ME 270 – Spring 2016 Exam 1 **NAME (Last, First):** ________________________________

***Group #*____________**

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 only authorized exam calculator is the TI-30IIS
- The allowable exam time for Exam 1 is 70 minutes.
- 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 J Gibert 1:30-2:20PM I Bilionis 3:30-4:20PM
J Jones Distance Learning

Problem 1 __________

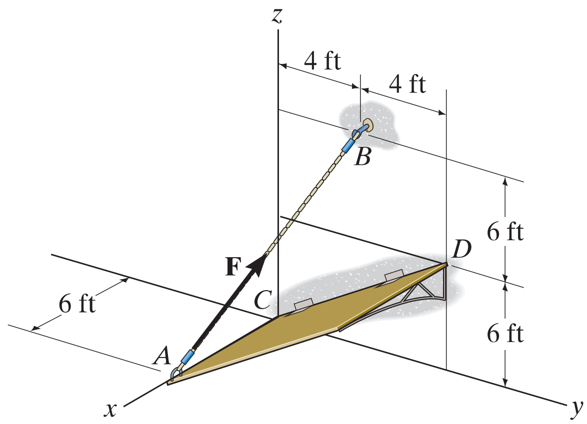
Problem 2 __________

Problem 3 __________

Total ______________

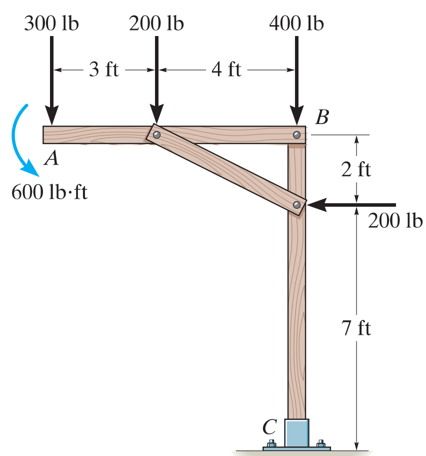
PROBLEM 1 (20 points) – Prob. 1 questions are all or nothing.

1A. Determine the <u>force vector expression</u> for cable AB (i.e., $\overrightarrow{F_{AB}}$) assuming the tension in the cable is 700lbs. Determine the moment of $\overrightarrow{F_{AB}}$ about point C (i.e., the origin of the coordinate axes).



$\vec{F}_{AB} =$	(2 pts)
$\vec{M}_{\mathrm{C}} =$	(3 pts)

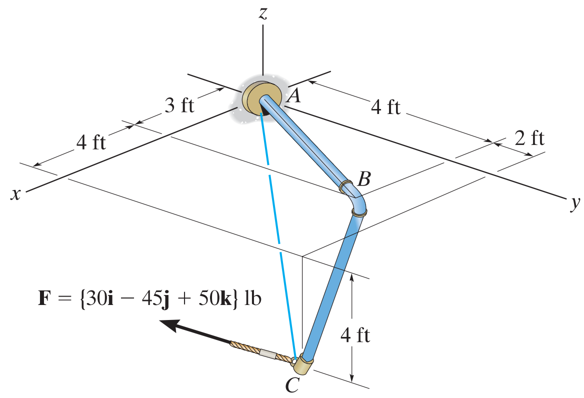
1B. For the system shown, determine the <u>equivalent force-couple system</u> at the base at C. Express the resultants in <u>vector form</u>. (<u>Hint</u>: This is not a static equilibrium problem.)



$\vec{F}_{\mathrm{eq}} =$	(2 pts)
$\vec{M}_{\mathrm{C,eq}} =$	(3 pts)

1C. The force on the rope attached at C is $\vec{F} = (30\vec{i} - 45\vec{j} + 50\vec{k})$lb.

(i) Find the unit vector $\vec{u}_{CB}$ that points from C to B.
(ii) Find the magnitude F_{CB} of the projection of $\vec{F}$ in the direction of the unit vector $\vec{u}_{CB}$.

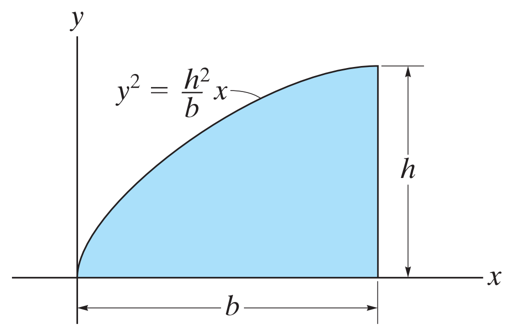


$\vec{u}_{CB} =$	(3 pts)
$F_{CB} =$	(2 pts)

1D. For the shaded area shown determine:

(i) the area A
(ii) the x-centroid.

