ME 270 – Fall 2015 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	I Bilionis 12:30-1:20PM	Y Fang 4:30-5:20PM
J Jones Distance Learning	J Gilbert 2:30-3:20PM	M Murphy 10:30-11:45AM
E Nauman 8:30-9:20AM	KM Li 11:30AM-12:20PM	

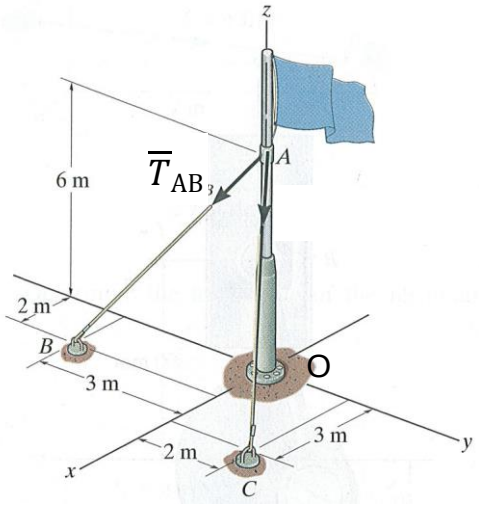
Problem 1 _____

Problem 2 _____

Problem 3 _____

Total _____

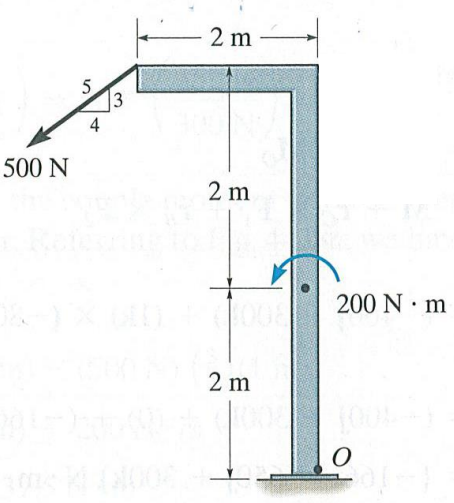
PROBLEM 1 (20 points) – Prob. 1 questions are all or nothing.



1A. Determine the force vector expression for cable AB (i.e. $\overline{T}_{AB}$) assuming the tension in the cable is 700N. Determine the moment cable AB exerts on the flag pole (OA) at base O. You can ignore cable AC.

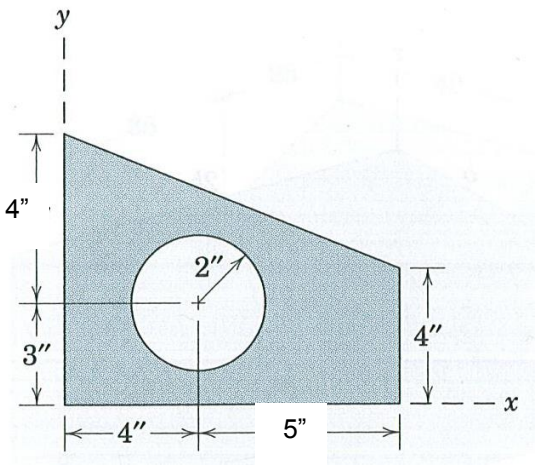
$\overline{T}_{AB} =$	(2 pts)
$\overline{M}_o =$	(3 pts)

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



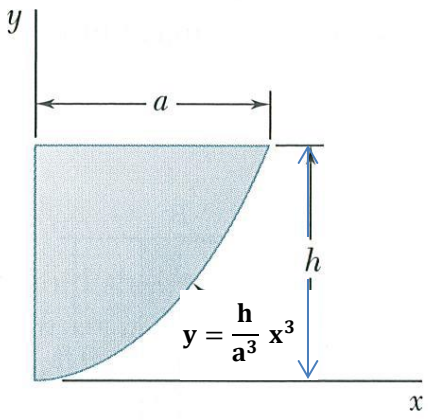
$\overline{F}_{eq} =$	(2 pts)
$(\overline{M}_o)_{eq} =$	(3 pts)

1C. For the shaded area shown, determine the y-centroid with respect to the coordinate frame shown. If the 2 inch radius hole was shifted toward the right, qualitatively what impact would this have on the y-centroid (No calculations are required).



