ME 270 – Fall 2016 Exam 1 **NAME (Last, First):** ______________________________

Please indicate your group number ___________

Instructor's Name and Section:

Circle One: J Jones 9:30-10:20AM I Bilionis 1:30-2:20 M Murphy 3:30-4:20PM
D Hoyniak 11:30-12:20 J Ackerman 2:30-3:20 A Buganza Tepole 4:30-5:20
V Zeinoddini Meimand 8:30-9:20 J Jones Distance Learning

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.

Problem 1 __________

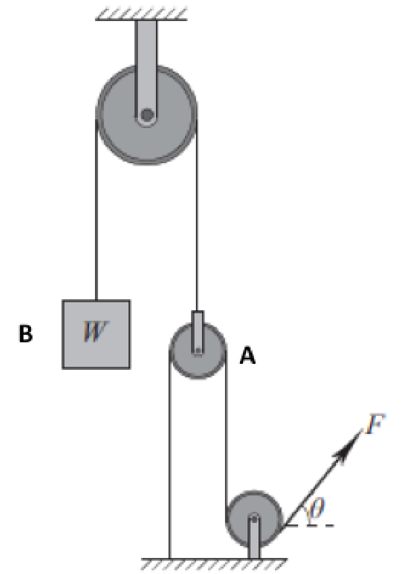
Problem 2 __________

Problem 3 __________

Total ______________

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

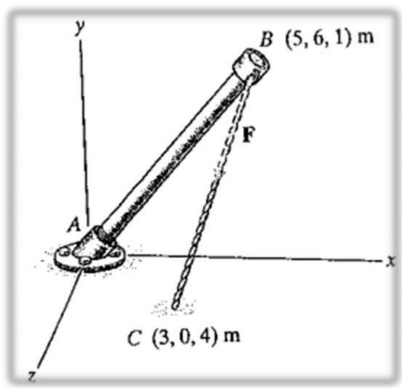
1A. Draw a free body diagram of the free pulley (A) and determine the force F required to keep the system in equilibrium if the block (B) weighs 350 lbs. You may assume that θ =60°. (6 points)



Free Body Diagram (2 pts)

Force Required:	(4 pts)

1B. Cable BC exerts a force $\vec{F} = (-2.86\hat{i} - 8.57\hat{j} + 4.28\hat{k})kN$ on the bar AB at B.

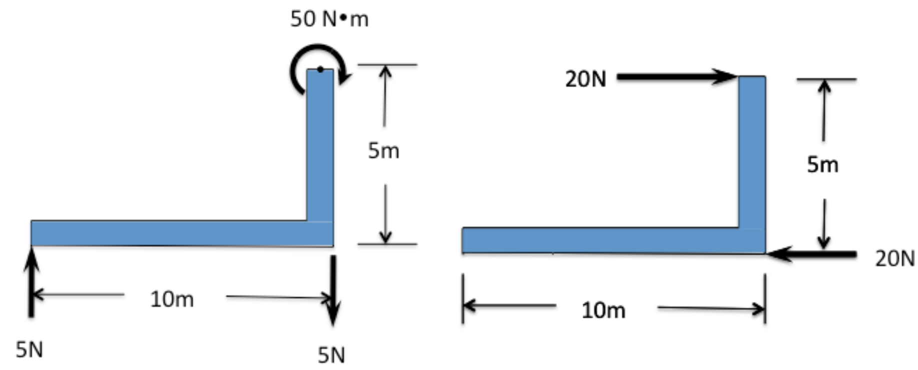


(i) Determine the unit vector $\vec{u}_{AB}$ that points from A towards B.

(ii) Find the magnitude F_{AB} of the projection of $\vec{F}$ in the direction of the unit vector $\vec{u}_{AB}$.