Note: Keep the answer in terms of constants b and h.

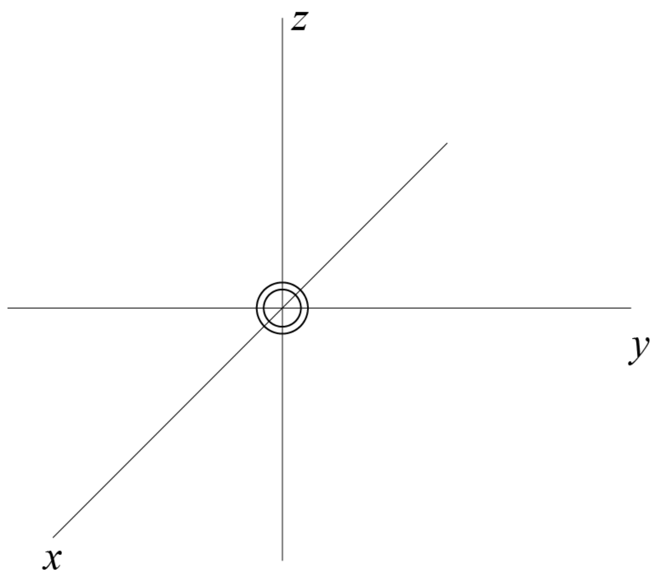


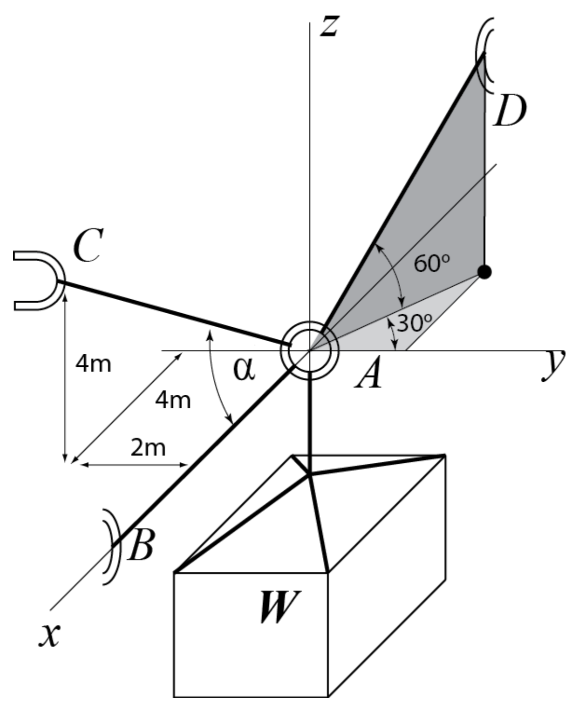
$A =$	(2 pts)
$\bar{x} =$	(3 pts)

PROBLEM 2 (20 points)

GIVEN: A ring holds a crate of weight ***W*** equal to 400N. Addtionally, the ring is held in place by cables *AD, AC,* and *rigid rod AB,* which acts along the *x*-axis as shown. Answer the following:

a) In the space below draw a FBD of the ring **(**4 pts**).**





b) Resolve the tension in ropes *AB*, *AC* and *AD* in Cartesian vector form.

$\vec{T}_{AB} = \lvert\vec{T}_{AB}\rvert[$ ________ $\hat{\imath}$ + ________ $\hat{\jmath}$ + ________ $\hat{k}]$	(2 pts)
$\vec{T}_{AC} = \lvert\vec{T}_{AC}\rvert[$ ________ $\hat{\imath}$ + ________ $\hat{\jmath}$ + ________ $\hat{k}]$	(2 pts)
$\vec{T}_{AD} = \lvert\vec{T}_{AD}\rvert[$ ________ $\hat{\imath}$ + ________ $\hat{\jmath}$ + ________ $\hat{k}]$	(2 pts)

c) Find the magnitude of the tensions in cable *AB*, *AC*, and *AD*.

