ME 270 – Spring 2014 Exam 1 **NAME (Last, First): _____**

Please review the following statement:

I certify that I have not given unauthorized aid nor have I received aid in the completion of this exam.

Signature: _____

INSTRUCTIONS

Begin each problem in the space provided on the examination sheets. If additional space is required, use the white lined paper provided to you.

Work on one side of each sheet only, with only one problem on a sheet.

Each problem is worth 20 points.

Please remember that for you to obtain maximum credit for a problem, it must be clearly presented, i.e.

- The coordinate system must be clearly identified.
- Where appropriate, free body diagrams must be drawn. These should be drawn separately from the given figures.
- Units must be clearly stated as part of the answer.
- You must carefully delineate vector and scalar quantities.

If the solution does not follow a logical thought process, it will be assumed in error.

When handing in the test, please make sure that all sheets are in the correct sequential order and make sure that your name is at the top of every page that you wish to have graded.

Instructor's Name and Section:

Sections: J Jones 9:30-10:20AM P Sojka 1:30-2:20PM J Silvers 3:30-4:20PM
J Jones Distance Learning

Problem 1 _____

Problem 2 _____

Problem 3 _____

Total _____

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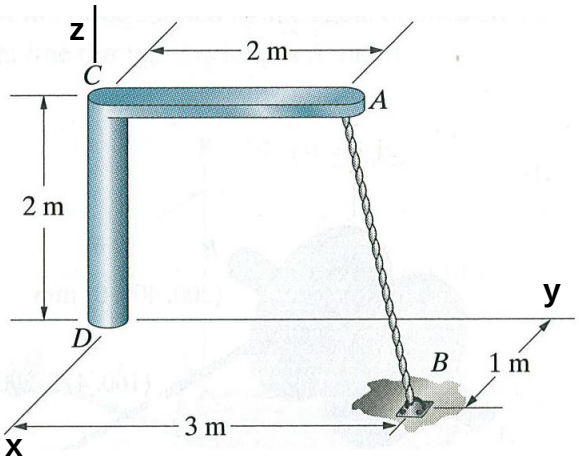
PROBLEM 1 (20 points) – Prob. 1 questions are all or nothing.

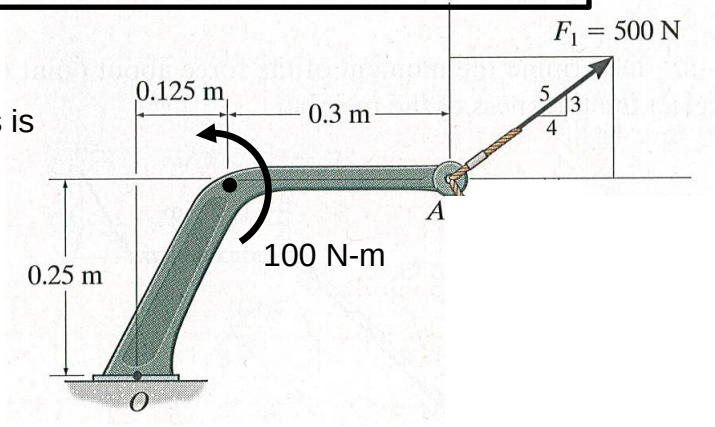
1A. Cable AB applies a 2kN tension on bar DCA. Determine the force vector $\bar{F}_{AB}$ and the moment vector due to this force about point C ($\bar{M}_C$).



$\bar{F}_{AB}$ = (2pts)

$\bar{M}_C$ = (3pts)

1B. Bar OA is loaded with a 500N force and a 100N-m couple as shown. Determine the equivalent force-couple system at base O in vector form. (**Hint**- This is <u>not</u> a static equilibrium problem.)



