ME 270 – Fall 2016 Exam 2 **NAME (Last, First): _____**

Please indicate your group number _____ (If applicable)

Instructor's Name and Section: _____

Circle One:

MWF 8:30-9:20 AM	V Zeinoddini Meimand	MWF 2:30-3:20 PM	J Ackerman
MWF 9:30-10:20 AM	J Jones	MWF 4:30-5:30 PM	A Buganza Tepole
MWF 11:30-12:20 PM	D Hoyniak	TTH 9:00-10:15 AM	M Murphy
MWF 12:30-1:20 PM	I Bilionis	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 _____

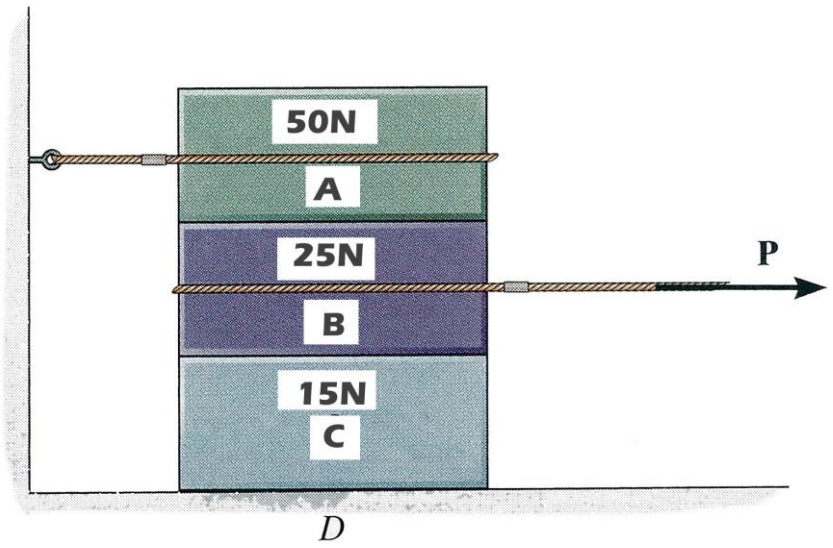
Problem 2 _____

Problem 3 _____

Total _____

PROBLEM 1 (20 points)

1A. Blocks A, B and C weigh 50N, 25N and 15N respectively. Assuming $\mu_{AB} = 0.3$, $\mu_{BC} = 0.4$, and $\mu_{CD} = 0.3$, determine the smallest horizontal force P that will cause impending motion. Circle the impending motion that will occur.



P = _____	(3 pts)
Impending Motion = (Block B moves, Block C moves, Block B and C move together)	(3 pts)

1B. Circle the correct equilibrium equation below for the wedge shown below. (3 pts)

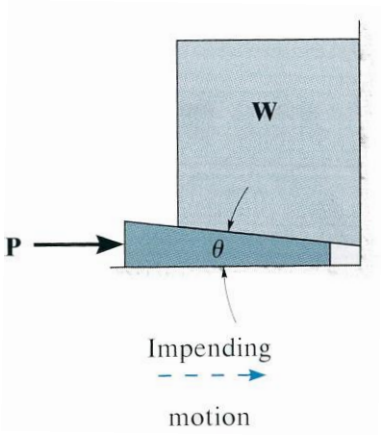
a) $\sum F_x = 0 = \mathrm{P} - f_1 + f_2 \cos\theta - N_2 \sin\theta$

b) $\sum F_x = 0 = \mathrm{P} - f_1 - f_2 \sin\theta - N_2 \sin\theta$

c) $\sum F_x = 0 = \mathrm{P} - f_1 - f_2 \cos\theta + N_2 \cos\theta$

d) $\sum F_x = 0 = \mathrm{P} - f_1 - f_2 \cos\theta - N_2 \sin\theta$

e) None of the Above

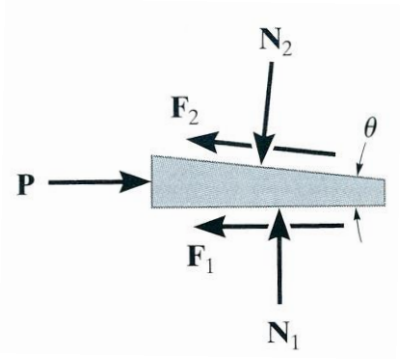


If you solved for P in this problem and found P to be greater than zero, circle the correct statement about the wedge.(2 pts)

