Department of Civil and Environmental Engineering,   Fall Semester, 2022

ENCE 353 Midterm 1, Open Notes and Open Book

Name : _____

E-mail (print neatly!): _____

Exam Format and Grading. This take home midterm exam is open notes and open book. You need to comply with the university regulations for academic integrity.

There are three questions. Partial credit will be given for partially correct answers, so please show all your working.

Please see the **class web page for instructions on how to submit your exam paper**.

Question	Points	Score
1	15	
2	15	
3	10	
Total	40	

Question 1 (15 points): Support Reactions and Bending Moments in a Connected Beam Structure.

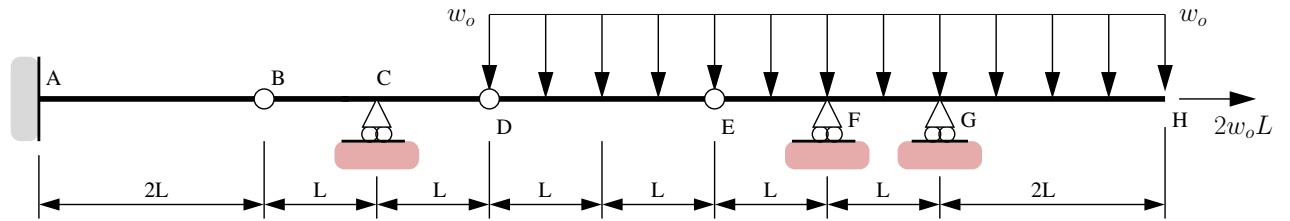Consider the multi-span beam structure shown in Figure 1.

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

The cantilever is fully-fixed to the wall at Point A. Points B, D and E are hinges. The beam segment D-E-F-G-H carries a uniformly distributed load w_o (force/per unit length). Finally, a horizontal point load $2w_oL$ is applied at point H.

[1a] (3 pts). Compute the degree of indeterminacy for the beam structure.

[1b] (3 pts). Compute the vertical reaction forces at nodes C, F and G.

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[1c] (3 pts). Compute the **total force** at hinge B.

[1d] (6 pts). 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 (15 points): Tension, Compression and Zero-Force Members in a Crane Tower Structure
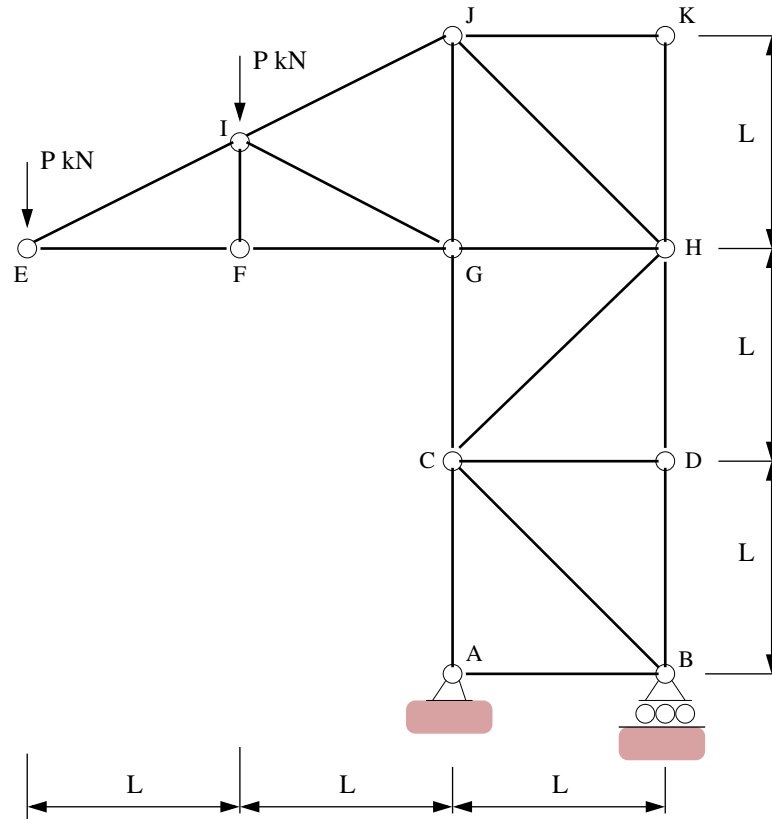
Consider the crane tower structure shown in Figure 2.

Figure 2. Elevation view of a simple crane tower.

Point loads **P** (kN) are applied at nodes E and I as shown in the figure.

[2a] (3 pts). Compute the support reactions at A and B.

[2b] (4 pts). Identify **all** of the zero-force members. If you wish, you can simply annotate Figure 2.

[2c] (6 pts). 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.

[2d] (2 pts). 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 3 (10 points): Degree's of Indeterminacy.

[3a] (4 pts). Compute the degree of indeterminacy for the structure shown in Figure 3.
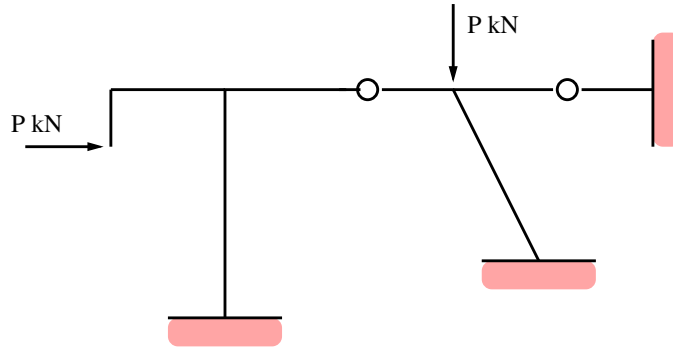

Figure 3. Simple portal frame.

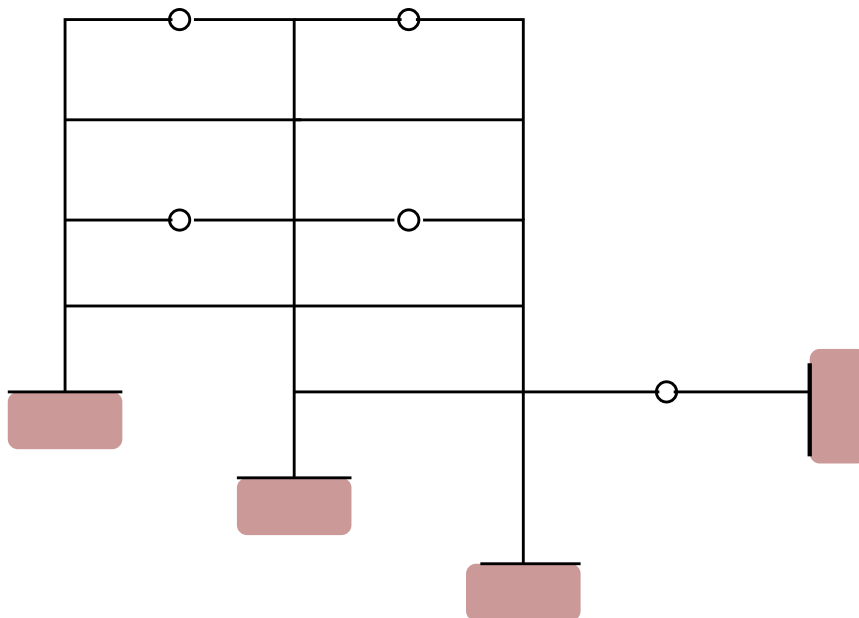[3b] (6 pts). Compute the degree of indeterminacy for the moment-resistant frame shown in Figure 4.

Figure 4. Elevation view of moment-resistant frame.