Department of Civil and Environmental Engineering, Fall Semester, 2018

ENCE 353 Midterm 1, Open Notes and Open Book

Name : ____________________

Exam Format and Grading. This exam has three questions. Partial credit will be given for partially correct answers, so please show all your working.

Question	Points	Score
1	15	
2	15	
3	10	
Total	40	

Question 1 (15 points): Shear Forces and Bending Moments in a connected Beam Structure.

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

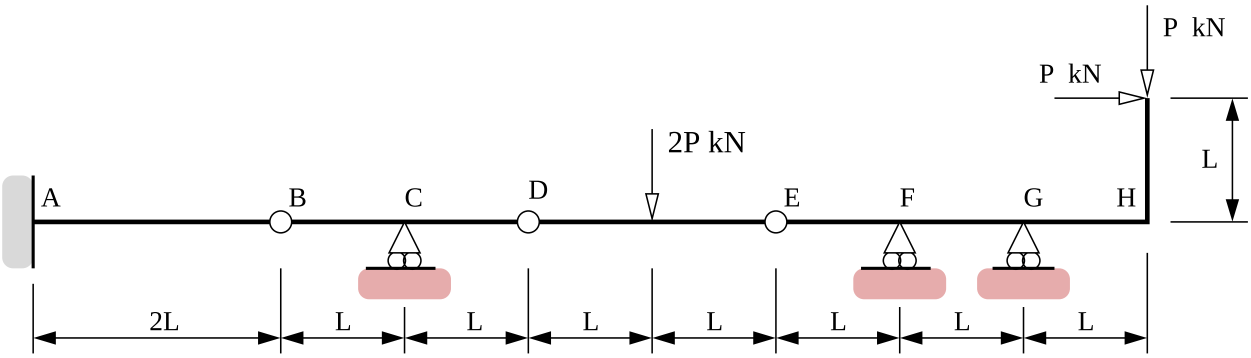

Figure 1: Multi-span beam structure carrying three point loads.

The cantilever is fully-fixed to the wall at Point A. Points B, D and E are hinges. A vertical point load **2P kN** is applied at the middle of element C-D. Horizontal and vertical point loads are applied at the beam end-point above H.

[1a] (2 pts). Compute the degree of indeterminacy for the beam structure.

[1b] (5 pts). Compute the support reactions at points A, C, F and G as a function of P and L.

[1c] (5 pts). Draw and label diagrams for shear force, bending moment and axial force throughout the structure. Indicate on the bending moment diagram regions where the fibre will be in tension and compression.

[1d] (3 pts). Compute the magnitude of the total force transfered across the hinge at E.

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

Consider the truss structure shown in Figure 2.

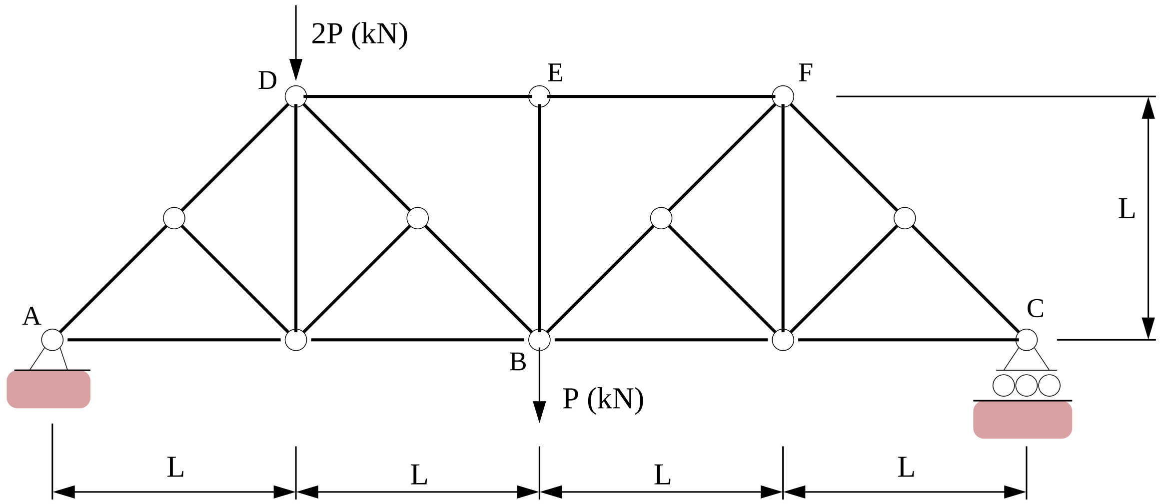

Figure 2: Twenty one bar truss structure.

