

**ENCE 353 Midterm 1, Open Notes and Open Book**

Name : Austin

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.

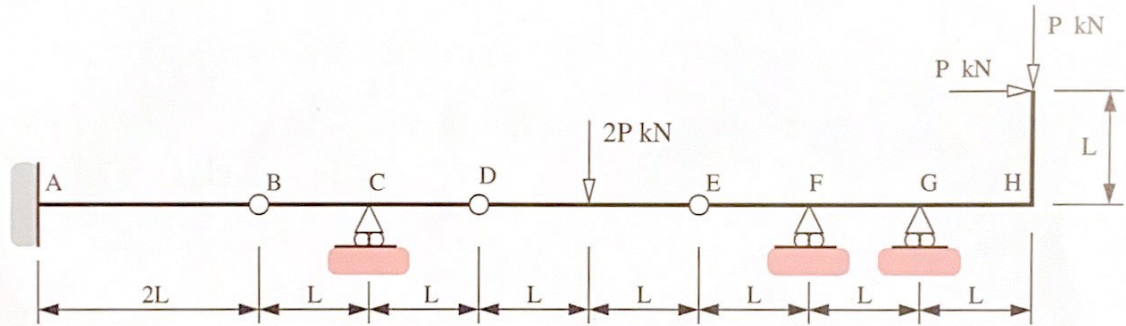


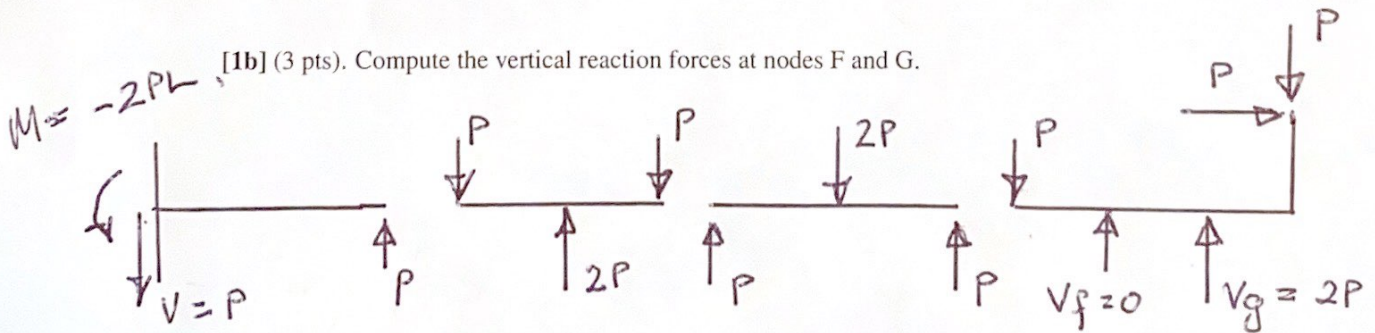
Figure 1. Front elevation view of multi-span beam structure.

The cantilever is fully-fixed to the wall at Point A. Points B, D and E are hinges. Horizontal and vertical point loads  $P$  (kN) and  $2P$  (kN) are applied as shown in Figure 1.

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

$$\left. \begin{array}{l} r = 12 \\ n = 4 \end{array} \right\} r - 3n = 0 \Rightarrow \text{determinate.}$$

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

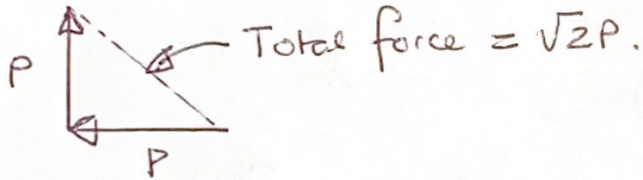


Note: first, compute shear forces at hinges D & E  
Then, look at equilibrium of E-F-G-H-I.

$$V_g = 2P, V_f = 0.$$



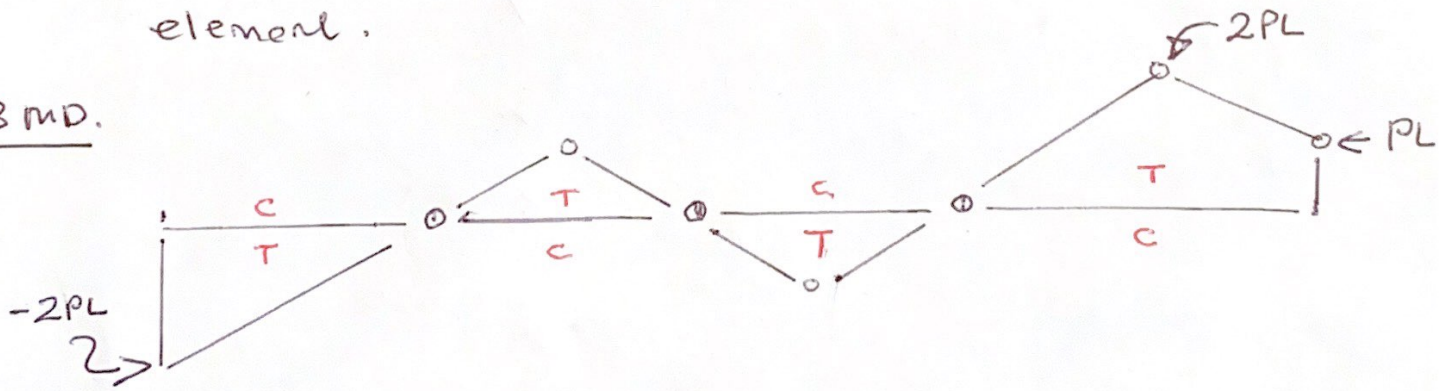
[1c] (3 pts). Compute the **total force** at hinge B.



