ME 270 – Spring 2018 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: ______________________________________

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

Sections: J Jones 9:30-10:20AM K Zhao 1:30-2:20PM F Semperlotti 4:30-5:20PM

J Jones Distance Learning

Please review and sign 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: ______________________________________

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. Also, please make note of the following instructions.

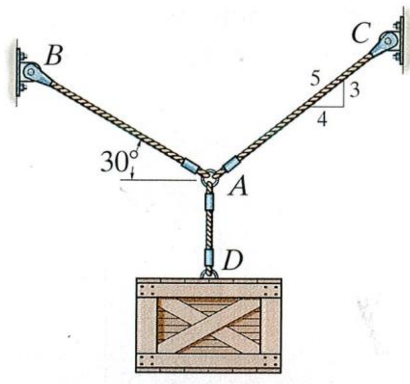
- The only authorized exam calculators are the TI-30XIIS or the TI-30Xa.
- The allowable exam time for Exam 1 is 70 minutes.
- The coordinate system must be clearly identified.
- Where appropriate, free body diagrams must be drawn. These should be drawn separately from the given figures.
- Units must be clearly stated as part of the answer.
- You must carefully delineate vector and scalar quantities.
- Please use a **black pen** for the exam.
- Do not write on the back side of your exam paper.

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 (20 points

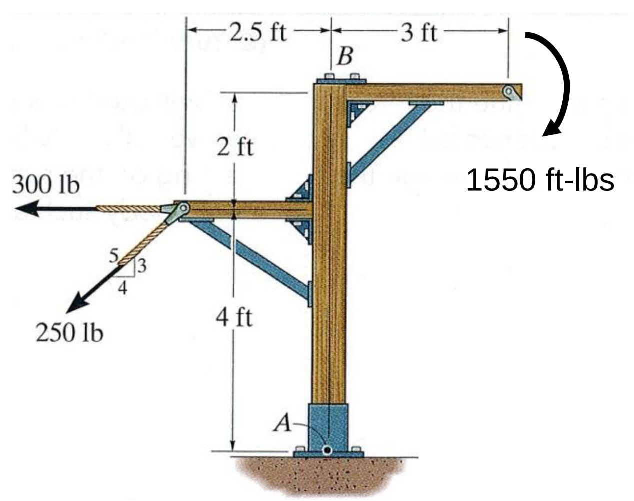
1A. Determine the magnitudes of the tensions in cables AB and AC given the weight of the crate is 550 lbs.



T_{AB}= (2 pts)

T_{AC}= (3 pts)

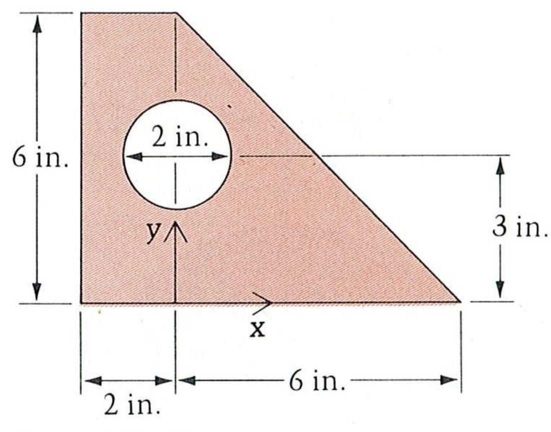
1B. Determine the equivalent force-couple system at point A for the structure shown. Express the results in vector form. (Note: This is not a static equilibrium problem).



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

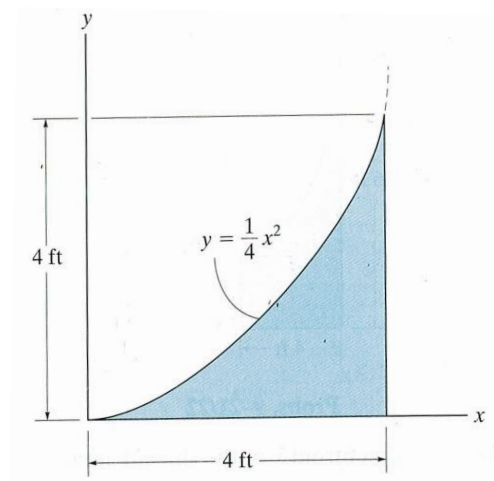
$(\bar{M}_A)_{eq}$= (3 pts)

1C. Determine the x-centroid for the shaded area with respect to the x-y axis shown. If the 2-in diameter hole were filled in, how would the x-centroid qualitatively change? (No calculations required)



$\bar{x} =$	(3 pts)
$(x)_{without\ hole} =$ increase, decrease, remains the same (Circle One)	(2 pts)

1D. Determine the area and the y-centroid of the shaded shape with respect to the x-y axis shown.