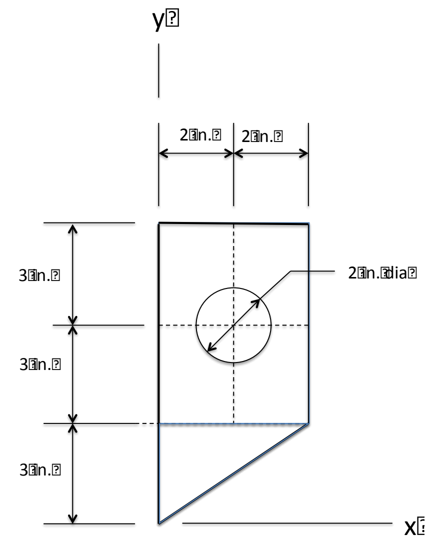
$\bar{u}_{AB} =$	(3 pts)
$\mathcal{F}_{AB} =$	(3 pts)

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



Circle One:	Yes they are equivalent	No they are not equivalent	(2 pts)

1**D.** Determine the Area (A) and the centroid location $(\bar{x}, \bar{y})$ for the shape below using the coordinate frame shown (6 points).

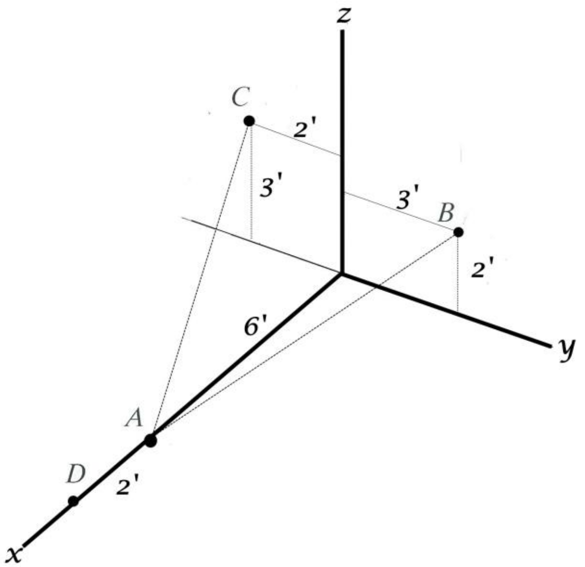


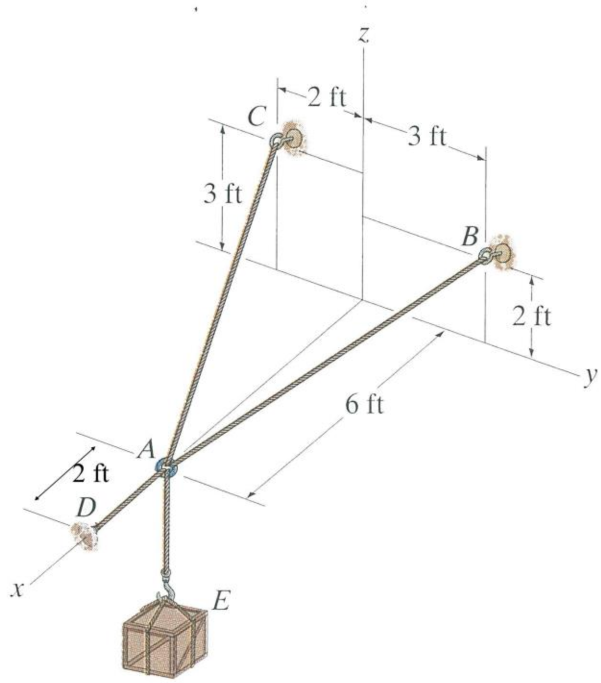
PROBLEM 2. (20 points)

$A =$	(2 pts)
$(\bar{x}, \bar{y}) =$	(4 pts)

GIVEN: A 150-lb crate (E) is supported by cables AB, AC, and AD as shown.

FIND: a) On the diagram below, show a complete free-body diagram of the cable system (2 pts):





b) Write the tension in cables AB, AC, and AD in vector form (an <u>unknown</u> magnitude multiplied by a <u>known</u> unit vector) (3 pts):

$\overline{T_{AB}} = T_{AB}$ (________ $\bar{\imath}$ + ________ $\bar{\jmath}$ + ________ $\bar{k}$) lbs.	(1 pt)
$\overline{T_{AC}} = T_{AC}$ (________ $\bar{\imath}$ + ________ $\bar{\jmath}$ + ________ $\bar{k}$) lbs	(1 pt)
$\overline{T_{AD}} = T_{AD}$ (________ $\bar{\imath}$ + ________ $\bar{\jmath}$ + ________ $\bar{k}$) lbs	(1 pt)
Example: $\overline{W_E}$ = 150 $(0\,\bar{\imath} + 0\,\bar{\jmath} + (-1)\,\bar{k})\,lbs.$	

c) Complete the equations of static equilibrium in the space provided below. (6 pts):

