ME 270 – Fall 2017 Exam 1 NAME (Last, First): ______________________________

Please review the following statement:

Purdue Honor Pledge – "As a Boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together – We are Purdue."

Signature: ____

Instructor's Name and Section: (Circle Your Section)

Sections: Li, Kai Ming – 8:30-9:20 AM

Jones, James – 9:30-10:20 AM

Hoyniak, Daniel – 11:30-12:20 PM

Buganza Tepole, Adrian – 12:30-1:20 PM

Semperlotti, Fabio – 2:30-3:20 PM

Zeinoddini Meimand, Vahid 4:30-5:20 PM

Murphy, Morgan – 9:00-10:15 AM

Jones, James – Distance Learning

INSTRUCTIONS

Begin each problem in the space provided on the examination sheets.

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.

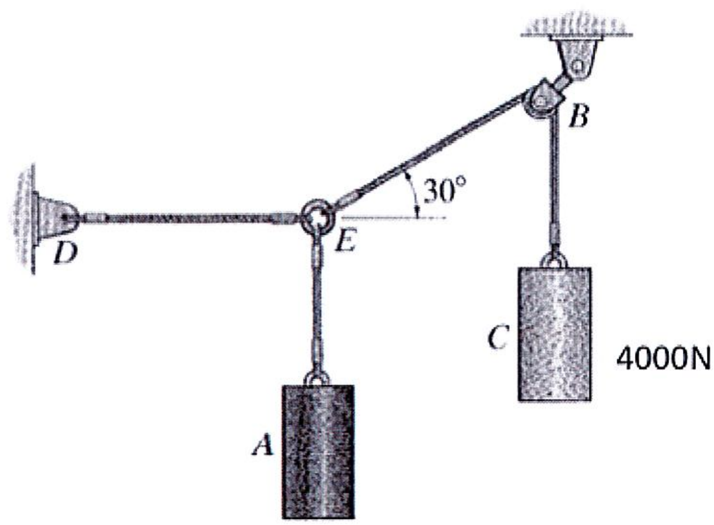
- The only authorized exam calculator is the TI-30XIIS or the TI-30Xa.
- The allowable exam time for Exam 1 is 70 minutes.
- The coordinate system must be clearly identified.
- Where appropriate, free body diagrams must be drawn. These should be drawn separately from the given figures.
- Units must be clearly stated as part of the answer.
- You must carefully delineate vector and scalar quantities.
- Please use a **black pen** for the exam.

If the solution does not follow a logical thought process, or is illegible, 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.

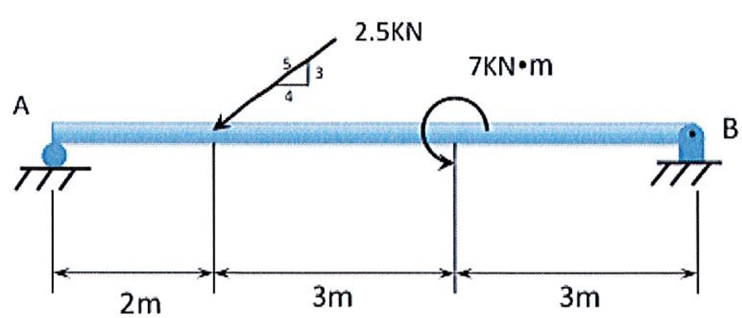
PROBLEM 1 (20 points) – Prob. 1 questions are all or nothing.

1A. If the weight of cylinder C is 4000N, determine the weight of cylinder A required to hold the system in equilibrium, and determine the magnitude of the tension in cable ED. You may assume that the pulley at B is frictionless. (5 pts)



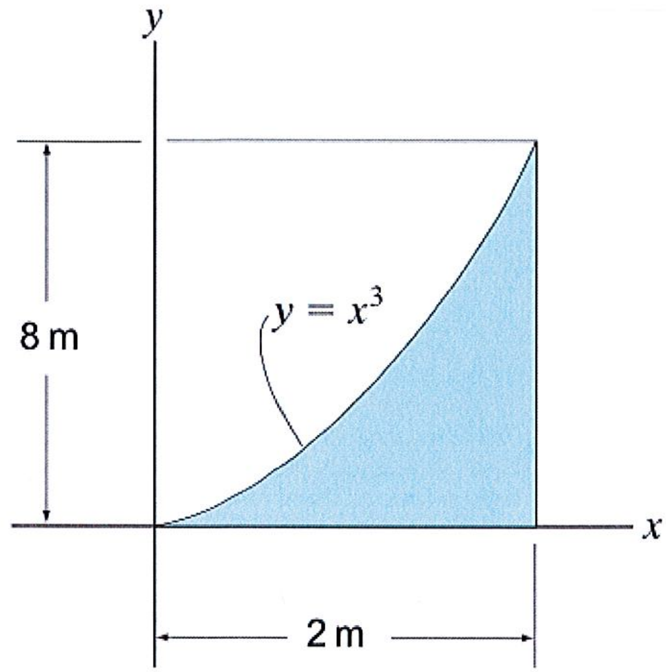
W_A =	(3 pts)
T_{ED} =	(2 pts)

