Name: _____ SID: _____

ME C85 / CE C30 Midterm 1 Exam
Monday October 4, 2010

Please…

1. Read through the test before starting.
2. If you're out of space, write on back side and add a note in your solution referring to back side; *do not detach any pages or add any extra pages.*
3. Be mindful of the time and pace yourself. 50 minutes goes by very quickly.
4. Try not to leave anything blank. You will not win if you do not play.
5. Uphold academic integrity: don't peak!

Good luck!

	Scored Points	Possible Points	Suggested Time (minutes)
Problem 1		35	15
Problem 2		25	10
Problem 3		40	18
Total		100	

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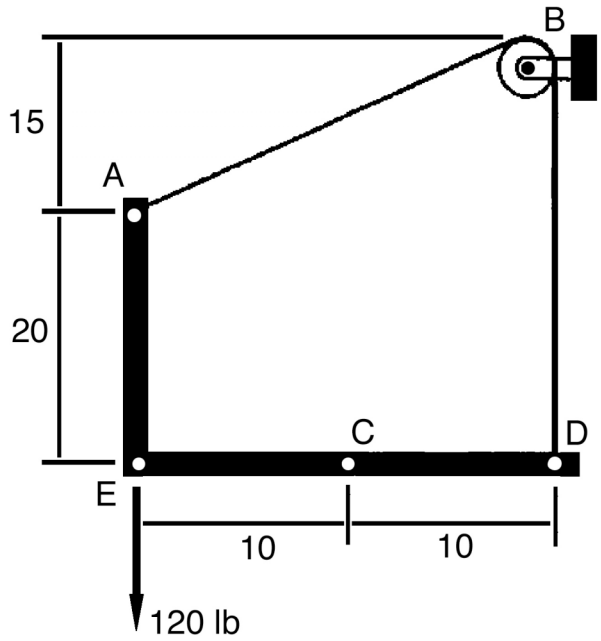
PROBLEM 1: 35pts



The rigid bracket AECD is loaded by a 120 lb downward force applied at point E, and is supported by cable ABD, which itself is supported by a frictionless pulley hinged at point B. This system is not in static equilibrium since other supporting loads are not shown. Neglecting the weights of the bracket, cable, and pulley:

A. (15pts) Draw a free body diagram of only the bracket. Assuming — for this part of the problem — that the tension in the cable is 120 lbs, find the magnitude and direction of the statically equivalent resultant (force) of all the forces acting on the bracket.

B. (5 pts) What is the equivalent force-couple system if the resultant force of part A is placed at point C?

C. (5 pts) Where along the line ED should the resultant force of part A be applied so that the couple of the equivalent force-couple system is zero?

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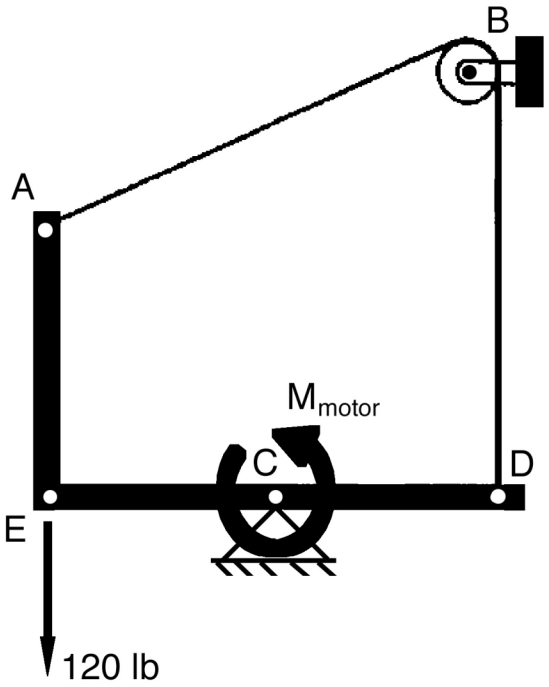

D. (10 pts) To keep the system in static equilibrium, a hinge joint and motor are both added at point C, as shown, the motor applying a pure moment M_{motor}. The motor is set to apply a sinusoidally varying moment $M_{motor} = 2400\sin(2\pi t)$, in units of lb-ft, positive moments acting counter-clockwise, and with time t in seconds. For this situation, the force in the cable will adjust to keep the system in static equilibrium. Develop an expression for the force in the cable as a function of time. (Ignore any inertial effects.)

******** See page 10 for a 5-pt bonus question related to this question ******

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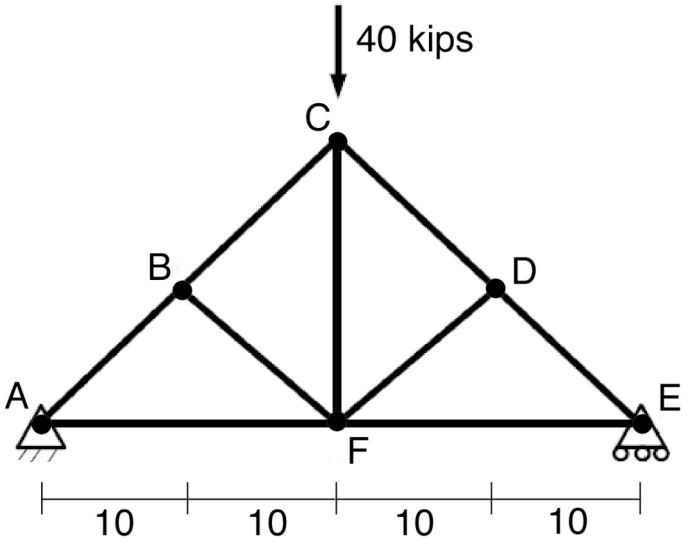
PROBLEM 2: 25pts



A. (15 pts) This simple truss structure consists of a set of trusses, all connected to each other by pin joints, that is supported by a pinned connection at point A and a roller connection at point E. The four triangles that make up the overall truss are similar isosceles triangles (angles BAF, AFB are 45 degrees and angle ABF is 90 degrees) and the structure is symmetrical about vertical truss CF. An external downward force of 40 kips is applied at point C as shown. Assuming this truss structure is in a state of static equilibrium, use the method of joints to determine the magnitude of the forces in members CB and CF and indicate if these are tensile or compressive.