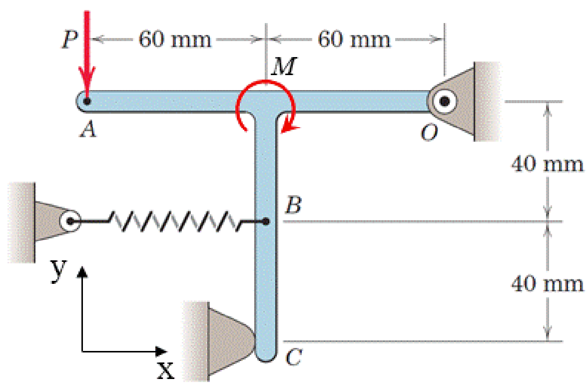
$A =$	(2 pts)
$\bar{y} =$	(3 pts)

PROBLEM 2 (20 points)

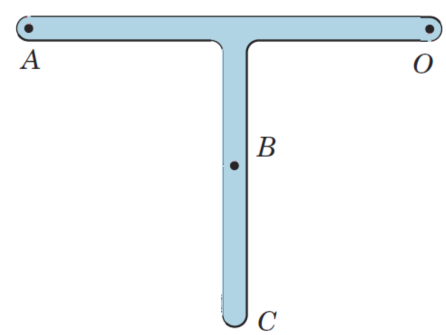
The rigid body in figure is constrained by a pin-joint at point O, an elastic spring at point B, and a smooth support at point C. The linear spring has a stiffness constant $k = 1750\ N/m$ and, at equilibrium, is stretched of an amount $\Delta = 0.01m$. A concentrated moment $M = 10\ Nm$ is also applied, as in figure.

a) **Draw** the free body diagram on the schematic provided below.
b) **Find** the amplitude of the force P needed so that rigid bar OABC is barely touching (i.e. just about to detach from) the smooth support at point C.
c) **Find** the reaction forces $\vec{R}_o$ at point O and express the result in vector form for this same loading condition.

Neglect friction and the weight of the rigid body.



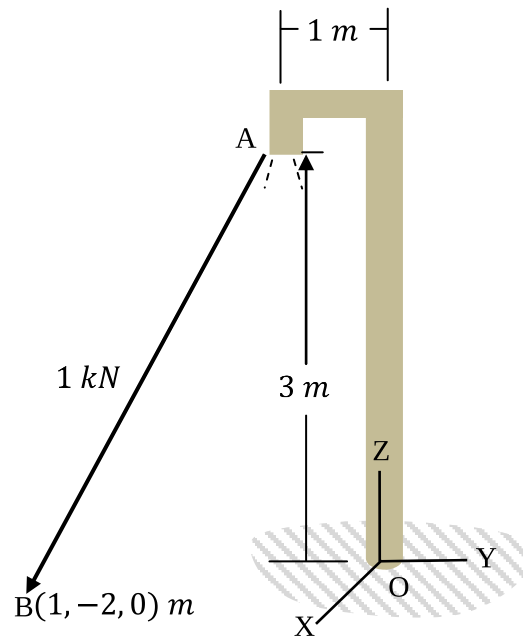
FBD (6 pts)



P =	(6 pts)
$\vec{R}_o = ($ $)\hat{\imath} + ($ $)\hat{\jmath}$	(8 pts)

Problem 3 (20 points)

A streetlamp is fixed at the ground O. A super bowl reveler attaches a rope to the lamp at A and pulls in the direction of *AB* with a force of 1 *kN* in an attempt to pull the lamp down. Ignore the weights of the column and the lamp. Determine the reactions at the ground O.



$\vec{F}_o = ($ $\quad\quad\quad$ $)\hat{\imath} + ($ $\quad\quad\quad$ $)\hat{\jmath} + ($ $\quad\quad\quad$ $)\hat{k}$

$\vec{M}_o = ($ $\quad\quad\quad$ $)\hat{\imath} + ($ $\quad\quad\quad$ $)\hat{\jmath} + ($ $\quad\quad\quad$ $)\hat{k}$

1A. $T_{AB} = 478 lbs$ $T_{AC} = 518 lbs$

1B. $(\bar{F}_A)_{eq} = -500\,\bar{\imath} - 150\,\bar{\jmath}\ lbs$ $(\bar{M}_A)_{eq} = +825\,\bar{k}\ ft-\ lbs$

1C. $\bar{x} = 0.894 in$ **Decrease**

1D. $A = 5.33\ ft^2$ $\bar{y} = 1.20\ ft.$

2A. **Free Body Diagram**

2B. $P = 89.166 N$ $\vec{R}_0 = (17.5)\hat{\imath} + (89.166)\hat{\jmath}\ N$

3A. $\vec{F}_0 = (-0.301)\hat{\imath} + (0.301)\hat{\jmath} + (0.905)\hat{k}\ kN$

3B. $\vec{M}_0 = (-1.808)\hat{\imath} + (-0.903)\hat{\jmath} + (-0.301)\hat{k}$ ***kN-m***

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

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

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

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

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