ME 270 – Fall 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 only authorized exam calculator is the TI-30IIS
- The allowable exam time for Exam 1 is 65 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 Hylton 8:30-9:20AM	J Jones 9:30-10:20AM	E Nauman 11:30AM-12:20PM
	J Seipel 12:30-1:20PM	I Bilionis 2:30-3:20PM	M Murphy 9:00-10:15AM
	Z Shen 4:30-5:20PM	J Jones Distance Learning	

Problem 1 __________

Problem 2 __________

Problem 3 __________

Total ______________

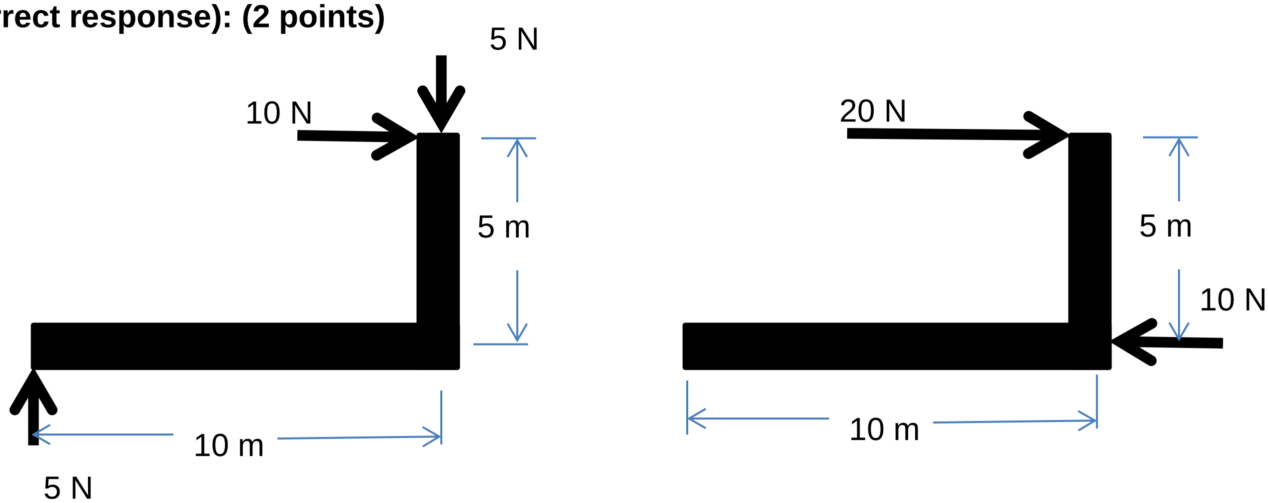
PROBLEM 1 (20 points) – Prob. 1 questions are all or nothing.

1A. Determine the angle (θ) between two position vectors given as:

$$\vec{R}_1 = 0.5\,\hat{\imath} + 0.5\hat{\jmath} + 0.707\hat{k}$$
$$\vec{R}_2 = 0.5\,\hat{\imath} - 0.5\hat{\jmath} + 0.707\hat{k}$$

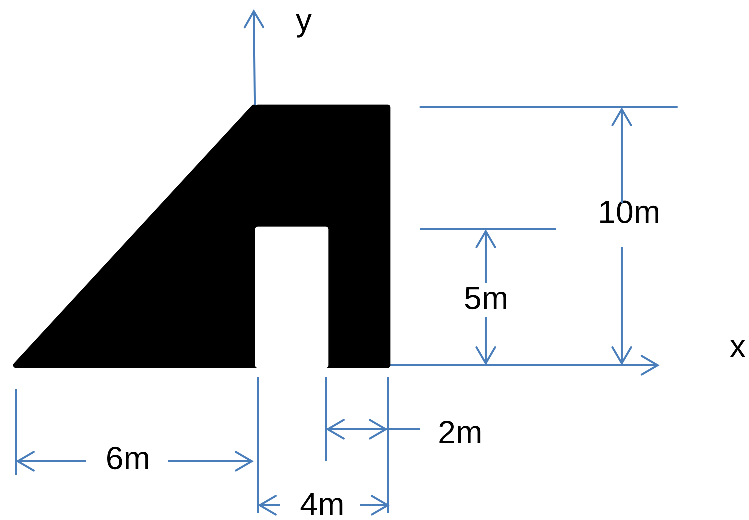
θ = ___________________________ (3 points)

