

ENCE 353 Midterm 2, 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

Moment-Area and Deflections. Consider the cantilevered beam structure shown in Figure 1.

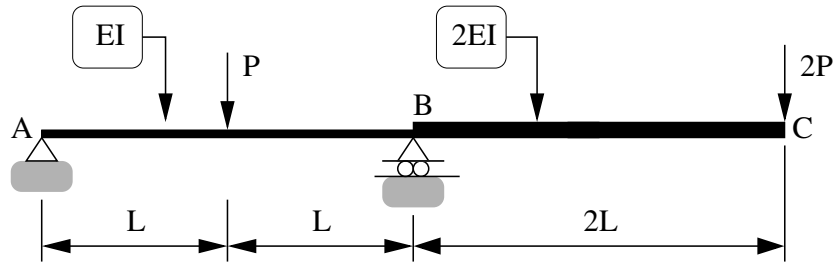


Figure 1: Front elevation view of a cantilevered beam structure.

Notice that segments A-B and B-C have cross-sectional properties EI and $2EI$, respectively.

[1a] (3 pts) Compute and draw the $M(x)/EI$ diagram for the complete beam A-B-C.

[1b] (4 pts) Draw and label a diagram of the deflected shape. Clearly indicate on your diagram regions (or points) of the beam having zero curvature.

[1c] (4 pts) Draw and label a diagram showing how the rotation at A is related to the beam deflections at points B and C.

[1d] (4 pts) Use the method of moment-area to compute the vertical deflection of the beam at point C.

Question 2: 15 points

Simple Three-Pinned Arch. Figure 2 is a front elevation view of a simple three-pinned arch. Vertical and horizontal loads $2P$ are applied at nodes B and D.