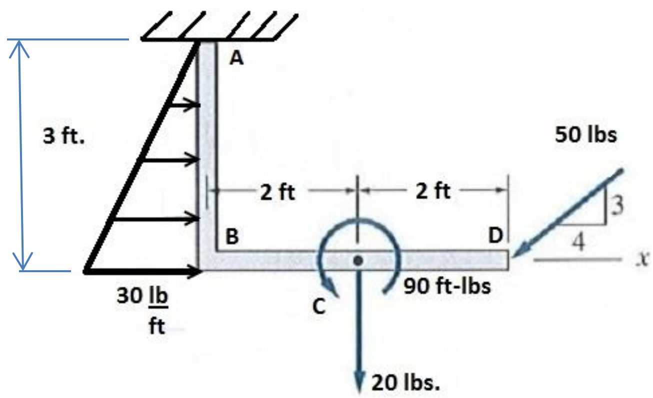
$\left\|\vec{T}_{AB}\right\| =$	(2 pts)
$\left\|\vec{T}_{AC}\right\| =$	(2 pts)
$\left\|\vec{T}_{AD}\right\| =$	(2 pts)

d) Find the angle α *between cables AB and AC* (4 pts).

$\alpha =$	(4 pts)

PROBLEM 3. (20 points)

GIVEN: Angled bar ABCD is loaded as shown and held in static equilibrium by a fixed support at A.

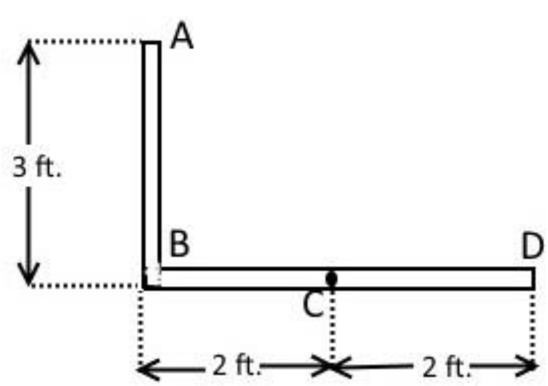


FIND:

a) Determine the equivalent force for the distributed load along the vertical bar (AB) and its location from support A. (5 pts)

F_{eq} =	(3 pts)
d_{fromA} =	(2 pts)

b) On the sketch provided, complete the free-body diagram of bar ABCD using the equivalent force computed above. (3 pts)



c) Determine the reactions at the fixed support A required to hold bar ABCD in static equilibrium. (10 pts)

M_A =	(4 pts)
A_x =	(3 pts)
A_y =	(3 pts)

d) If the 90 ft-lb couple were shifted toward point B, what impact would this have on the reactions at A? (2 pts)

Reactions would = (increase, decrease, remain the same) (Circle One)

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

$$\bar{x} = \frac{\int x_c dA}{\int dA}$$

$$\bar{y} = \frac{\int y_c dA}{\int dA}$$

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

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

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

Centers of Mass

$$\tilde{x} = \frac{\int x_{cm} \rho dA}{\int \rho dA}$$

$$\tilde{y} = \frac{\int y_{cm} \rho dA}{\int \rho dA}$$

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

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

Final Answers

1A) $\bar{F}_{AB} = -301\bar{\imath} + 203\bar{\jmath} + 602\,\bar{k}\ lbs$ $\bar{M}_c = -3612\,\bar{\jmath} + 1218\,\bar{k}\ lbs - ft$

1B) $\bar{F}eq = -200\bar{\imath} - 900\bar{\jmath}\ lbs$ $\bar{M}_{C,eq} = 4900\bar{k}\ lbs - ft$

1C) $\bar{u}_{CB} = -0.67\bar{\imath} - 0.33\bar{\jmath} + 0.67\bar{k}$ F_{CB} = 28.15 lbs

1D) A = (2/3) hb $\bar{x} = \left(\frac{3}{5}\right) b$

2A) FBD

2B) $\bar{T}_{AB} = T_{AB}\,(\,1\bar{\imath}\,)$ $\bar{T}_{AC} = T_{AC}\,(\,0.67\bar{\imath} - 0.33\bar{\jmath} + 0.67\bar{k}\,)$ $\bar{T}_{AD} = T_{AD}\,(\,-0.25\bar{\imath} + 0.43\bar{\jmath} + 0.87\bar{k}\,)$

2C) T_{AB} = -142N (Treat as strut rather than a cable) T_{AC} = 300N T_{AD} = 231 N

2D) α = 48 degrees

3A) F_{eq} = 45 lbs d_{fromA} = 2 ft 3B) FBD

3C) M_A = 100 ft-lbs A_x = -5 lbs A_y = 50 lbs

3D) Reaction would Remain the Same