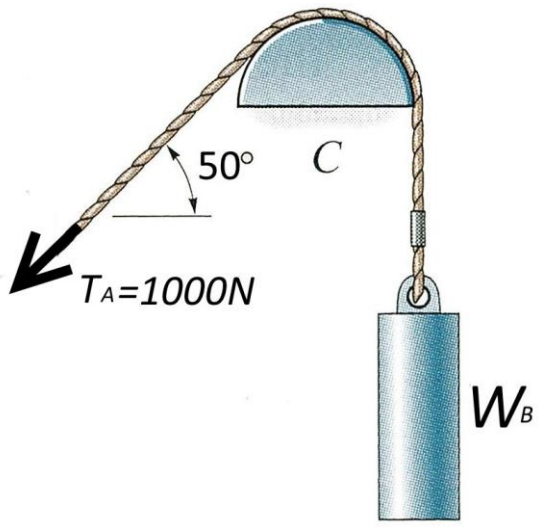
a) The wedge **is** self-locking.

b) The wedge **is not** self-locking.

c) It **cannot be** determined from this information.

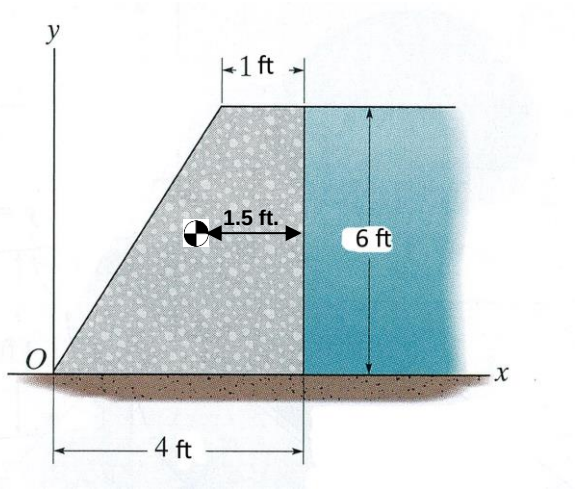


1C. Determine the angle of wrap (β) and <u>largest</u> weight (W_B) that can be held in static equilibrium using the cable system shown with a tension T=1000N. Assume the static coefficient of friction between A the cable and fixed drum C is μ_s=0.3.



$\beta =$	(3 pts)
$(W_{B)max} =$	(2 pts)

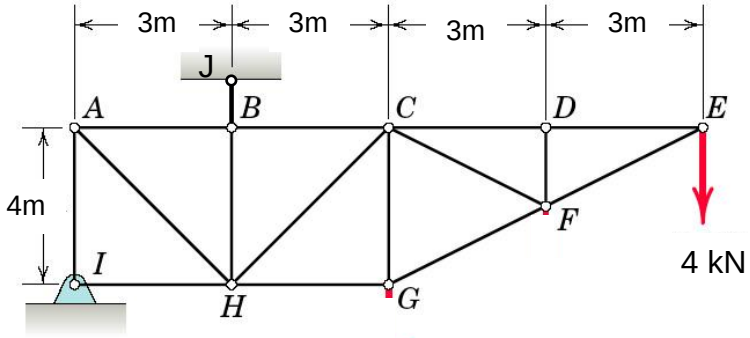
1D. A Determine the magnitude of the hydrostatic force (F_{eq}) acting on the concrete dam. Assume ρg=62.5 lb/ft^3 and the dam is 4 ft wide. What is the minimum weight of the concrete dam (W_D) needed to prevent the dam from tipping assuming the center of mass is as shown.



