

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.

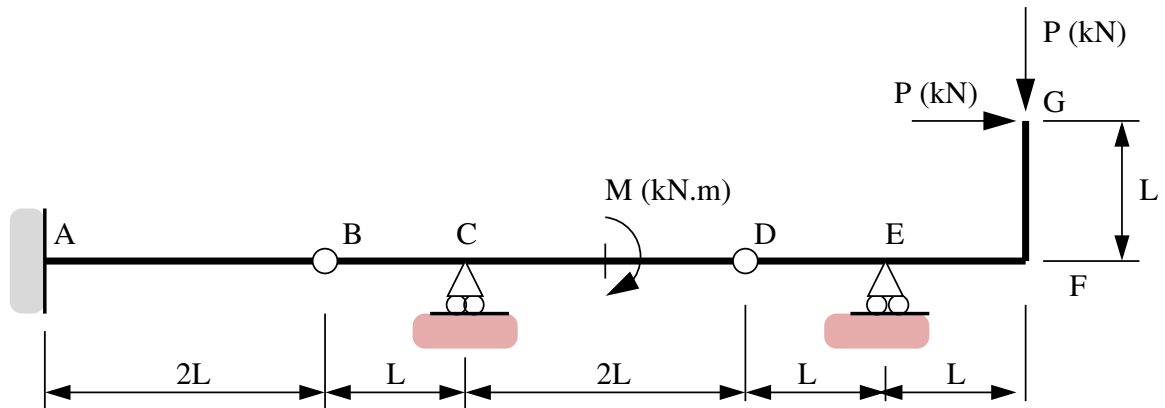


Figure 1. Front elevation view of multi-span beam structure.

The cantilever is fully-fixed to the wall at Point A. Points B and D are hinges. Horizontal and vertical point loads \mathbf{P} (kN) are applied at point G. A clockwise moment \mathbf{M} (kN.m) is applied at the midpoint of beam segment C-D. Assume that \mathbf{P} and \mathbf{M} are both positive values.

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

[1b] (3 pts). Show that the **total force** at hinge D is $\sqrt{5}P$.

[1c] (3 pts). Derive an expression for the vertical reaction force at C as a function of P, M and L.

[1d] (6 pts). Now suppose that $M = k PL$, where k is a constant that can take values 0, 3, 6 or 9. Draw and label a diagram that shows how the bending diagram for beam element B-C-D varies as function of k.

I suggest that you create one diagram with four bending moment diagram profiles. Clearly indicate on the bending moment diagram regions where the fibre will be in tension and compression, and **any conditions on P and M that also apply**.

Question 2 (15 points): Tension, Compression and Zero-Force Members in a Truss Structure.

Consider the truss structure shown in Figure 2.

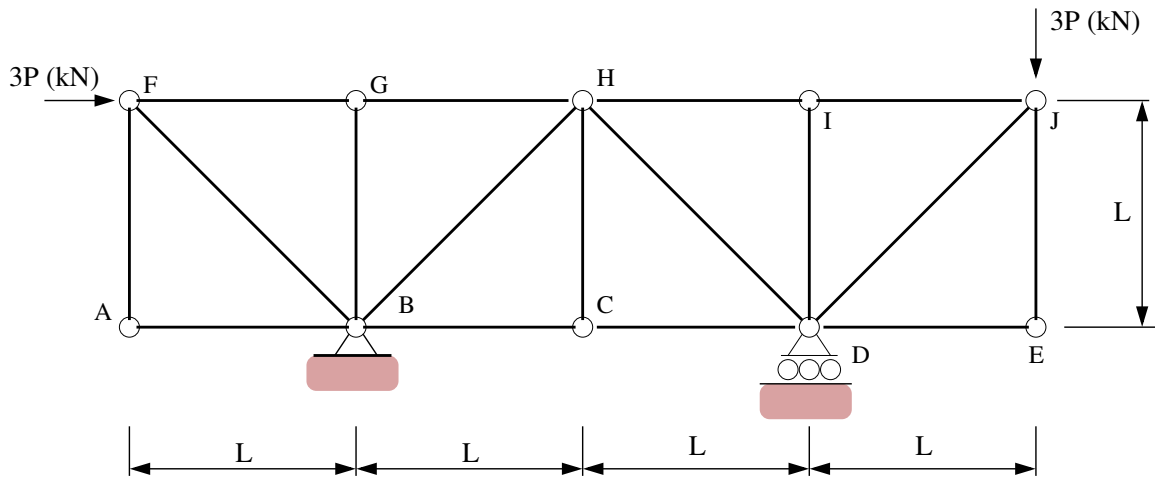


Figure 2. Elevation view of 17 bar truss structure.