$\overline{y} =$					(3 pts)
$\overline{y} =$	increase	decrease	remain the same	(Circle One)	(2 pts)

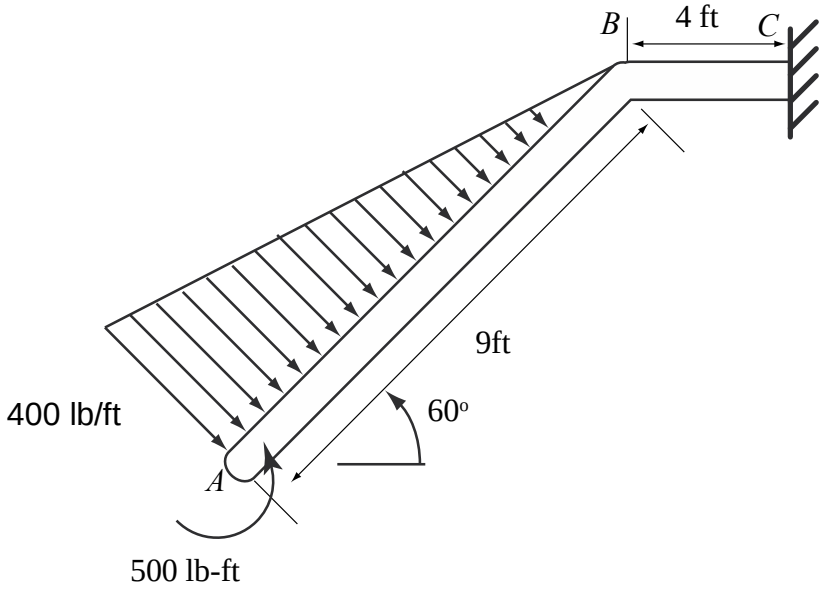
1D. For the shaded area shown, determine the area and x-centroid in terms of constants a and h.



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

PROBLEM 2. (20 points)

GIVEN: The cantilevered bracket *ABC*, it is subject to a triangular shaped distributed load that acts perpendicular to segment *AB*, and 500 lb-ft couple at *A*. The bracket is held in static equilibrium by a fixed support at C.



FIND:

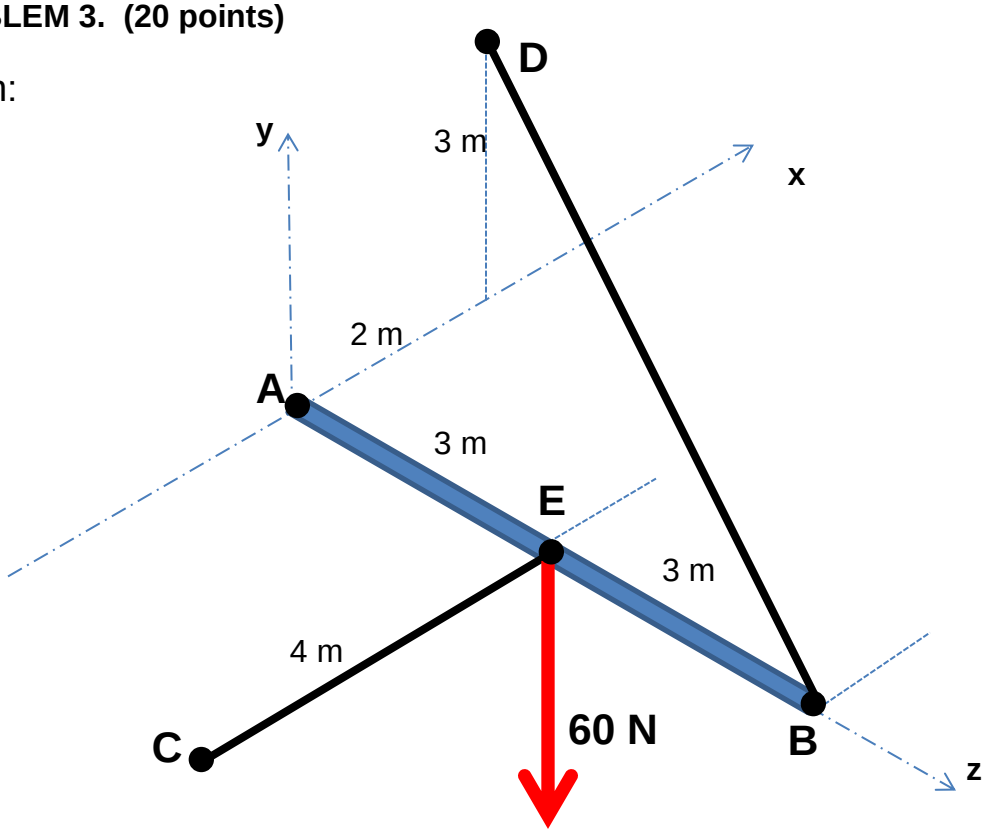
a) Determine the single force equivalent due to the distributed load and its location from point *A*. (4 pts.)

b) Draw a free body diagram (FBD) of bracket ABC using the equivalent force from a). (6pts.)

c) Find the reactions at the fixed support C. (10 pts.)