$(\bar{F})_{eq}$ = (2pts)

$(\bar{M}_o)_{eq}$ = (3pts)

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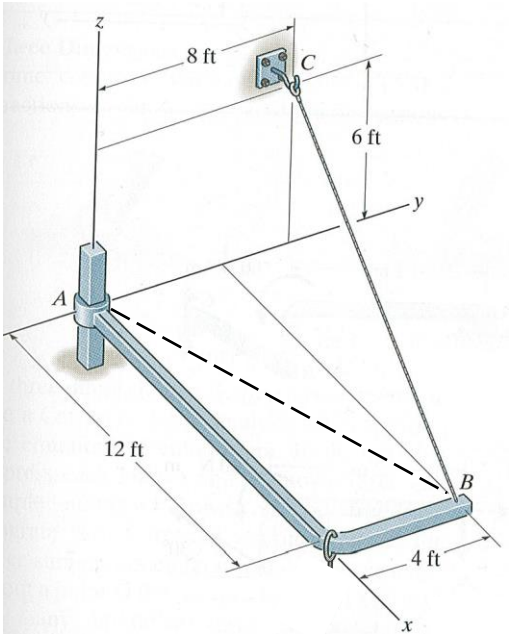
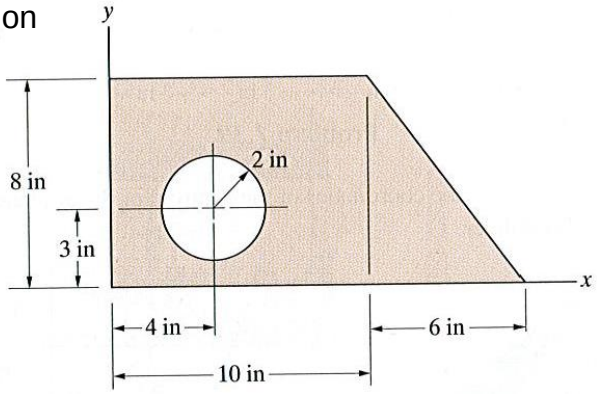
1C. Cable BC exerts a tension of 100 lb on angled Bar AB.
The force in cable BC is given by $\bar{F}_{BC} = -85.7\bar{i} + 28.6\bar{j} + 42.9\bar{k}$ lbs.
Determine the unit vector $\bar{u}_{BA}$ and the magnitude of the projection of $\bar{F}_{BC}$ along the dotted line BA.



$\bar{u}_{BA} =$ (2pts)

$\left|\bar{P}roj\right| =$ (3pts)

1D. Determine the total area and x-centroid of the shaded region with respect to the x-y coordinate system provided.



$A_{tot} =$ (2pts)

$\bar{x} =$ (3pts)

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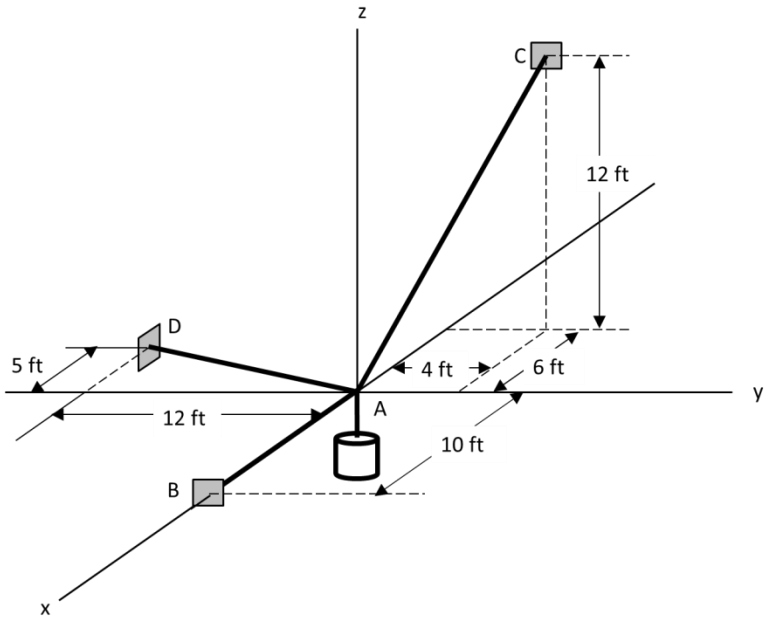
PROBLEM 2. (20 points)



GIVEN: A 108 lb cylinder is suspended from three cables attached to a ring at point A, and is in static equilibrium. Cable AB runs along the x-axis and cable AD lies in the x-y plane.