1B. Replace the given force and moment with an equivalent force and moment at point A. Write the solution in vector form. (5 pts)



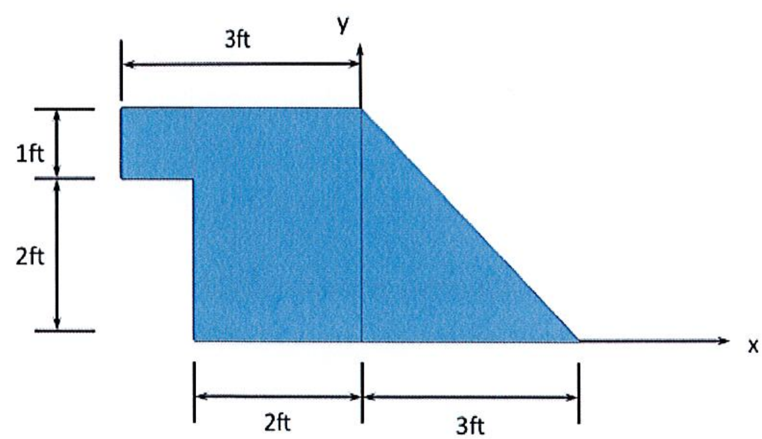
$\overline{F_R}$=	(3 pts)
$\overline{M_R}$ =	(2 pts)

1C. Compute by integration the shaded area (A) and the y-coordinate of the centroid ($\overline{\mathbf{Y}}$) for the shaded shape shown in the figure. (5 pts)



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

1D. Calculate the area, A, and the location of the centroid $(\bar{x}, \bar{y})$ for the plane area shown with respect to the coordinate system provided. (5 pts)



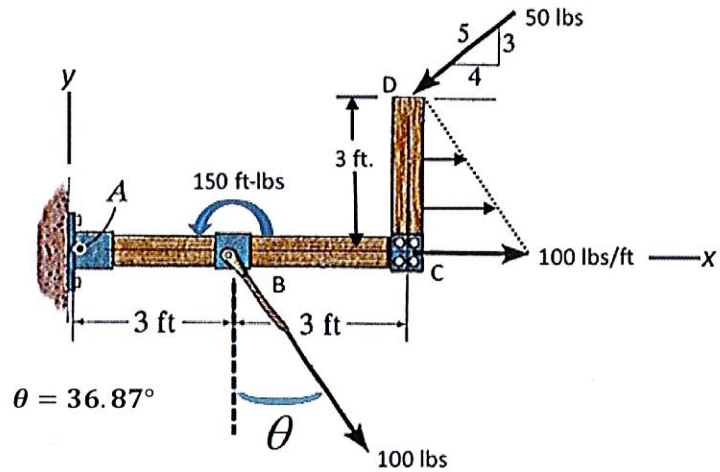
$A=$	(1 pts)
$\bar{x}=$	(2 pts)
$\bar{y}=$	(2 pts)

PROBLEM 2. (20 points)

GIVEN: Angled bar ABCD is loaded with two forces, a distributed load and a couple as shown. The rigid bar is held in static equilibrium by a fixed support at A.

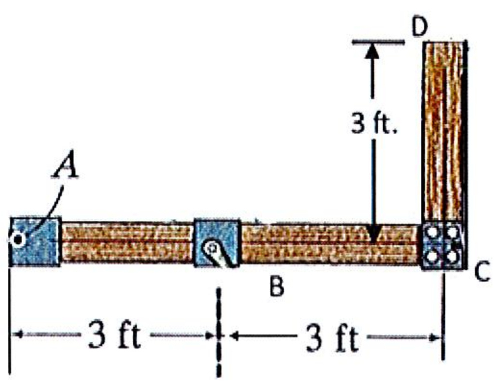
FIND:

2A. Determine the magnitude of the equivalent force (F_{eq}) for the distributed load and its location (d) above the x-axis. (3 pts)



F_{eq} =		(2 pts)
d =	(from the x-axis)	(1 pt)

2B. On the artwork provided, complete the free body diagram of bar ABCD using the equivalent force determined above in place of the distributed load. (3 pts):



2C. Determine the reactions required at A needed to hold bar ABCD in static equilibrium. Express these reactions in vector form. (12 pts):

$\overline{F}_A =$	(6 pts)
$\overline{M}_A =$	(6 pts)