PROBLEM 3. (20 points)

Given:



A 60 Newton load is applied to a massless rod.

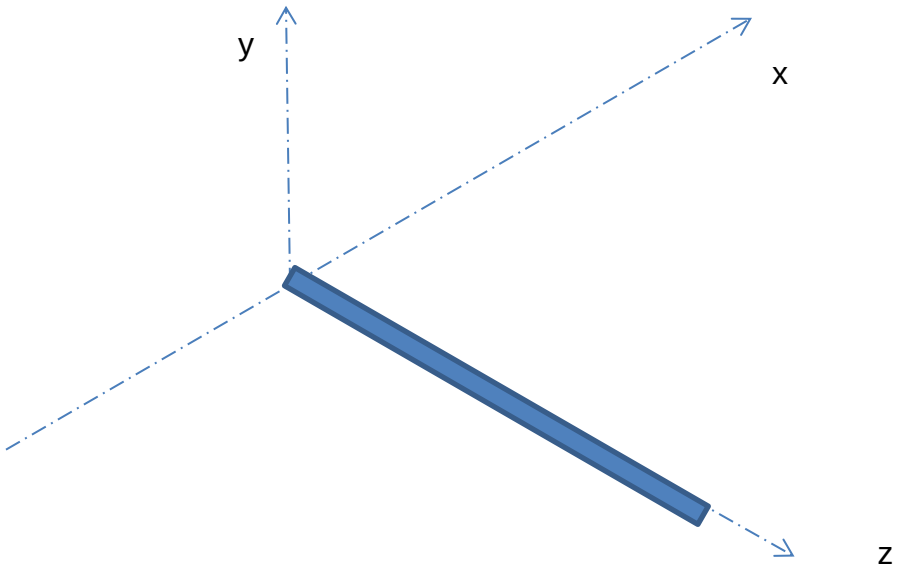
Cable **BD**, Cable **EC** and the ball & socket joint at **A** support the loading and the system is in equilibrium. ***Please use the designated areas provided for your responses. Show All work!***

a. (3 points) Please determine the expression for $\overrightarrow{T_{BD}}$ in terms of its unit vector and unknown magnitude. The expression for $\overrightarrow{T_{EC}}$ is provided for reference.

$$\vec{T}_{BD} = |\vec{T}_{BD}|[\_\_\_\_\_\,\hat{\imath} + \_\_\_\_\_\,\hat{\jmath} + \_\_\_\_\_\,\hat{k}]$$

$$\vec{T}_{EC} = |\vec{T}_{EC}|[\quad(-1.00)\hat{\imath} + \qquad 0\hat{\jmath} + \qquad 0\hat{k}]$$

b. (5 points) Please draw the free-body diagram for the beam on the figure provided below.



c. (6 points). Please determine the magnitudes of the tension in the cables.

$|\vec{T}_{BD}| =$ _____

$|\vec{T}_{EC}| =$ _____

(more on the next page).

d. (6 points) Please determine the force reaction at point A and express your answer as a vector.

$$\vec{A} = [\_\_\_\_\_\,\hat{\imath} + \_\_\_\_\_\,\hat{\jmath} + \_\_\_\_\_\,\hat{k}](N)$$

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

1a. $\overline{T}_{AB} = 200\bar{i} - 300\bar{j} - 600\bar{k}\ N$ $\overline{M}_O = 1800\bar{i} + 1200\bar{j}\ N - m$

1b. $\overline{F}_{eq} = -400\bar{i} - 300\bar{j}\ N$ $(\overline{M}_o)_{eq} = 2400\bar{k}\ N - m$

1c. $\overline{y} = 2.76$ inches $\overline{y} =$ remain the same

1d. $A = 0.75$ ha $\overline{x} = 0.4$ a

2a. $\overline{x} = \frac{1}{3}$ from A $\overline{x} = \frac{1}{3}(9\ ft)$ $\overline{x} = 3ft$

2b. Free body diagram

2c. $M_C = -14900\ \bar{k}\ lb - ft$ $\bar{C} = -1559\bar{\imath} + 900\bar{\jmath}\ lbs$

3a.

$$\vec{T}_{BD} = |\vec{T}_{BD}|\left[\frac{2}{7}\hat{\imath} + \frac{3}{7}\hat{\jmath} + \frac{-6}{7}\hat{k}\right]$$

$$\vec{T}_{EC} = |\vec{T}_{EC}|\left[(-1.00)\hat{\imath} + 0\hat{\jmath} + 0\hat{k}\right]$$

3b. Free body diagram

3c. $|\vec{T}_{BD}| = 70N$ $|\vec{T}_{EC}| = 40N$

3d. $\vec{A} = [20\ \hat{\imath} + 30\hat{\jmath} + 60\ \hat{k}](N)$