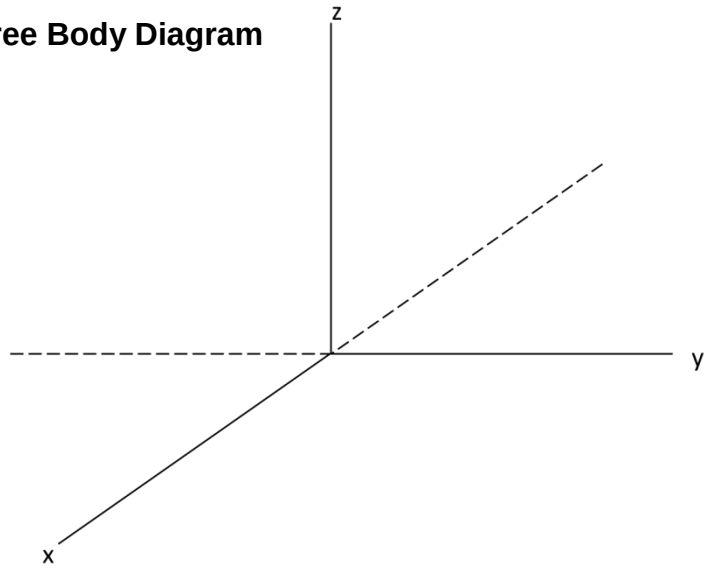
FIND:

a) On the axes provided, draw a free body diagram of ring A. (4 pts)

b) Write vector expressions for the forces in cables AB, AC and AD in terms of their unknown magnitudes and their known unit vectors. (6 pts)

c) Using your equations of static equilibrium, determine the magnitude of the forces in cables AB, AC, and AD. (10 pts)

Free Body Diagram



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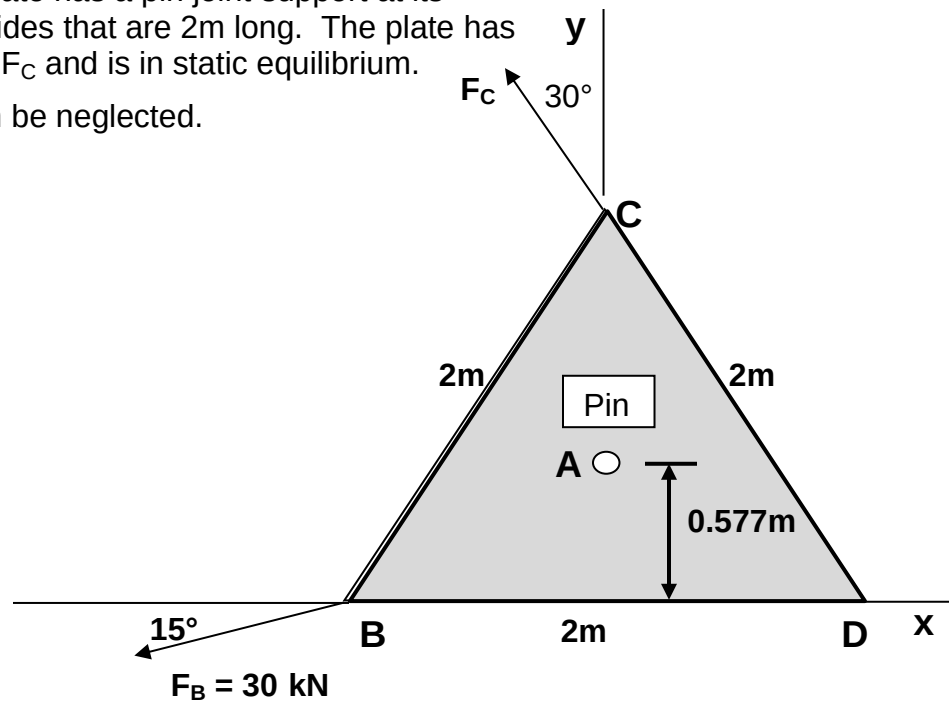
PROBLEM 3. (20 points)

GIVEN: The equilateral triangular plate has a pin joint support at its geometric center (A) and sides that are 2m long. The plate has two external forces F_B and F_C and is in static equilibrium.