1B. Please indicate if the two loadings are Equivalent Systems shown below (Circle the correct response): (2 points)



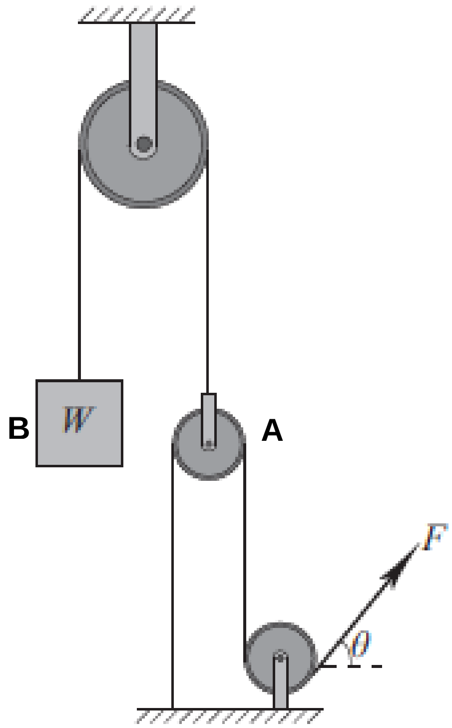
Yes they are equivalent **No** They are not equivalent

1C. Determine the Area (A) and the centroid $\bar{x}$ for the shape below (5 points):

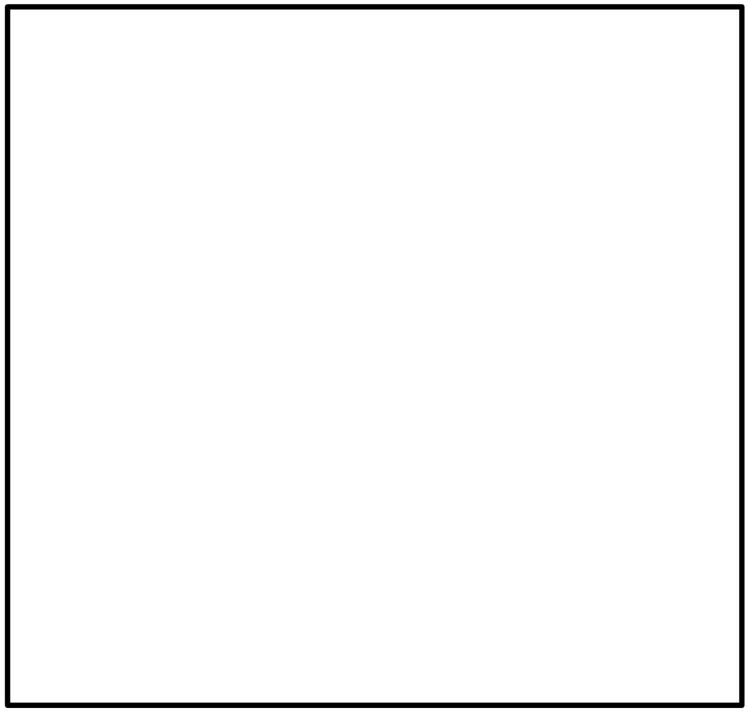


A =	(2pts)
$\bar{x}$ =	(3pts)

1D. Draw a free body diagram of the free pulley (A) and determine the force F required to keep the system in equilibrium if the block weighs 350 lbs (B). You may assume that $\theta = 60^{o}$. (6 points)

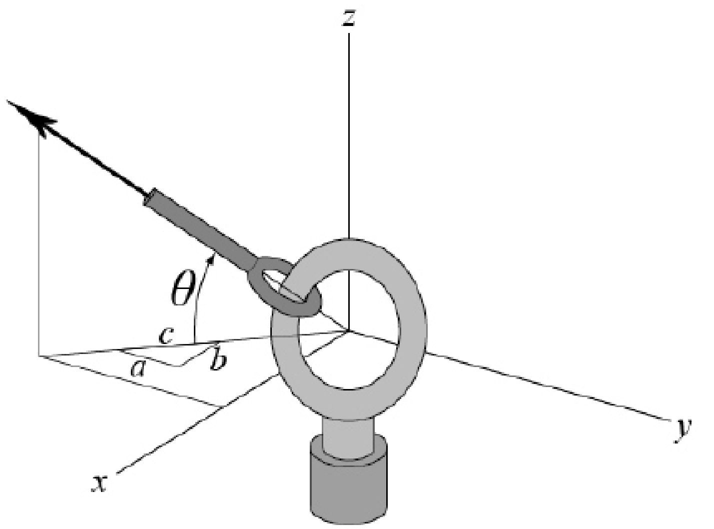


Free Body Diagram



Force required: ________________________________

1E. If the force vector shown below has x, y, and z components of 300 N, 400N, and 800N respectively, write it in vector form. Then determine the scalar component of the force in the direction defined by, **u** = 0.250**i** + 0.968**j** (4 points)