Vertical loads of **2P** kN and **P** kN are applied at nodes B and D, respectively.

[2a] (4 pts). Compute the **magnitude** and **direction** of the **total support reactions** at points A and C.

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

[2c] (5 pts). Using the method of joints (or otherwise) show that: (1) The maximum tensile force in the structure is $2P$ kN (T), and (2) The maximum compressive force in the structure is $-2\sqrt{2}\ P$ 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.

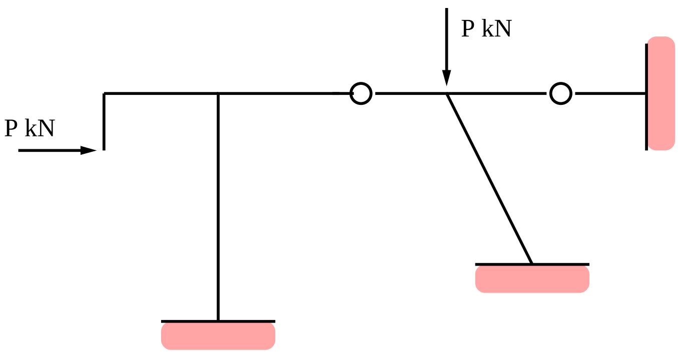

Figure 3: Simple portal frame.

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

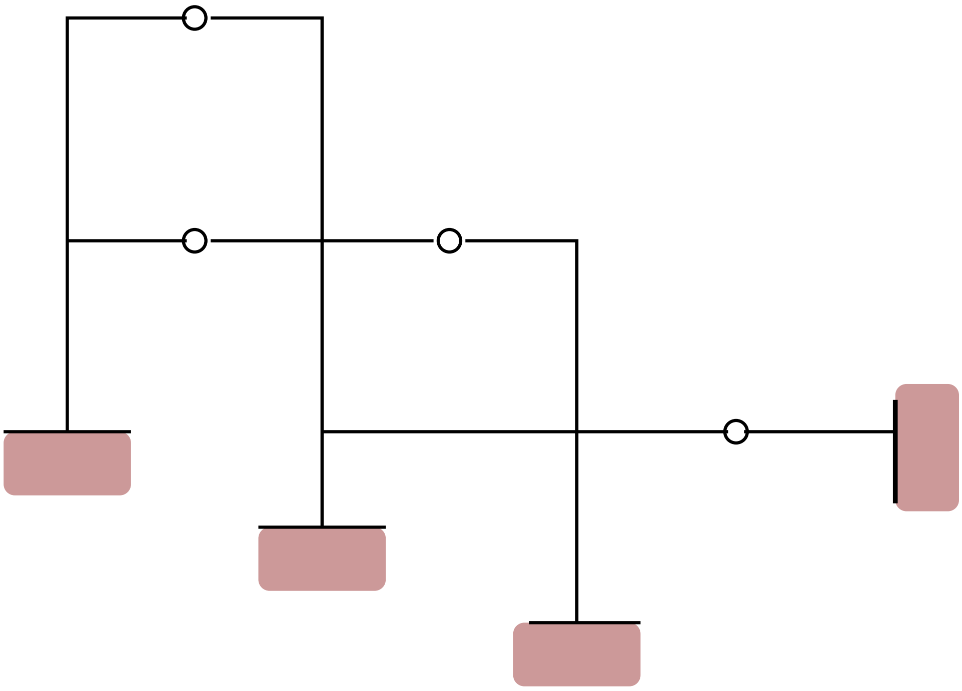

Figure 4: Elevation view of a moment-resistant frame.