Department of Civil and Environmental Engineering, Spring Semester, 2020

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): Support Reactions and Bending Moments in a connected Beam Structure.

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

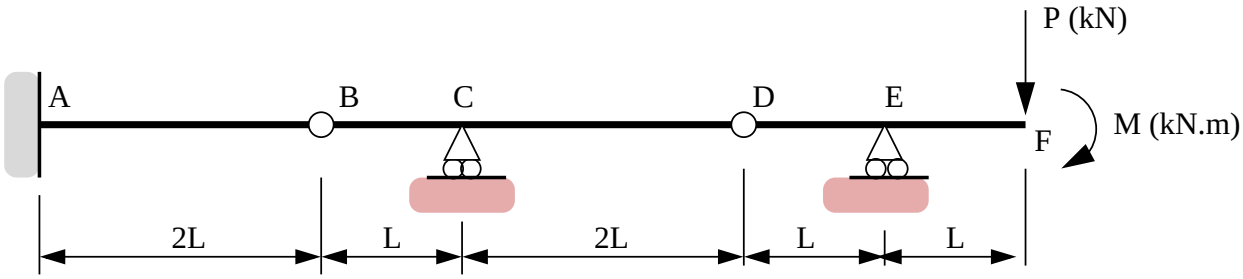

Figure 1: Front elevation view of multi-span beam structure.

The cantilever is fully-fixed to the wall at Point A. Points B and D are hinges. A vertical point load **P (kN)** and a clockwise moment **M (kN.m)** is applied at point F. Assume that **P** and **M** are both positive values.

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

[1b] (5 pts). Show that the support reactions at C and E are:

$$V_c = -3\,[P + M/L]\,, \tag{1}$$

and

$$V_e = [2P + M/L]\,; \tag{2}$$

respectively.

Question 1b: continued:

[1c] (5 pts). Derive expressions for the shear force and bending moment at A.

[1d] (2 pts). Draw and label the bending moment diagram for beam segment A-B alone. Clearly indicate on the bending moment diagram regions where the fibre will be in tension and compression.

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

Consider the truss structure shown in Figure 2.

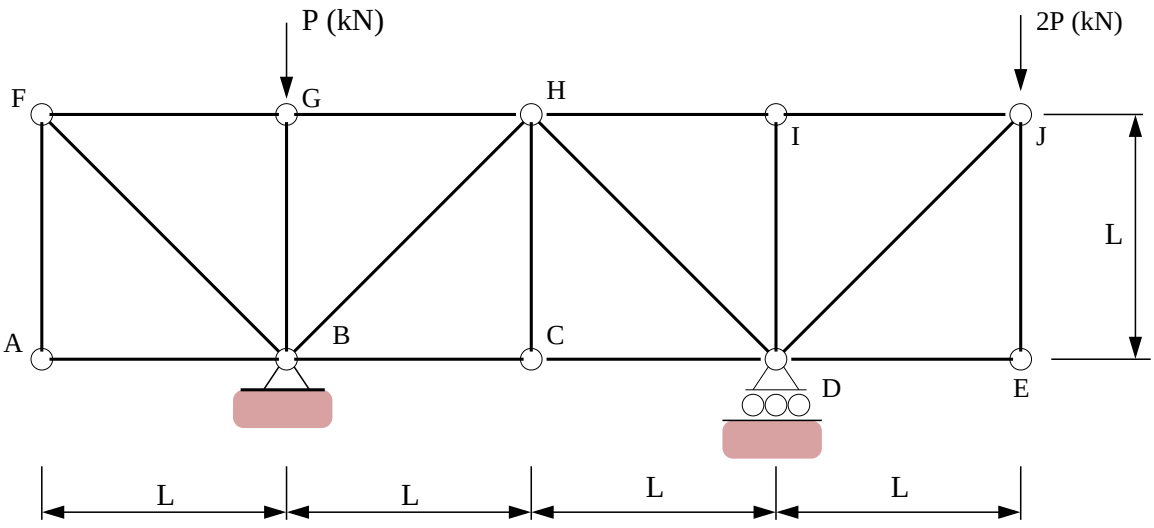

Figure 2: Elevation view of 17 bar truss structure.

Vertical loads of **2P** kN and **P** kN are applied at nodes G 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 $2P$ 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.

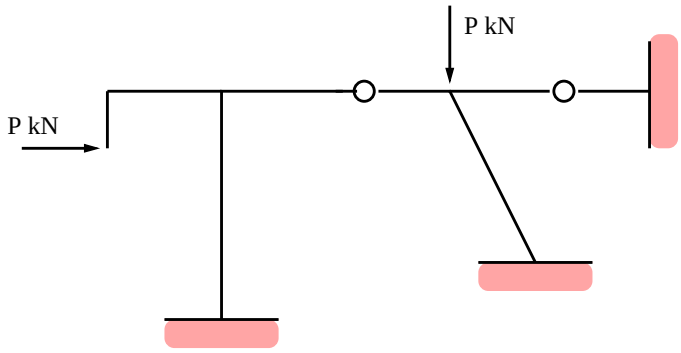

Figure 3: Simple portal frame.

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

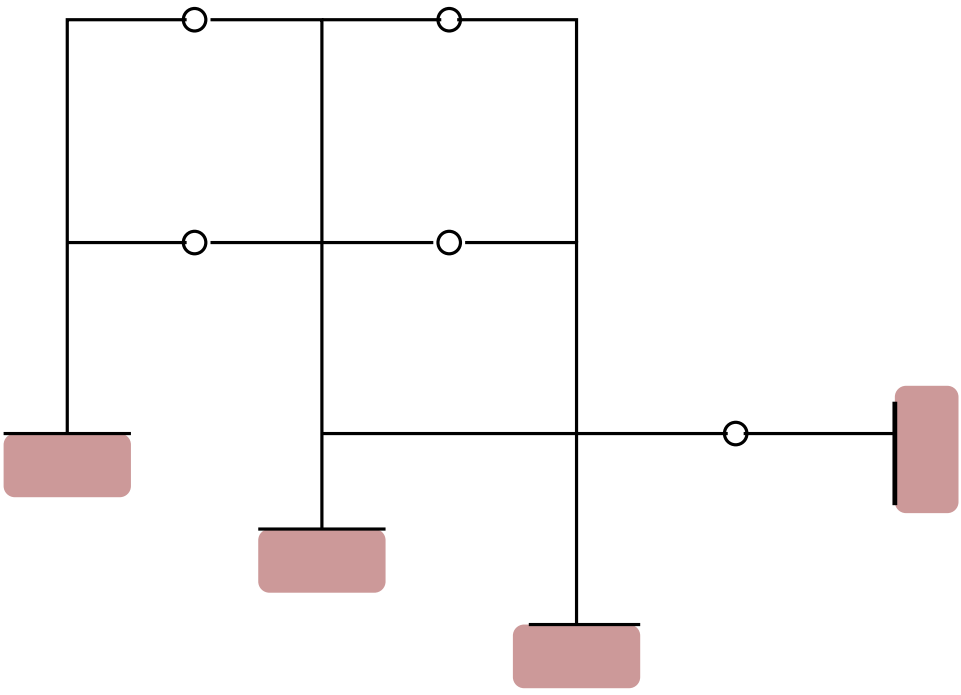

Figure 4: Elevation view of a moment-resistant frame.