

School of Engineering
Brown University

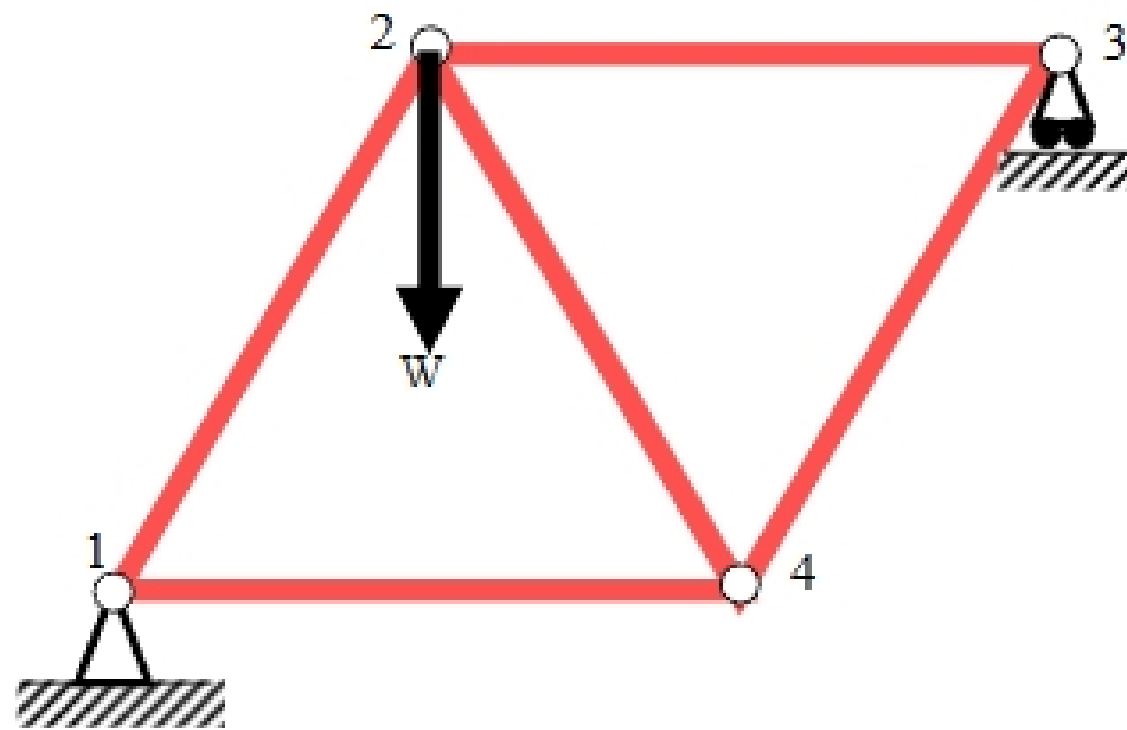
ENGN0030: Introduction to Engineering and Statics

Homework 7:
Thursday November 18, 2010.

1. Read through the tutorials for the structural analysis spreadsheets, available on the homework page. (no solution is required for this problem)

(0 points)

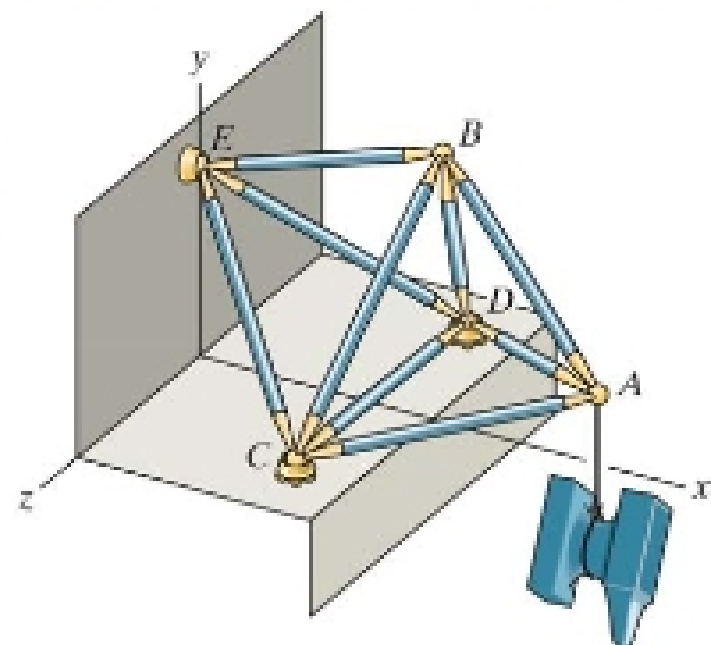
2. The bicycle frame shown below is idealized as a truss. The members are titanium with the cross section and length in the previous problem set. The length of each tube is 50 cm. The outer diameter is 3 cm and the tube thickness is 1mm. For titanium, $E = 116\text{GN/m}^2 = 116 \times 10^9 \text{N/m}^2$; $\sigma_y = 200\text{MN/m}^2 = 200 \times 10^6 \text{N/m}^2$.



Set up the Excel 2-D program to calculate the force in each tube under a vertical load $W=1000$ Newtons to the seat. Report the force in each tube, and the vertical and horizontal deflection at the seat in mm. Compare with the member forces with those calculated in the class example. (5 points)

3. Consider the space truss shown in problem 6.65 in the textbook. (Problem set 5). The anvil has weight W , and the coordinates of the points are

- A: (1.6,0.4,0) meters
- B: (1.0,1.0,-0.2) meters
- C: (0.9,0,0.9) meters



D: (0.9,0,-0.6) meters

E: (0,0.8,0) meters

The structure is made from 3/4" PVC tubular members; the dimensions and properties of these members can be found in the design project specifications. The objective of this problem is to use the 3D structural analysis spreadsheet to calculate the internal forces in the members. You will use this spreadsheet for your design project.

(a) Calculate the following: You may find it helpful to use the EXCEL 3D structural analysis worksheet to find the member lengths. Once you enter the joint coordinates, the program calculates the distance between all the joints in the 'Calculations' sheet. (5 points)

- The stiffness of all the members. Express your answer in N/m.
- The maximum load that each member can withstand, $F_y = A\sigma_y$, without fracture or rupture, expressing your answer in Newtons.
- The buckling load for each member in the structure, expressing your answer in Newtons.

(b) Take $W=400$ Newtons. Use the excel spreadsheet to find the internal loads. Will the structure support the load? Which members would fail? (5 points)

(c) Use your excel sheet to determine the largest weight (to within 10 Newtons) that can be applied without the structure failing. (2 points)

Problems from the book: (10 points each.)

4. 9.11

5. 9.13

6. 9.15

7. 9.46

8. 9.50