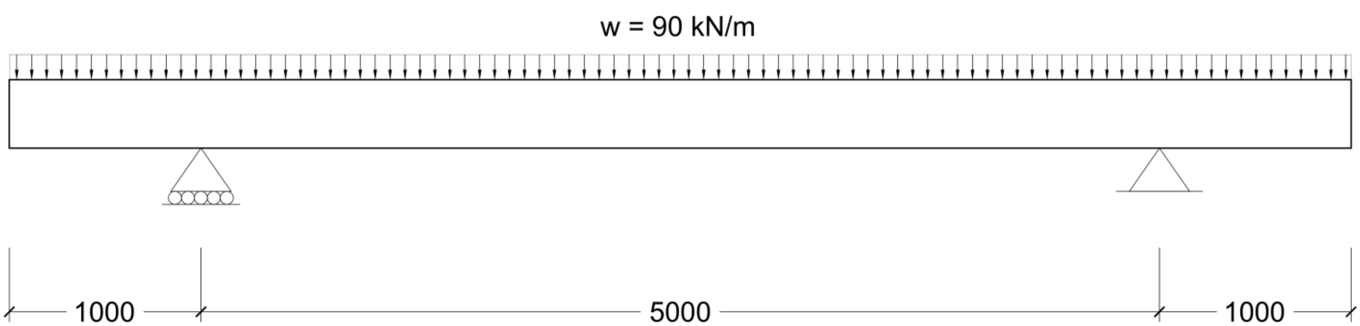


Hint: At hinge locations, the internal bending moment is guaranteed to be 0. Therefore, a cut taken at hinge locations will only result in 2 unknown internal forces (N, V, M = 0) whereas a cut taken at other locations will result in 3 unknown internal forces (N, V, M) as seen in Q1.

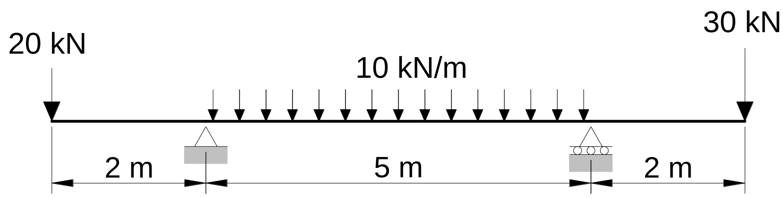
4. Shown below is a steel I-beam subjected to two concentrated point loads of 200 kN each, as well as a distributed load of 60 kN/m. Draw the shear force and bending moment diagrams and calculate the maximum tensile and compressive stresses in the beam. Indicate where along the length and height on the beam these maximum stresses occur. Neglect the self-weight of the beam. All dimensions are in mm. The second moment of area, I, for this section is 2,840 × 10^6 mm^4.

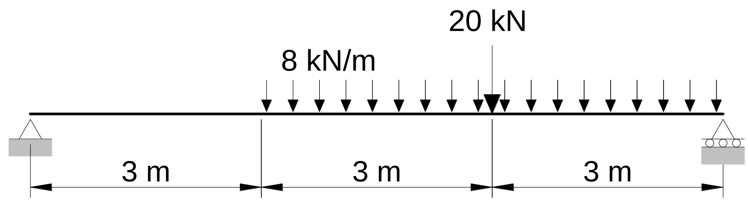


5. The wooden beam shown below is subjected to a high uniform load of 90 kN/m. It has a square cross section with dimensions 356 × 356 mm and is made of spruce. Calculate the factor of safety against **flexural failure** for this member. Use Appendix A to find the material properties of spruce. All dimensions are given in mm.



6 (OPTIONAL). Draw the bending moment and shear force diagrams for the beams shown below. Show the important values on the diagrams.





7 (OPTIONAL). A 10 m long timber beam is subjected to four concentrated loads as shown below. Calculate and draw the shear force and bending moment diagrams. Show all the important values. Find the maximum flexural stresses in the beam, and indicate where they occur. Ignore the self-weight of the beam.