ME 323: Mechanics of Materials **Homework 8**

Spring 2024 **Due: March 22, 2024**

Problem 1 (10 points):

The beam AD is fixed to a rigid wall at A and is supported by props at B and C as shown in *figure 1*. In sections AB and BC, the flexural rigidity is EI, but in section CD the flexural rigidity is 2EI. The beam supports a linearly distributed load over span BC.

Use Castigliano's Second Theorem (neglecting shear strain energy due to bending) to determine:

1. Reactions at end A.
2. Slope θ of the beam at the support C.

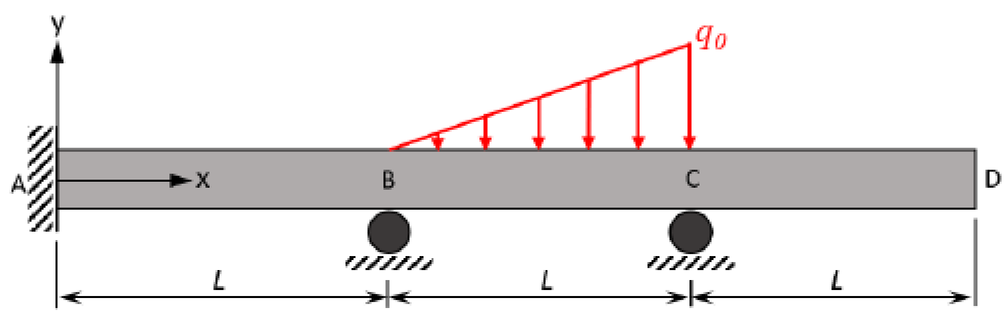

Figure 1: Beam loading for Problem 1

Problem 2 (10 points):

A simply-supported beam *ABC* is subjected to a vertical load *P* at C. The cross section of the beam is shown in *figure 2*, and given that P = 1000 N and L = 2 m. The elastic and shear modulus of the material are 200 GPa and 75 GPa, respectively. The form factor for a square cross section is $f_s = 6/5$.

a) Compare the flexural energy and the shear energy due to bending by calculating their ratio.

b) Use Castigliano's second theorem to determine the vertical deflection of the end *C including the strain energy due to shear.*

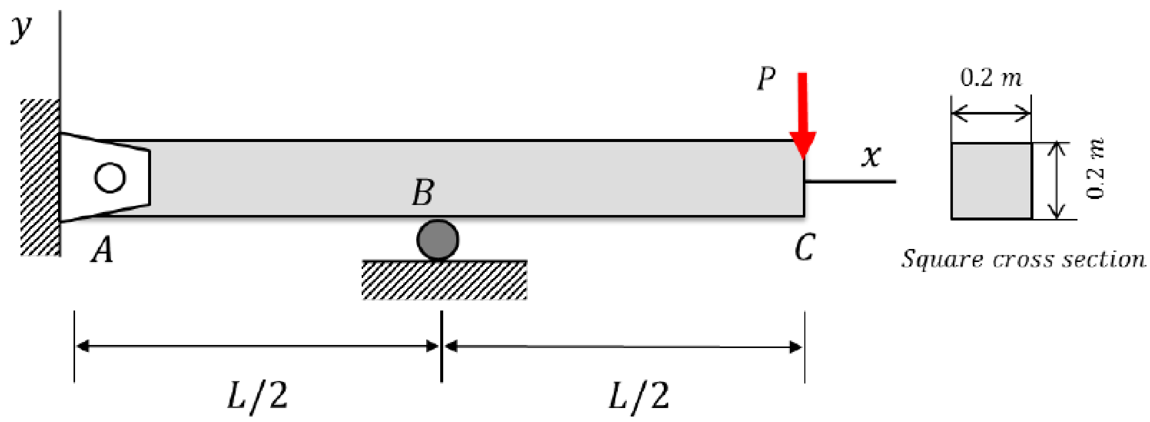

Figure 2: Beam ABC and its cross-section

Problem 3 (10 points):

Figure 3 shows a cantilevered beam (ABC) with modulus E and moment of inertia I. A distributed load of w_0 spans 1/3[rd] of its length. The beam is simply supported at point B. Use Castigliano's theorem to determine the reactions at A and B. You can neglect the shear energy due to bending.

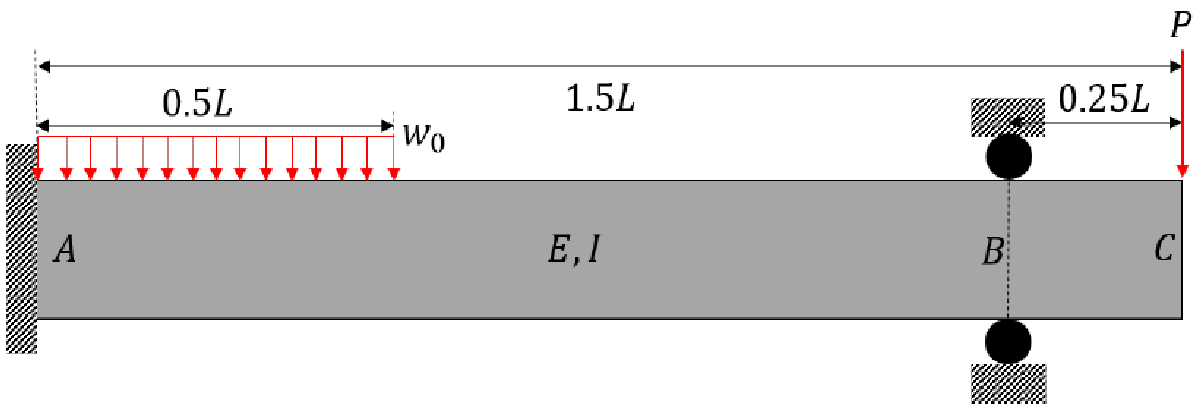

Figure 3: Cantilever beam loading for Problem 3

Problem 4 (5 points):

Considering all the contributions to strain energy, the total strain energy for the figure 4.1 will have how many non-zero terms?

a. 3
b. 5
c. 6
d. 7

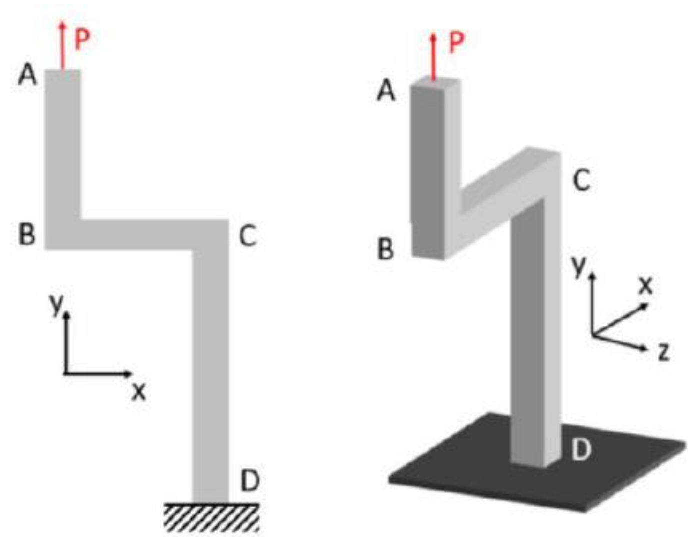

Figure 4: Loading of 3D structure for Problem 4