$\Sigma F_x = 0 =$	(2 pts)
$\Sigma F_y = 0 =$	(2 pts)
$\Sigma F_z = 0 =$	(2 pts)

d) Solve the equations of static equilibrium for the magnitude of the tension in each cable. (6 pts):

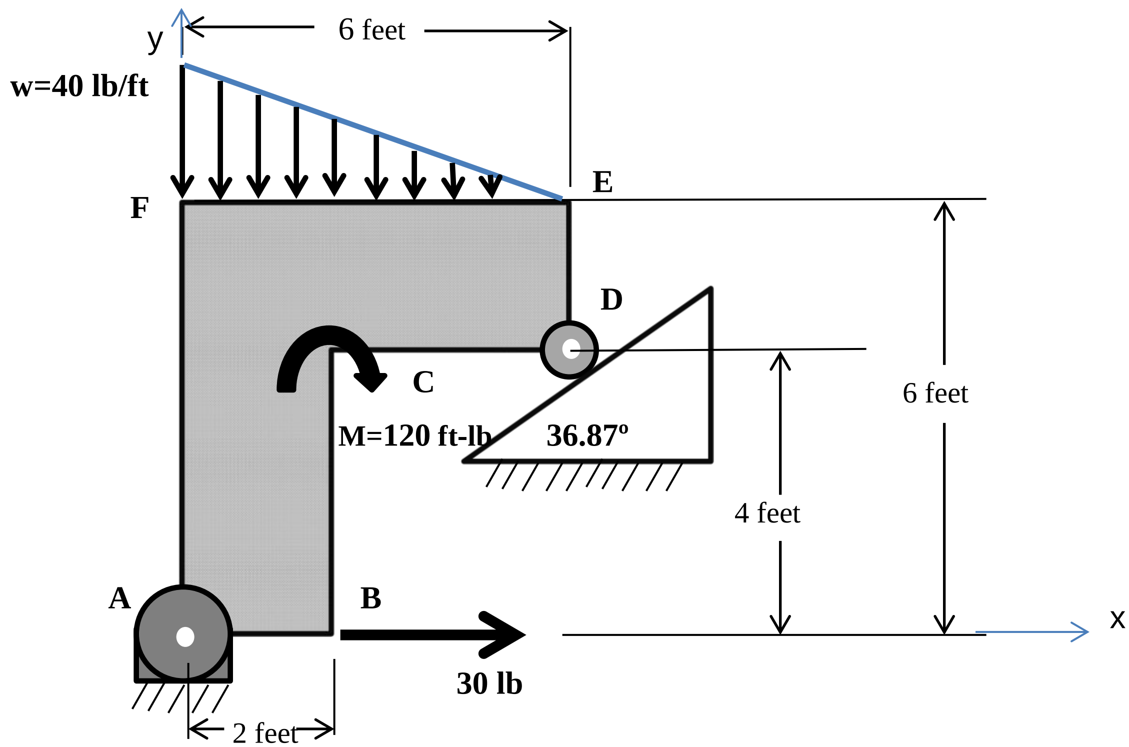
$T_{AB} =$	(2 pts)
$T_{AC} =$	(2 pts)
$T_{AD} =$	(2 pts)

e) If the maximum tension that the cables can experience before failure is 500 lbs, determine the heaviest crate that can be supported by the cable system (T_{AB}, T_{AC}, T_{AD}) without failing. (3 pts)

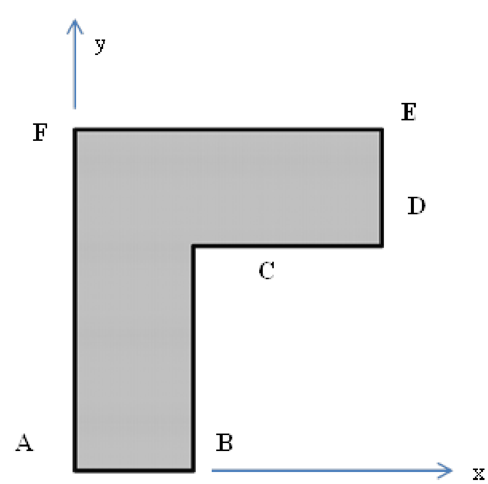
$(W_E)_{max} =$	(3 pts)

