**MASSACHUSETTS INSTITUTE OF TECHNOLOGY**
**DEPARTMENT OF OCEAN ENGINEERING AND**
**CIVIL AND ENVIRONMENTAL ENGINEERING**
**13.10J/1.573J Introduction to Structural Mechanics**
**Fall 1999**
**Problem Set 11**

**Assigned : November 23, 1999**
**Due : December 2, 1999**

1. Find a formula for determining the critical buckling loads for the stepped column shown in Figure 1. Assume the Young's modulus of the column is $E$.

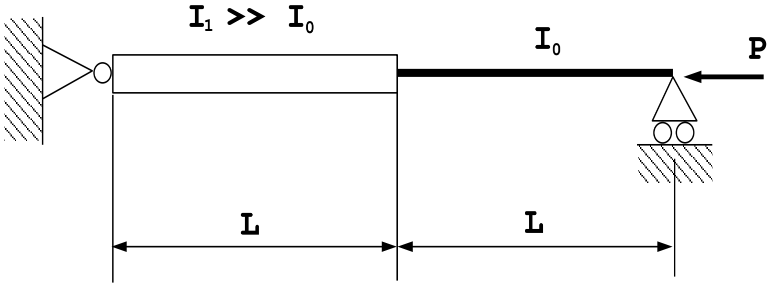


Figure 1

2. The column shown in Figure 2 is fixed at the base and free at the upper end. A compressive load $P$ acts at the top of the column with an eccentricity $e$ from the axis of the column. The bending rigidity is $EI$. Beginning with the differential equation, derive formulas for:

   (a) the maximum deflection $\delta$ of the column.

   (b) the maximum bending moment $M_{max}$ in the column.

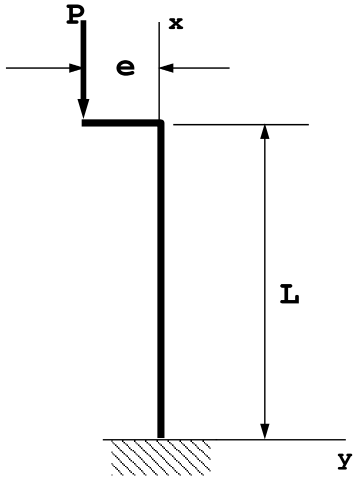


Figure 2

3. 17.19 of the course textbook.

4. A beam ABC (Figure 4) is simply supported at A and B and is hung from a cable CD at point C. Prior to the application of the uniform load $q$, there is no force in the cable nor is there any slack in the cable. When the load $q$ is applied, the beam deflects downward at C and a tensile force $T$ develops in the cable. Assume the bending rigidity of the beam is $EI$; the Young's modulus of the cable material is $E$; and the cross sectional area of the cable is A. Find the magnitude of the tensile force $T$ in the cable. (Use energy method.)

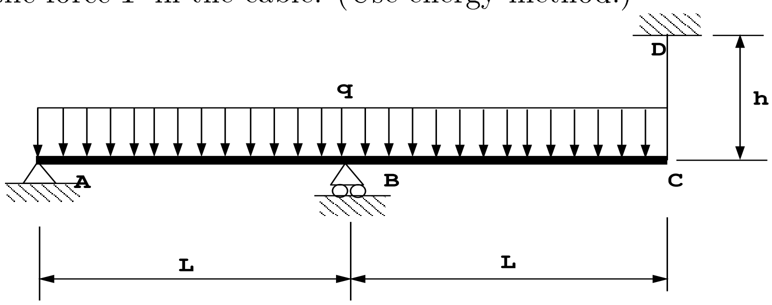


Figure 4

5. A slender curved bar ACB of semicircular shape is pin-supported at A and roller-supported at B. A vertical load $P$ acts at the midpoint C. Determine the vertical deflection $\delta_c$ at C and the horizontal deflection $\delta_b$ at B. The bending rigidity is $EI$ and consider only the effect due to

bending.

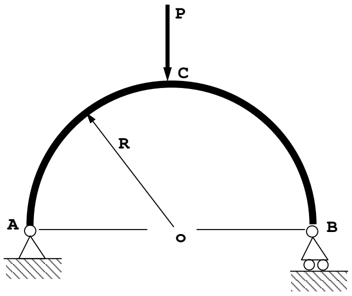


Figure 5

6. The forces in the spoke of a bicycle wheel under a statically applied load $P$ may be determined approximately by considering the rim to be rigid and the spokes to be radial. The spokes are prestressed in tension so that they can carry a compressive load (a compressive load merely reduces the tension). Using the energy method, determine the downward displacement $\delta$ of the hub due to the load $P$ if there are 32 equally spaced spokes having cross-sectional area $A$, length $L$, and the Young's modulus $E$.
   Hint : Find the relation between extension/compression of each spoke and $\delta$.

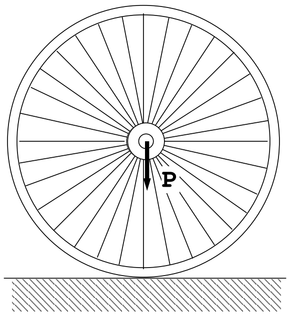


Figure 6

Problem sets are available also in the course homepage.