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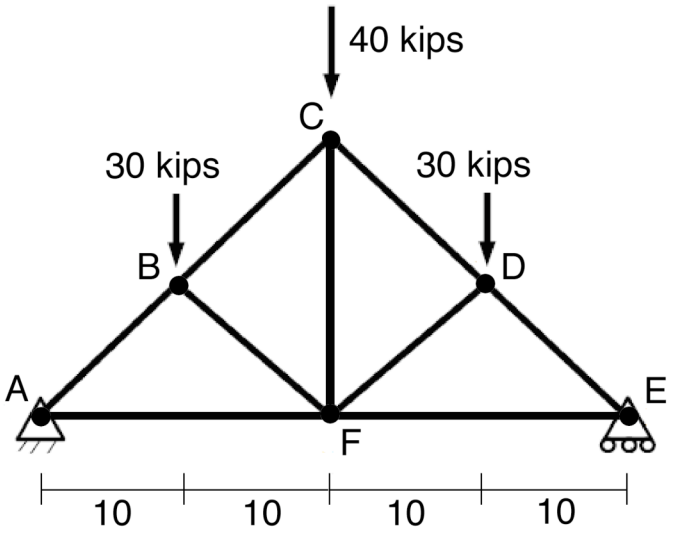

B. (10 pts) The truss structure is now loaded by additional external downward forces at B and D as shown; all else is unchanged. Use the method of sections to find the magnitude of the force in member AB.

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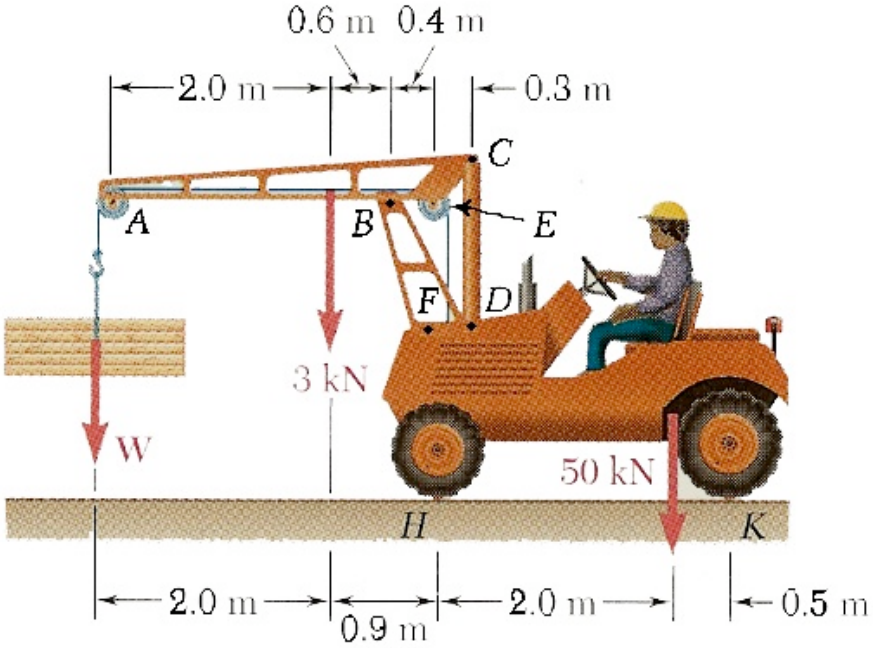
PROBLEM 3: 40pts



A load of lumber of weight *W* is raised as shown by a mobile crane. At this instant, the wheel at *H* is locked and the wheel at *K* is free to rotate. The external load *W* is attached via a hook to a cable that is supported by frictionless pulleys A and E, attached to boom ABC, and the cable is secured to a motorized winch under the hood. Boom *ABC* is supported by both boom *BF* and rod *CD* via hinge joints at *B* and *C*, respectively. The piston rod *CD* is also hinged at *D* and is used to change the angle of boom ABC by pivoting the boom about hinge B; at this instant, AB is horizontal and CD is vertical, as shown. The weight of the boom *ABC* and the weight of the vehicle body are 3kN (acting at 2.0 m from *A,* as shown) and 50kN (acting 2.0 m from *H,* as shown), respectively. All dimensions are in meters.

A. (10 pts) Determine the maximum operating load *W* that can be sustained without tip over.

B. (5 pts) For an assumed load W of 25 kN, determine the tension in the cable.

C. (10 pts) What are the magnitudes and directions of the reaction forces in the hinges at A and E that support the pulleys?

D. (15 pts) Based on a free body diagram analysis of boom ABC, determine the magnitude of the force in rod CD.

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BONUS QUESTION (+ 5 pts)
For question #1D: do you notice anything unusual about the solution? Provide a one-sentence comment on this.