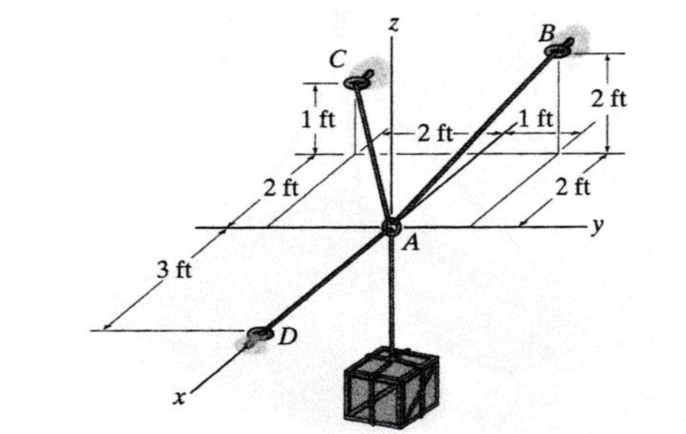
Vector form: ____________________________________ (2 pts)

Scalar Component: ______________________________ (2 pts)

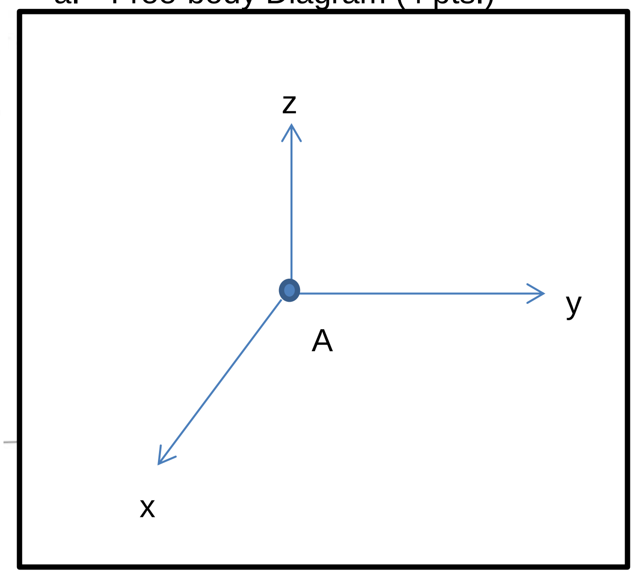
PROBLEM 2. (20 points)

GIVEN: The crate weighs 450-lb and is supported by three cables as shown in the figure below.
Please place your responses in the answer boxes provided and show all your work!

a. Draw a free-body diagram for point A (4 points).
b. Express the tension in each cable in terms of the unit vector and its unknown magnitude (6 points).
c. Determine the magnitude of the tension in each cable (8 points).
d. What is the maximum weight for a crate that can be supported if the maximum tension in any cable is 900-lb? (2 points)



a. Free-body Diagram (4 pts.)



b. Express tensions in terms of the unknown tensions and their unit vectors; in other words, provide the unit vectors. The weight is provided as an example of the format (6 pts.)

$$\vec{T}_{AB} = T_{AB}[\qquad\qquad\qquad\qquad\qquad]\ lb.$$

$$\vec{T}_{AC} = T_{AC}[\qquad\qquad\qquad\qquad\qquad]\ lb.$$

$$\vec{T}_{AD} = T_{AD}[\qquad\qquad\qquad\qquad\qquad]\ lb.$$

$$\vec{W}_{Crate} = 450[\ \ 0\,\hat{\imath} \quad + \quad 0\,\hat{\jmath} \quad - \ 1\,\hat{k}\ \ ]\ lb.$$