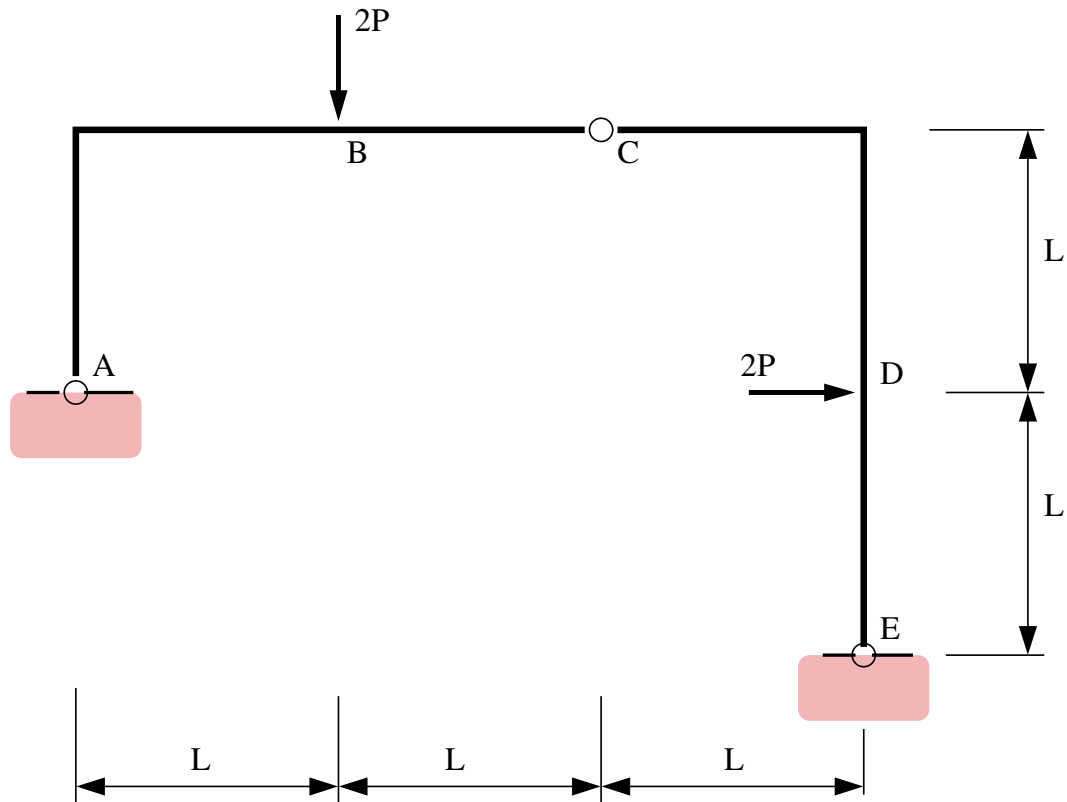


Figure 2: Front elevation view of a simple three-pinned arch.

[2a] (4 pts) Compute the vertical and horizontal components of reaction force at supports A and E as a function of P .

Question 2a continued:

[2b] (3 pts) Compute and axial and shear forces transfered across the hinge at C. You can annotate Figure 2 if you think it will help to explain your solution.

[2c] (3 pts) Draw and label the bending moment diagram.

Question 3: 10 points

Analysis of Forces in a Cable Structure. Figure 3 is a front elevation view of a cable structure and bridge deck that carries a snow loading.

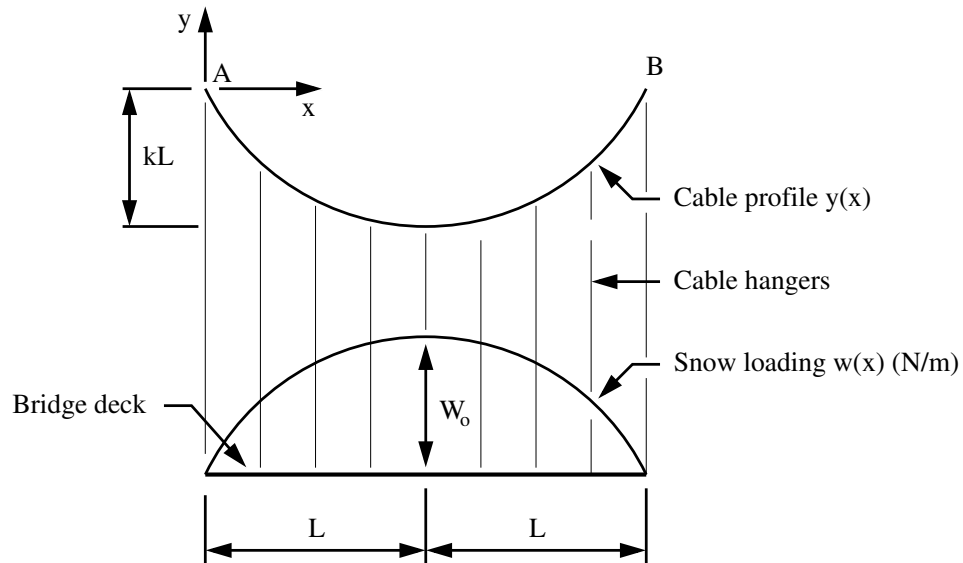


Figure 3: Cable structure carrying a snow loading.

The bridge deck and cable system have total span $2L$. The cable sag is kL , where $0 < k < 1$. Roughly speaking, the distribution of snow loading follows a sinusoidal shape:

$$w(x) = W_0 \sin\left(\frac{\pi x}{2L}\right) \quad (N/m). \quad (1)$$

[3a] (4 pts) Starting from first principles of engineering (i.e., the differential equation for cable behavior) show that the horizontal component of cable force is:

$$H = \frac{W_0}{kL} \left(\frac{2L}{\pi}\right)^2 \quad (2)$$

[3b] (3 pts) Determine the vertical and horizontal components of cable force at the supports A and B.

[3c] (3 pts) Show that the maximum force in the cable, T_{max} , is:

$$T_{max} = W_o \left(\frac{2L}{\pi} \right) \left[1 + \left(\frac{2}{k\pi} \right)^2 \right]^{1/2} \quad (3)$$