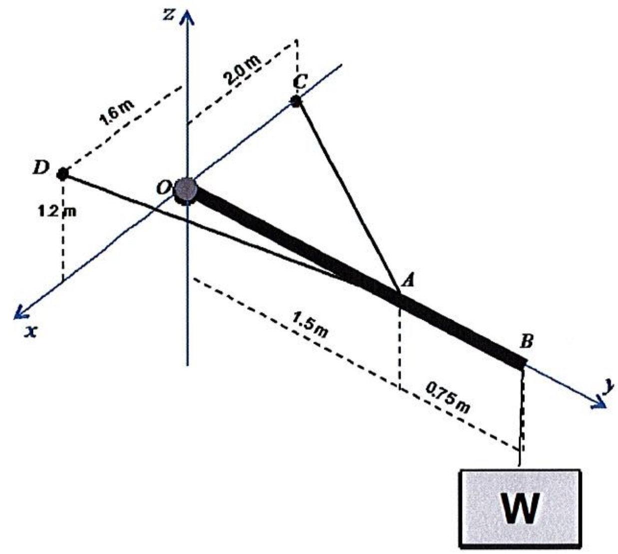
2D. If the applied couple at B was shifted towards end C, what impact would this have on the reaction moment at A. (2 pts):

Reaction Moment (increases remains the same decreases) Circle One	(2 pts)

PROBLEM 3 (20 points)

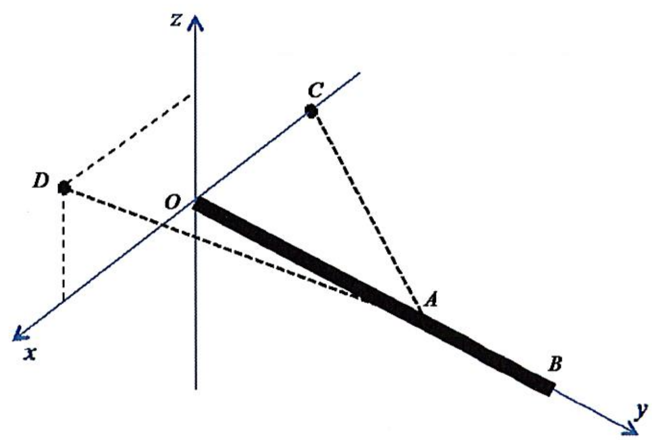
Given:

The mass-less bar (OAB) shown in the figure is supported by a ball and socket support at point O and two cables (AD and AC). The bar is supporting a weight (W=320 N) at its end (point B) as shown.



Find:

3A. Complete the **free-body diagram** for the bar on the figure provided. (5 points)



3B. Express the tension in cables (T_{AC} and T_{AD}) in terms of their **known unit vectors** and **unknown magnitudes**. (4 points)

$\overline{T_{AC}}$ =	(2 pts)
$\overline{T_{AD}}$ =	(2 pts)

PROBLEM 3. (cont.)

3C. Determine the **magnitude of the tension** in the cables. (6 points)

$\left\|\overline{T_{AC}}\right\|$=	(3 pts)
$\left\|\overline{T_{AD}}\right\|$ =	(3 pts)

PROBLEM 3 (cont.)

3D. Determine the **reactions at point O** and express them as a vector. (3 points)

Reaction at O= $\bar{i}$ + $\bar{j}$ + $\bar{k}$	(3 pts)

3E. If the cables are designed to hold up to 1400N, what is the largest load (W_{max}) the boom OAB could hold at B without either cable failing? (2 pts)

W_{max}=	(2 pts)

ME 270 Exam 1 Equations

Distributed Loads

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

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

Centroids

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

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

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

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

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

Centers of Mass

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

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

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

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

1A) $W_A = 2000N$ $T_{ED} = 3464N$

1B) $\overline{F_R} = -2\bar{\imath} - 1.5\bar{\jmath}\ kN$ $\overline{M_R} = 4\bar{k}\ kN - m$

1C) $A = 4m^2$ $\bar{Y} = 2.29m$

1D) $A = 11.5ft^2$ $\bar{x} = -0.348ft$ $\bar{y} = 1.39ft$

2A) $F_{eq} = 150\ lbs$ $d = 1\ ft$

2B) Free body diagram

2C) $\bar{F}_A = -170\bar{\imath} + 110\bar{\jmath}\ lbs$ $\bar{M}_A = +300\bar{k}\ ft - \ lbs$

2D) Reaction remains the same

3A) Free body diagram

3B) $T_{AC} = T_{AC}(-0.8, -0.6, 0)$ $T_{AD} = T_{AD}(0.64, -0.6, 0.48)$

3C) $\overline{|T_{AC}|} = 800N$ $\overline{|T_{AD}|} = 1000N$

3D) Reaction at O = $0\bar{\imath} + 1080\bar{\jmath} - 160\bar{k}$

3E) $W_{max} = 448N$