PROBLEM 3. (20 points)

GIVEN: A rigid-massless plate is loaded as shown in the figure provided.
The beam has a pin connection at Point A and rests on a roller on a 36.87º ramp at Point D.
At Point C, a 120 ft-lb couple **M** is directed in the clockwise direction. **M** = $-120\hat{k}\ ft-lb$.
At Point B, a 30 lb load **F** is directed horizontally. **F** =$30\hat{\imath}\ lb$
Along the top of the plate, a triangular distributed load is applied as shown.



a) Replace the distributed load by an equivalent load at the correct distance from F along the top of the plate and draw the complete free-body diagram on the figure provided below (8 points).



b) Determine the reaction loads at A & D, express them as vectors and determine their magnitude. Please show ALL of your work and write reactions as vectors. Please list your answers in the box provided.

$\overline{\boldsymbol{F_A}} = ($ ______ $\bar{\imath}$ + ______ $\bar{\jmath})(\boldsymbol{lb})$	$\|\overline{\boldsymbol{F_A}}\| =$ ______ $(\boldsymbol{lb})$	(5 pt)
$\overline{\boldsymbol{F_D}} = ($ ______ $\bar{\imath}$ + ______ $\bar{\jmath})(\boldsymbol{lb})$	$\|\overline{\boldsymbol{F_D}}\| =$ ______ $(\boldsymbol{lb})$	(5 pt)

c) If the 120 ft-lb couple is moved to Point B what will happen to the magnitude of the reaction force at Point D (circle one) (2 points)

$\|\overline{\boldsymbol{F_D}}\|$will increase $\|\overline{\boldsymbol{F_D}}\|$will decrease $\|\overline{\boldsymbol{F_D}}\|$will not change

1A. $Free\ body\ diagram$ Force Required: 175 lb

1B. $\bar{u}_{AB} = 0.635\ \bar{\imath} + 0.762\ \bar{\jmath} + 0.127\ \bar{k}$ $\mathcal{F}_{AB} = +7.8\ kN$

1C. Circle One: Yes they are equivalent

1D. $A = 26.86\ in^2$ $(\bar{x}, \bar{y}) = (1.85, 5.11)$ in

2A. Free body diagram

2B. $\overline{T_{AB}} = T_{AB}$ (-6/7 $\bar{\imath}$ + 3/7 $\bar{\jmath}$ + 2/7 $\bar{k}$) lbs.

$\overline{T_{AC}} = T_{AC}$ (-6/7 $\bar{\imath}$ + -2/7 $\bar{\jmath}$ + 3/7 $\bar{k}$) lbs

$\overline{T_{AD}} = T_{AD}$ (1 $\bar{\imath}$ + 0 $\bar{\jmath}$ + 0 $\bar{k}$) lbs

2C. $\Sigma F_x = 0 = -\frac{6}{7}\ T_{AB} - \frac{6}{7}\ T_{AC} + T_{AD}$

$$\Sigma F_y = 0 = \frac{3}{7}\ T_{AB} - \frac{2}{7}\ T_{AC}$$

$$\Sigma F_z = 0 = \frac{2}{7}\ T_{AB} + \frac{3}{7}\ T_{AC} - 150$$

2D) T_{AB} = 162lbs., T_{AC} = 242lbs , T_{AD} = 346lbs

2E) $(W_E)_{max}$ = 217lbs.

3A) F_{eq} = 120 lbs., x = 2 ft.

3B) $\overline{F_A} = (0i + 80j)lbs.$ F_A = 80 lbs.

$\overline{F_B} = (-30i + 40j)lbs.$ F_B = 50 lbs

3C) $\overline{F_D}$ will not change.

Type equation here.

ME 270 Exam 1 Equations

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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

$$p = \rho g h$$

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