Horizontal and vertical loads of $3P$ kN are applied at nodes F and J, respectively.

[2a] (3 pts). Compute the **magnitude** and **direction** of the **total support reactions** at points B and D.

[2b] (3 pts). Identify the zero-force members (If you wish, you can simply annotate Figure 2).

[2c] (7 pts). Using the method of joints (or otherwise) show that: (1) The maximum tensile force in the structure is $3\sqrt{2}P$ kN (T), and (2) The maximum compressive force in the structure is $-3\sqrt{2} P$ kN (C).

[2d] (2 pts). Draw a simplified version of Figure 2 with **all of the zero force elements** removed.

Question 3 (10 points): Degree's of Indeterminacy.

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

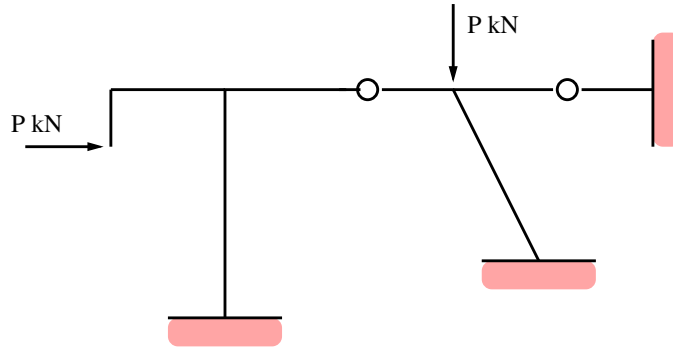


Figure 3. Simple portal frame.

[3b] (6 pts). Using the method of trees (or otherwise), compute the degree of indeterminacy for the moment-resistant frame shown in Figure 4.

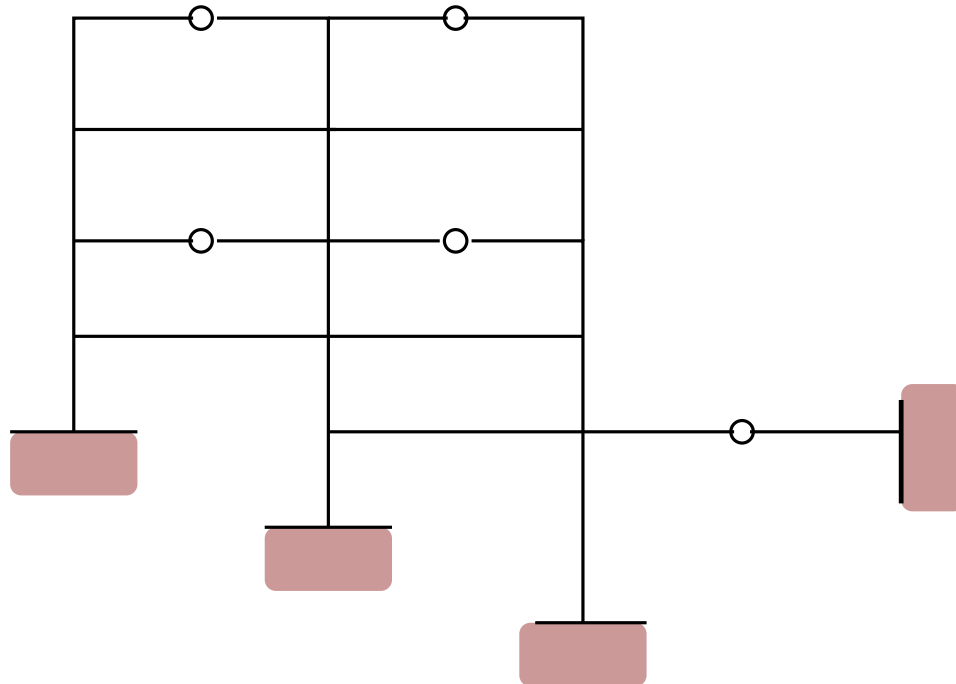


Figure 4. Elevation view of a moment-resistant frame.