$\mathrm{F}_{eq} =$	(3 pts)
$\mathrm{W}_D =$	(2 pts)

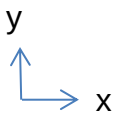
PROBLEM 2. (20 points)

GIVEN: The truss is loaded with a 4 kN load at point E with the geometry shown in the figure below.



The tension in the two-force member JB is 16 kN.

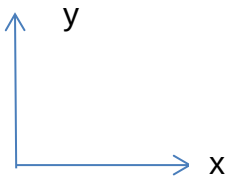
The reaction force at point I is given as $\vec{F}_I = (0\hat{\imath} - 12\hat{\jmath})kN$



2A. Determine all of the **zero-force members** and list here:_____ (3 points)

2B. Draw an appropriate free-body diagram in the box below and determine the force in member EF and circle whether it is in tension, compression or zero. (5 points)

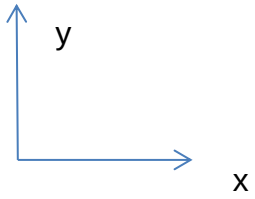
Free-body diagram (2 points)



Force in member EF_____Tension, Compression, Zero (Circle One) (3 points)

2C. Draw an appropriate free-body diagram (in the box provided below) and determine the forces carried by members **BC, HC and HG.** Determine the magnitudes of BC, HC and HG and circle whether the members are in tension, compression or zero (list your answers in the box provided).

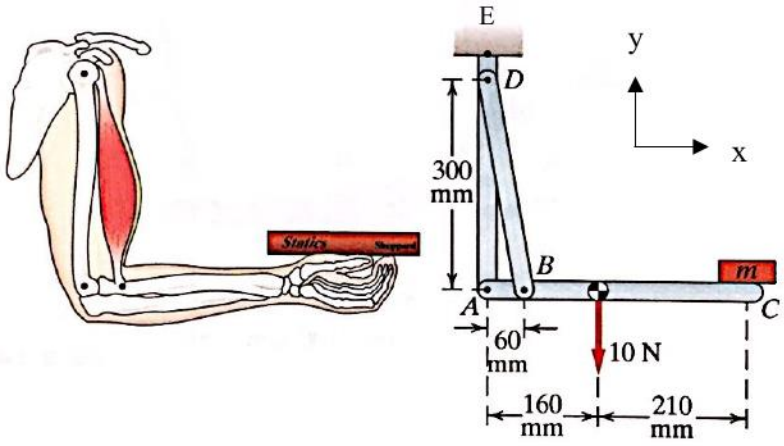
Free-body diagram (3 points)



Force in member BC_____ Tension, Compression, Zero (Circle One)	(3 pts)
Force in member HC _____ Tension, Compression, Zero (Circle One)	(3 pts)
Force in member HG_____ Tension, Compression, Zero (Circle One)	(3 pts)

PROBLEM 3. (20 points)

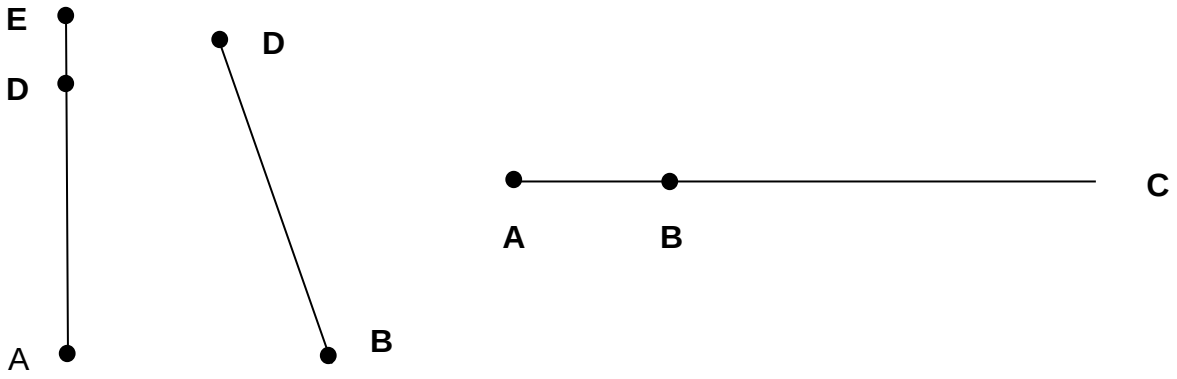
GIVEN: The human arm can be modeled as a simple frame as shown below with BD representing the bicep muscle and ADE and ABC representing the upper arm and forearm, respectively. The arm is supporting a 1 kg mass in the posture shown. The biceps muscle (BD) can be represented as a 2-force member, and the member *ADE* is assumed to be held in place by a fixed point *E*. The weight of the forearm *ABC* is 10 N; the weights of the members AE and BD can be neglected.