The weight of the plate can be neglected.



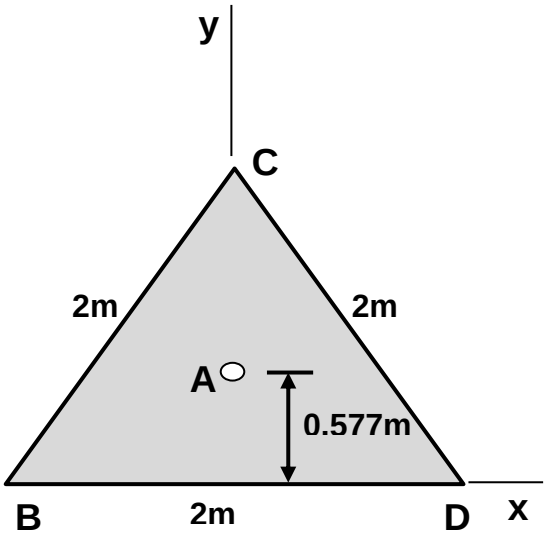
FIND:

a) Sketch a free body diagram of the triangular plate (3 pts)

b) Determine the force F_c needed to hold the plate in static equilibrium. (9 pts)

c) Determine the reactions at pin A. (8 pts)

a) Free Body Diagram



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ME 270 Exam 1 Equations

Distributed Loads

$$F_{eq} = \int_0^L w(x)\,dx$$

$$\bar{x}F_{eq} = \int_0^L x\, w(x)\,dx$$

Centroids

$$\bar{x} = \frac{\sum_i x_{ci} A_i}{\sum_i A_i}$$

$$\bar{y} = \frac{\sum_i y_{ci} A_i}{\sum_i A_i}$$

In 3D, $$\bar{x} = \frac{\sum_i x_{ci} V_i}{\sum_i V_i}$$

Centers of Mass

$$\tilde{x} = \frac{\sum_i x_{cmi} \rho_i A_i}{\sum_i \rho_i A_i}$$

$$\tilde{y} = \frac{\sum_i y_{cmi} \rho_i A_i}{\sum_i \rho_i A_i}$$

Spring 2014 Exam 1 Solutions

1A. $\bar{F}_{AB} = 0.816\bar{i} + 0.816\bar{j} - 1.63\bar{k}$ kN $\quad \bar{M}_C = -3.26\bar{i} - 1.63\bar{k}$ kN-m

1B. $(\bar{F})_{eq} = 400\bar{i} + 300\bar{j}$ N $\quad (\bar{M}_o)_{eq} = 128\bar{k}$ N-m

1C. $\bar{u}_{BA} = -0.949\bar{i} - 0.316\bar{j}$ $\quad |\bar{P}roj| = 72.3$ lbs

1D. $A_{tot} = 91.4$ in^2 $\quad \bar{x} = 6.98$ in

2A. Free Body Diagram

2B. $\bar{T}_{AB} = T_{AB}\bar{i}$ $\quad \bar{T}_{AC} = T_{AC}(-0.429\bar{i} + 0.286\bar{j} + 0.857\bar{k})$

$\bar{T}_{AD} = T_{AD}(-0.385\bar{i} - 0.923\bar{j})$

2C. $T_{AC} = 126$ lbs $\quad T_{AD} = 39.0$ lbs $\quad T_{AB} = 69.1$ lbs

3A. Free Body Diagram

3B. $\therefore F_c = 15.5$ kN

3C. $A_x = 36.7$ kN $\quad A_y = -5.66$ kN