Department of Civil and Environmental Engineering, Fall Semester, 2019

ENCE 353 Midterm 2, Open Notes and Open Book

Name : _____

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

Question	Points	Score
1	15	
2	15	
3	10	
Total	40	

Question 1: 15 points

Analysis of a Supported Cantilever Beam Structure. Consider the supported cantilever beam structure shown in Figure 1.

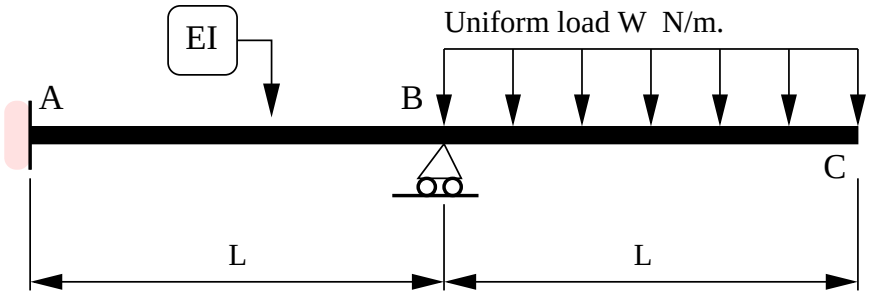

Figure 1: Front elevation view of a supported cantilever beam structure.

The cantilever is fully fixed (no rotation) at support A and is restrained against vertical displacements at B. It carries a uniform load W (N/m) along the segment length B-C.

[1a] (8 pts) Use the methods of **moment area** and **compatibility of displacements** to show that the support reaction at B is:

$$V_b = \frac{7}{4} W L. \tag{1}$$

[1b] (7 pts) Use the method of **moment area** to compute the vertical displacement at C.

Question 2: 15 points

Consider the cantilevered beam structure shown in Figure 2.

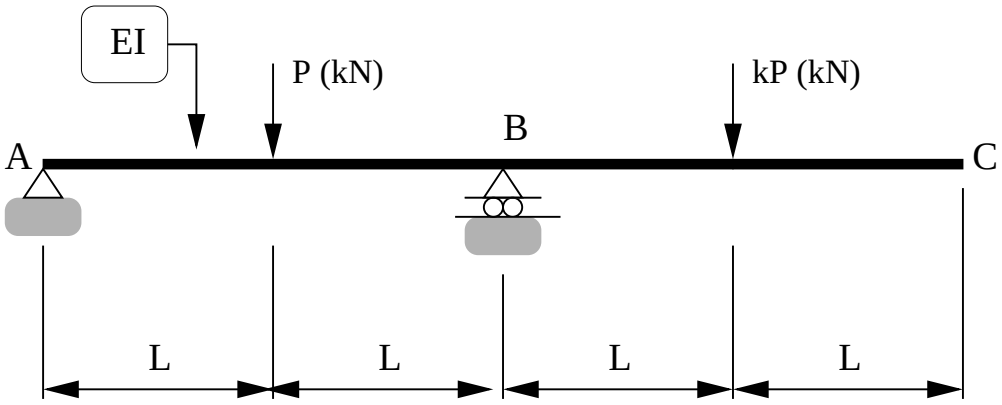

Figure 2: Front elevation view of a cantilevered beam structure.

Vertical loads of P (kN) and kP (kN) are applied at the mid-spans of beam segments A-B and B-C, respectively.

[2a] (3 pts) Briefly explain how the **principle of superposition** — hint, hint hint! – can be applied to this problem.

[2b] (8 pts) Use the **method of moment-area** to show that the clockwise rotation of point A is:

$$\theta_A = \left[\frac{3-4k}{12}\right]\frac{PL^2}{EI}. \tag{2}$$

Question 2a continued:

[2c] (4 pts) Draw and label the deflected shape of the beam when k = 3/4. Indicate sections of beam where the fibre is in tension/compression, and where the curvature is zero.

Question 3: 10 points

The cable structure shown in Figure 3 carries a triangular load that is zero at the left-hand support and increases to w_o N/m at the right-hand support.

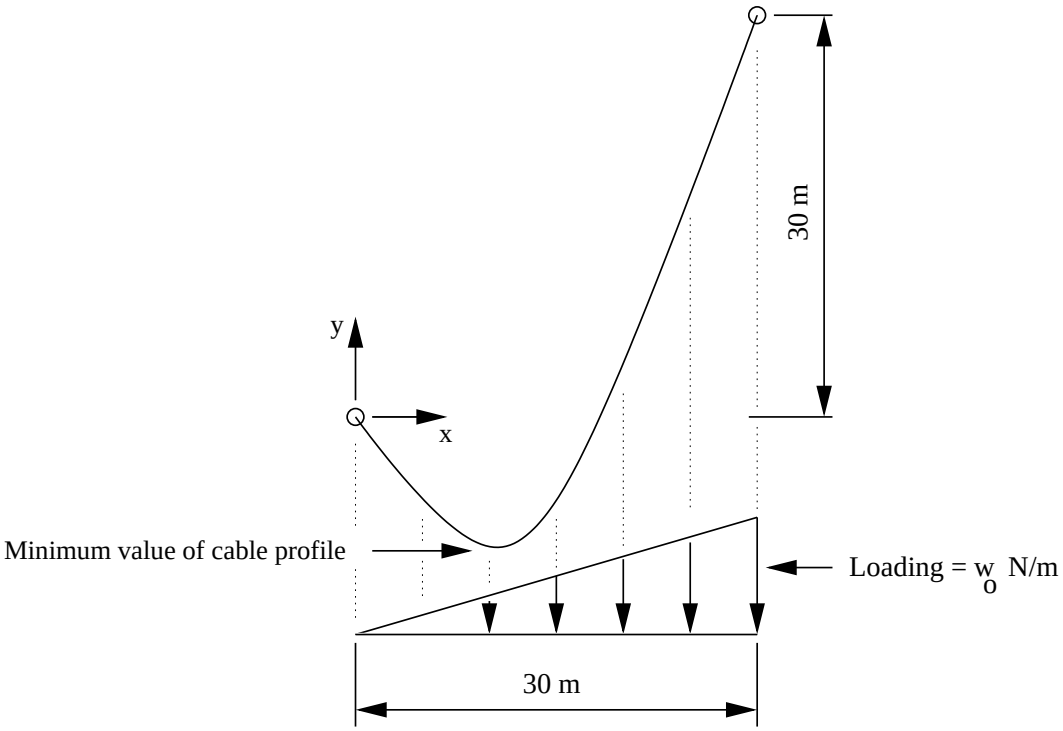

Figure 3: Elevation view of a swing bridge carrying a triangular loading.

[3a] (4 pts). Starting from first principles (i.e., the differential equation), show that cable profile is given by the equation

$$y(x) = \frac{w_o x^3}{180H} + \left(1 - \frac{5w_o}{H}\right) x. \tag{3}$$

Now let us assume that the minumum value of the cable profile occurs at x = 10.

[3b] (4 pts). Show that the horizontal cable force is:

$$H = \frac{20 w_o}{6}. \tag{4}$$

[3c] (2 pts). Draw and label a diagram showing the horizontal and vertical components of reaction force at the left- and right-hand cable supports.