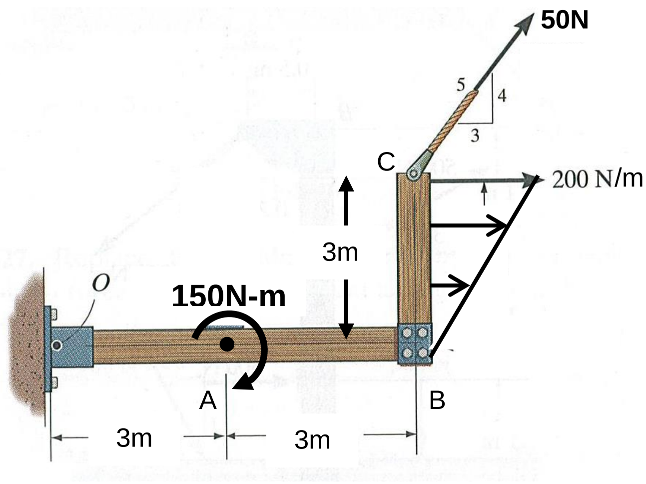
c. **Magnitude** of the tension in each cable for crate weighing 450-lb. (8 pts.)

$T_{AB} =$ ______________________________ lb.
$T_{AC} =$ ______________________________ lb.
$T_{AD} =$ ______________________________ lb.

d. What is the maximum allowable weight for the crate if the maximum tension in any one of the cables is 900-lb? (2 pts.)

W_{crate} = ______________________________ lb.

PROBLEM 3. (20 points)



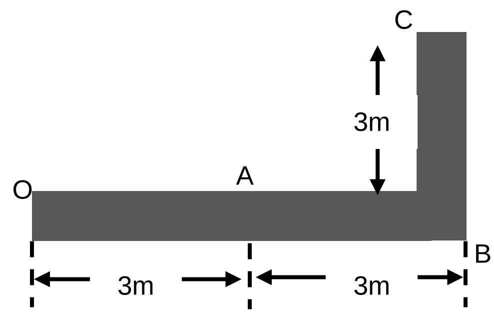
GIVEN: Angled bar OABC is loaded with a point couple at A, a distributed load from B to C and a point load at C as shown. The bar is held in static equilibrium by a fixed support at O.

FIND:

a) For the distributed load, determine the magnitude of the equivalent force and the location of the force above the x-axis. (4 pts)

F_{eq} =	(2pts)
y_{eq} =	(2pts)

b) On the artwork provided, complete the free-body diagram including the equivalent force (above) and all other applied forces and moments and all reactions at the support. (3 pts)



c) Using your free-body diagram, determine the magnitudes of the reactions at support O that are necessary to hold the bar in static equilibrium. (11pts)

O_x =	(3pts)
O_y =	(3pts)
M_o =	(5pts)

d) If the applied 150N-m couple at A were shifted toward point B, what effect would this have on the moment reaction at O? (2 pts)

M_o would (increase, decrease, remain the same) (Circle one) (2pts)

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

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

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

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

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

Buoyancy

$$F_B = \rho g V$$

Fluid Statics

$$p = \rho g h$$

$$F_{eq} = p_{avg}(Lw)$$

ME 270 Exam 1 Solutions – Fall 2014

1A. $\theta = 60^o$

1B. Yes they are equivalent.

1C. $A = 60m^2$ $\bar{x} = \frac{1}{6}m = 0.167m$

1D. FBD Force required = 175 lbs

1E. Vector Form = $300\bar{i} - 400\bar{j} + 800kN$ (or $300\bar{i} + 400\bar{j} + 800\bar{k}N$)

Scalar Component = 312N (or 462N)

2A. FBD

2B. $\vec{T}_{AB} = T_{AB}[-\frac{2}{3}\bar{i} + \frac{1}{3}\bar{j} + \frac{2}{3}\bar{k}]$ $\vec{T}_{AC} = T_{AC}[-\frac{2}{3}\bar{i} - \frac{2}{3}\bar{j} + \frac{1}{3}\bar{k}]$

$\vec{T}_{AD} = T_{AD}[\bar{i} + 0\bar{j} + 0\bar{k}]$

2C. $T_{AB} = 540$ lb. $T_{AC} = 270$ lb. $T_{AD} = 540$ lb.

2D. $W_{crate} = 750$ lb.

3A. $F_{eq} = 300$ N $y_{eq} = 2$m (above x-axis)

3B. FBD

3C. $O_x = -330$ N $O_y = -40$ N $M_o = +600$ N-m

3D. M_o would remain the same.