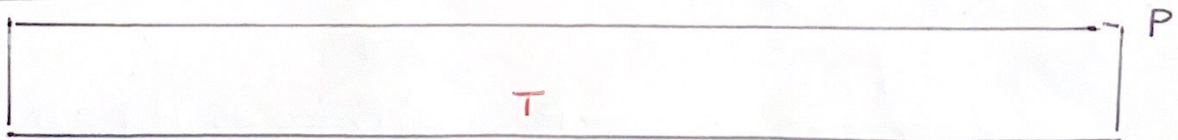
[1d] (6 pts). Draw and label diagrams showing how the **bending moment** and **axial force** vary along the beam, nodes A through H. Clearly indicate on your bending moment diagram, regions that are in tension/compression.

Am going to draw BM on tension side of beam element.

BMD.



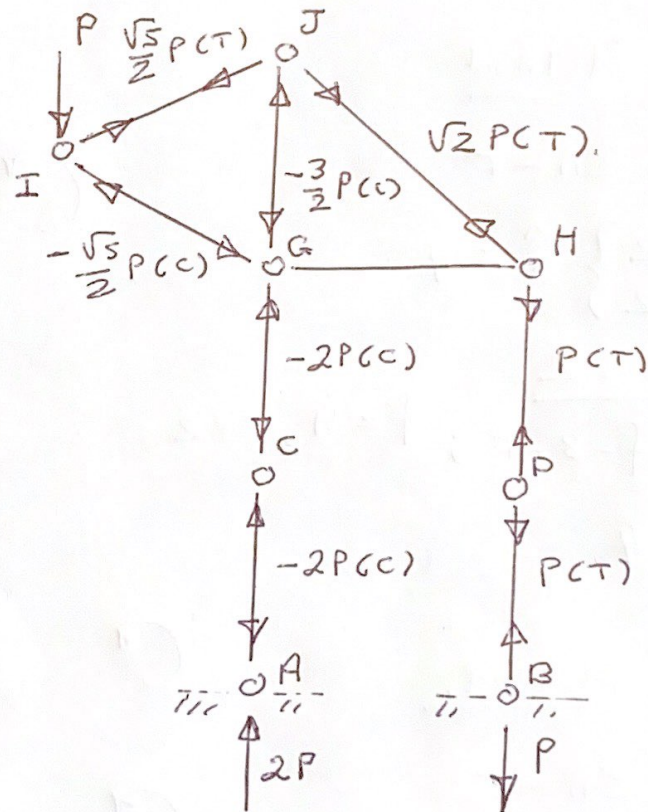
Axial Force







[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.



Note: Max tension =  $\sqrt{2}P(T)$

" compression =  $-2P(C)$

[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.

limiting constraint is compression  $-2P = 7 \text{ kN}$

$$\Rightarrow P_{\max} = -3.5 \text{ kN}$$

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

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

Ring Method

$$\hat{i} = 3n - r$$

$$\left. \begin{array}{l} n = 2 \\ r = 2 \end{array} \right\} \hat{i} = 4$$

Method 2

$$\hat{i} = f - 3 - r ; f = 9, r = 2$$

$$= 4$$

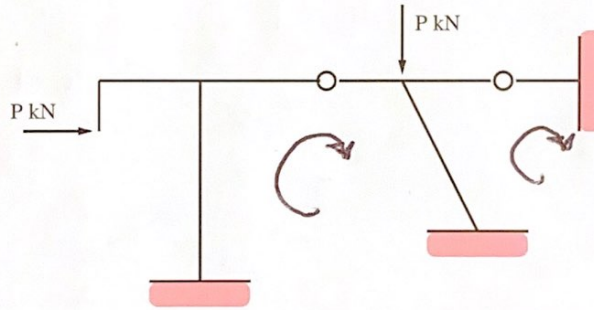


Figure 3. Simple portal frame.

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

$$= 4$$

Ring Method.

$$\hat{i} = 3n - r$$

$$\left. \begin{array}{l} n = 4 \\ r = 3 \end{array} \right\} \hat{i} = 12 - 3 = 9$$

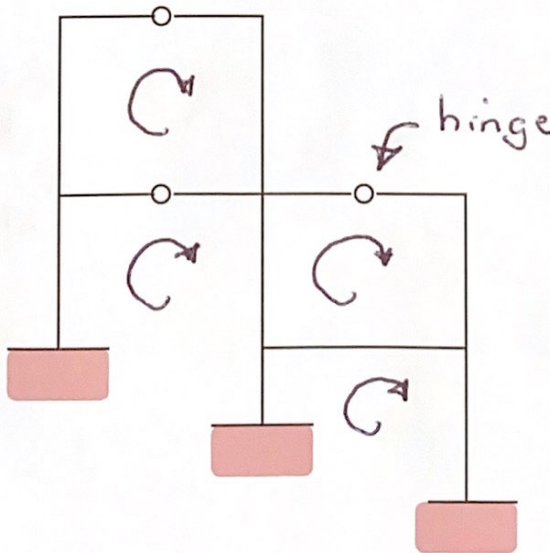


Figure 4. Elevation view of large moment-resistant frame.