Division of Engineering
Brown University

EN3: Introduction to Engineering and Statics

Statics Proficiency Examination, Advanced Section
Tuesday November 18, 2008

NAME:

General Instructions

- No collaboration of any kind is permitted on this examination.
- You may not consult notes or textbooks during the examination.
- Write all your solutions in the space provided. No sheets should be added to the exam.
- Make diagrams and sketches as clear as possible, and show all your derivations clearly. Incomplete solutions will receive only partial credit, even if the answer is correct.
- If you find you are unable to complete part of a question, proceed to the next part.

Please initial the statement below to show that you have read it

"By affixing my name to this paper, I affirm that I have executed the examination in accordance with the Academic Honor Code of Brown University."

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1 (10 points) _____
2 (10 points) _____
3 (10 points) _____
4 (10 points) _____
5 (10 points) _____
Total (50 points)_____

Problem 1 (10 points):

An experiment was designed to determine the elastic modulus of human bone. Three nearly identical bone specimens, of cross-section 2x2 mm^2, were prepared for the tests. Two sections were marked on the bone specimens at a fixed distance apart; the specimens were then subjected to tensile loading of various magnitudes, and the lengths between the marked sections were measured electronically.
The following data was obtained:

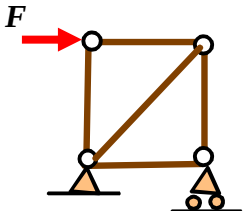
Applied Force, *F* [Newtons]	**Measured Gage Length, *l* [mm]**
0	5.000
240	5.017
480	5.033
720	5.050

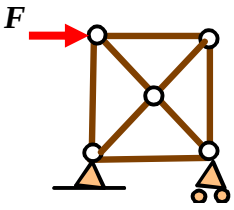
a) Use the data above to plot the stress strain curve for the bone. (4 points)

b) On your curve, label (but do not calculate) the Elastic Modulus (*E*) for bone. What does this value give you an indication of in terms of the mechanical properties of bone? (2 points)

c) How might you determine whether the specimen was tested to failure in this tensile loading scenario? Use and equation and include a brief explanation for full credit. (2 points)

d) Label each of the following as mechanisms, statically determinant, or statically indeterminant. (2 points)





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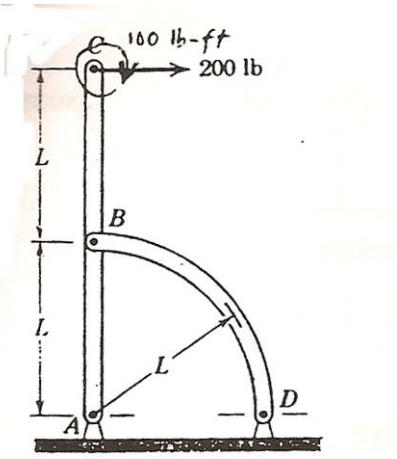
Problem 2 (10 points):

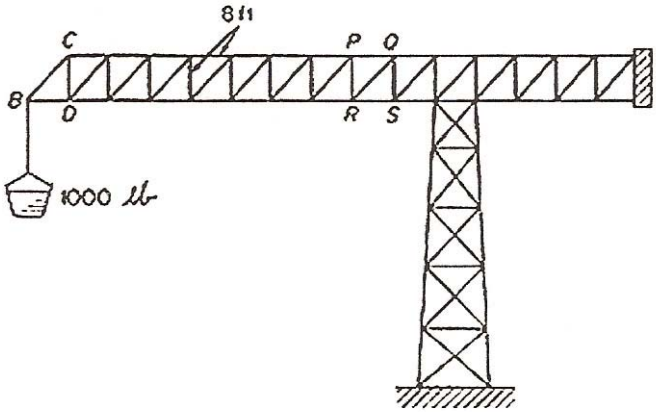
a.) Using static equilibrium, show that member BD of the frame shown below is a two force member. ***Hint: you only need <u>one</u> FBD to answer this question.*** (4 points)



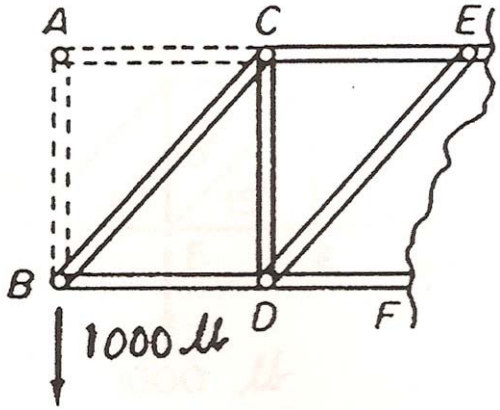
b.) Solve for the force in member BD. (6 points)

Problem 3 (10 points):

a.) A heavy-weight lift as shown in the sketch below is used at a construction site. Assume that it is a pin-jointed truss. All vertical and horizontal truss members have a length of 8ft. Find the loads in members PQ, RP, and RS. (7 points)

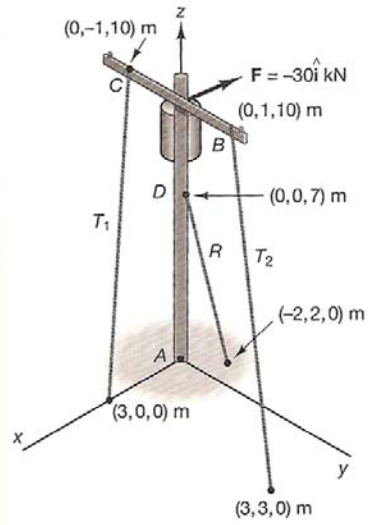


b.) For the same truss that is pictured above, the left end of the truss is enlarged below. Two members AB and AC are added (denoted by the dotted lines). Explain why members AB and AC would not make any difference in loading of the rest of the truss under the 1000lb loading scenario shown. (3 points)



Problem 4 (10 points):

A power line pole of negligible weight is held in place by a ball-and-socket connection at *A*, two cables at *C* and *B*, and a rod at *D*. Your goal is to determine the tensions T_1 and T_2.



You do not need to solve this problem. For full credit:

a.) Draw a complete FBD (2 points);
b.) Set up all force equations (3 points);
c.) Set up (as a vector expression, with position and force vectors specified) the moment equation about point C (3 points); and
d.) Solve for the moment contributed by the reactions at A about point C. (2 points)

Problem 5 (10 Points):

A man is holding a load of 16 lb with one arm as shown below. The biceps muscle (labeled TB) is the main contributor in this activity. Determine the magnitude of the joint reaction force, *J*, at the frictionless elbow joint (idealized at point O). Assume that the weight of the forearm is negligible compared to the 16 lb load. ***Hint: How might you idealize a frictionless elbow joint in 2D?***