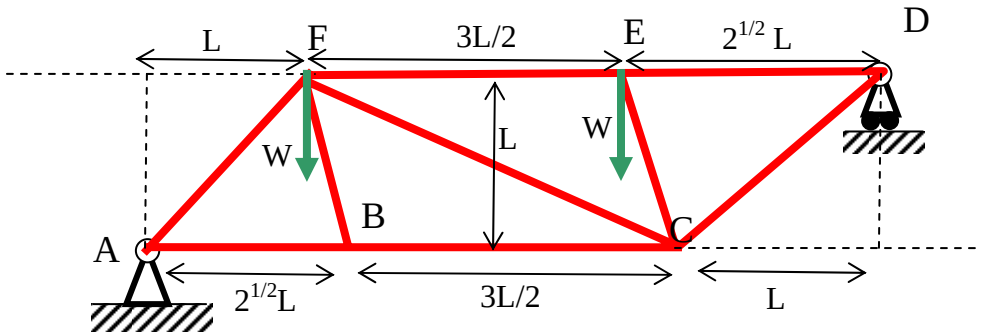
EN130: Structural Analysis

Homework 1
Due Wednesday February 3, 2010

Division of Engineering
Brown University

Note: You are encouraged to use Maple on this and any problem set. Please turn in a copy of your worksheet (with annotations).

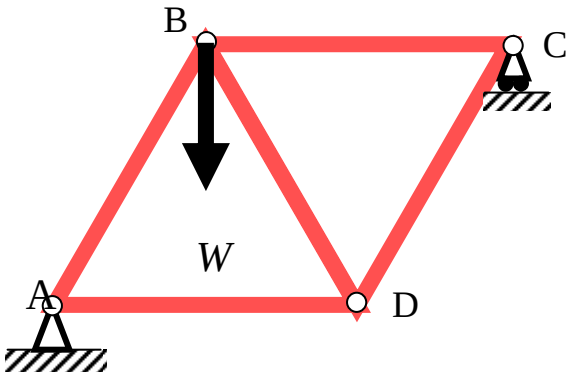
1. The picture shows a tandem bicycle frame. The frame may be idealized as a truss as shown. We neglect the slight angle the upper bars make with the horizontal. The weight of the riders is applied at the seat joints *F* and *E*. Neglect the weight of the frame.



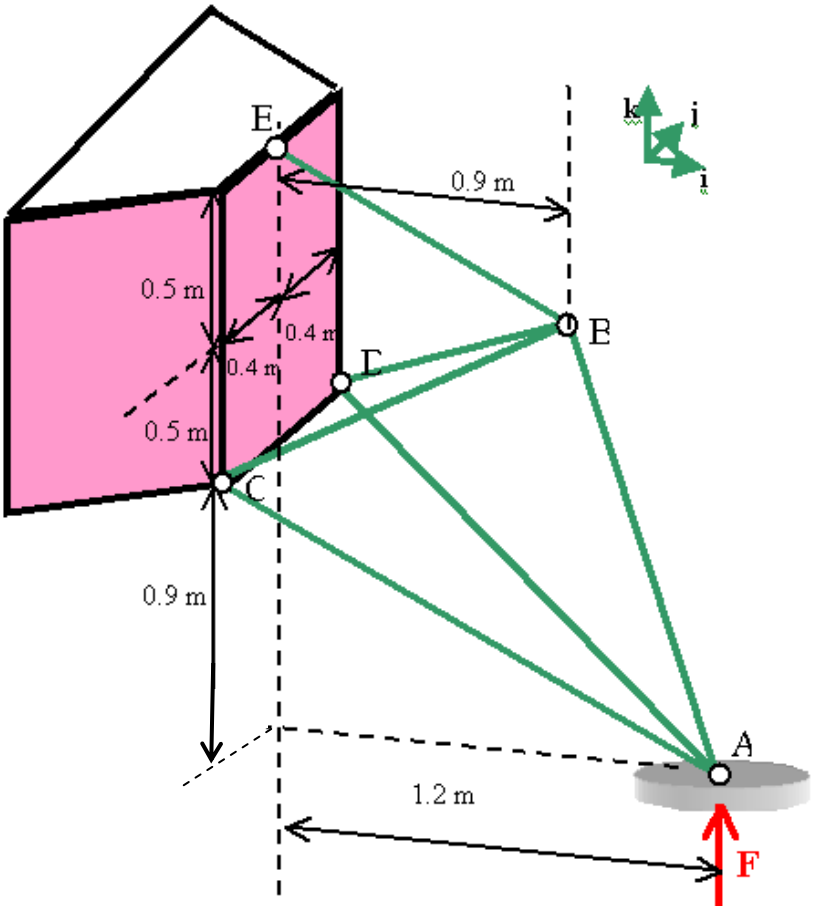
a. Draw free body diagrams for each of the 6 joints. Represent the force in each member as T_{AB}, T_{BC}, etc, with $T_{AB}>0$ corresponding to tension.

b. Determine the force in each member of the bike frame.

c. Which member carries the largest tensile load? Which carries the largest compressive load? Compare the loads in the members with the loads in the single rider bike frame shown below. For this bike frame, all members have equal length.



2. The figure below shows the landing strut of a spacecraft. Neglect the weight of the strut.



a. Find unit vectors parallel to each member, using the basis shown. For members AB, AC, and AD, define the unit vectors so that these vectors point away from point A. For members BC, BD, and BE, define the unit vectors so that they point away from point B.

b. Draw a diagram showing the forces acting at joint A and solve for the internal forces in members AB, AD, and AC.

c. Draw a diagram showing the forces acting at joint B and solve for the internal forces in members BE, BD, and BC.

e. The members are to be made from identical solid aluminum shafts (circular cross section, radius *r*). A member will fail by material yield if its stress (Force/cross-sectional area) meets or exceeds the yield stress σ_y=0.04GPa=4x10^7 Newtons/meter^2. In addition, a member in compression may fail by buckling if the compressive force in that member reaches the critical buckling load $P_{cr}=\pi^3 Er^4/(4L^2)$. Here, *E*=70GPa=7x10^{10} Newtons/meter^2 is Young's Modulus for aluminum. Determine the minimum radius *r* for which no member will fail either by yield or by buckling if the anticipated load *F* is 2.2kN.