FIND:

3A. Identify all 2-force members in the frame and list them here. _____ (1 pt)

3B. Draw the free body diagrams of the three members of the system (ADE, BD, ABC) (6 pts)



3C. Calculate the tension in the biceps muscle (member BD) and the force acting on BD at joint B. (4 pts):

$\overline{F}_{BD} = (\_\_\_\_\_\ \bar{\imath} + \_\_\_\_\_\ \bar{J}), \overline{|F_{BD}|} = \_\_\_\_\_$ (4 pt)

3D. Calculate the force at the elbow joint A on member ABC, $(F_A)_{\text{on ABC}}$. Calculate the force at the elbow joint A on member ADE, $(F_A)_{\text{on ADE}}$. (7 pts)

$(\overline{F}_{A)\ on\ ABC} = (\_\_\_\_\_\ \bar{\imath} + \_\_\_\_\_\ \bar{J})$ (4 pts)

$(\overline{F}_{A)\ on\ ADE} = (\_\_\_\_\_\ \bar{\imath} + \_\_\_\_\_\ \bar{J})$ (3 pts)

3E. If the maximum force that the biceps can generate is 470N, what is the maximum mass that can be supported on the hand in the posture shown in the diagram? (2 pts):

$m =$_____ (2 pts)

ME 270 Exam 2 Equations

Buoyancy

$$F_B = \rho g V$$

Fluid Statics

$$P = \rho g h$$

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

Belt Friction

$$\frac{T_L}{T_s} = e^{\mu\beta}$$

1A. $P = 42N \ \ (Since\ P_{BC} < P_B)$
Impending Motion = Block B and C move together

1B d) $\sum F_x = 0 = \mathrm{P} - f_1 - f_2\ cos\theta - N_2\ sin\theta$
c) It **cannot be** determined from this information

1C $\beta = 140° = \frac{7}{9}\pi = 0.778\pi = 2.44\ rad.$ $(W_B)_{max} = 2081N$

1D. $F_{eq} = 4500\ lbs$ $W_D = 3600\ lbs$

2A. IH, DF, CF

2B. 7.21 kN Compression

2C. Force in member BC 9 kN Tension
Force in member HC -5 kN Compression
Force in member HG -6 kN Compression

3A. Free body diagram

3B. $\bar{\boldsymbol{F}}_{\boldsymbol{BD}} = (-\mathbf{17.43N}\,\bar{\boldsymbol{\imath}} + \mathbf{87.16N}\,\bar{\boldsymbol{\jmath}}), \overline{|\boldsymbol{F_{BD}}|} = \mathbf{88.88}\boldsymbol{N}$

3C. $\bar{\boldsymbol{F}}_{\boldsymbol{A\ on\ ABC}} = (\mathbf{17.43}\,\bar{\boldsymbol{\imath}} + -\mathbf{67.34}\,\bar{\boldsymbol{\jmath}})\mathbf{N}$ $\bar{\boldsymbol{F}}_{\boldsymbol{A\ on\ ABC}} = (-\mathbf{17.43}\,\bar{\boldsymbol{\imath}} + \mathbf{67.34}\,\bar{\boldsymbol{\jmath}})\mathbf{N}$

3D. $\boldsymbol{m = 7.17\ kg}$