Allowed Materials: *F.E. approved calculator(s)* *see syllabus*; *pencils and/or pens.*

ExamForm := 22

Honor Statement: *On my honor, I promise that I have not received any unauthorized assistance on this exam (I didn't look at another student's paper, I didn't view any unauthorized written materials, I didn't talk or listen to another student, I didn't use an unauthorized calculator, I didn't use any electronic device, any visual or auditory signals, or any other techniques of exchanging information with others.) I have maintained the highest standards of academic integrity while completing this exam.*

Signed:_____

Instructions: *Encode your answer to each question by darkening the appropriate circle on your response form. You are also encouraged to work neatly and circle your chosen answers on the exam document so that you are better able to review your work if you find the need. However, the answers you encode on the response form will be taken as your definitive answers, and the entire basis for your grade. Please review your response form carefully before submission.*

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wwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwww

1. *(2 point deduction for failure to complete this problem!)*

wwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwww

Bubble:	For Course Section:	
91	H01 - Crittenden	TR 10-11:50
92	H02 - Reeves	TR 2-3:50
93	H03 - Swanbom	TR 12-1:50
94	H04 - Hall	TR 8-9:50
95	H05 - Evans	MW 8-9:50
01	001 - Swanbom	MW 2-3:50
02	002 - Moller	TR 12-1:50
03	003 - Moller	TR 8-9:50
04	004 - Easley	TR 2-3:50

- Write in all of the indicated information in the boxes of your response form.
- Darken the appropriate circles to encode the corresponding information.
- Write your name on this exam and sign the Honor Statement.

Notes:
- If your last name is too long, just write the first 10 letters.
- **"F.I."** and **"M.I."** are your first and middle initials, respectively
- Your **"Username"** is the first part of your LATech email address
- For **"Section"** use the guide provided to the right
- Your **"Exam Form"** is printed on the upper right corner of this page.
- Indicate "ENGR" as the **"Program"**

Exam Form	Program
	○ BIEN
	○ CMEN
	○ CVEN
	○ CVTE
⓪ ⓪	○ CYEN
① ①	○ ELEN

Last Name										F.I.	M.I.	LA Tech Username						Course #					Section (last 2 digits)	

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"I properly completed all required items in problem 1, so I will not lose these points"} \\ \text{"B"} & \text{"I did not properly complete problem 1 because I am fine with losing these points."} \end{pmatrix}$$

---

2. (3 points) Equilibrium equations used to analyze **concurrent force systems** do NOT typically include...

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"}\Sigma M=0 \text{ because the efficiency (}\eta\text{) of the system is lossless (100\%)"} \\ \text{"B"} & \text{"}\Sigma M=0 \text{ because the sum of the moments is non-zero"} \\ \text{"C"} & \text{"}\Sigma M=0 \text{ because all forces' lines of action pass through one point"} \\ \text{"D"} & \text{"}\Sigma M=0 \text{ because the addition of all of the forces equal zero anyway"} \\ \text{"E"} & \text{"}\Sigma Fy=0 \text{ because the addition of all of the forces equal zero anyway"} \\ \text{"F"} & \text{"}\Sigma F=0 \text{ because the object under analysis is not moving"} \\ \text{"G"} & \text{"}\Sigma M=0 \text{ because one of the forces' lines of action never converges"} \\ \text{"H"} & \text{"}\Sigma Fx=0 \text{ because the addition of all of the forces equal zero anyway"} \end{pmatrix}$$

---

3. (3 points) The concept of force pairs (i.e., the actions of two bodies on each other are always equal and directly opposite) is properly identified with...

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"Newton's fifth law"} \\ \text{"B"} & \text{"Newton's third law"} \\ \text{"C"} & \text{"Newton's fourth law"} \\ \text{"D"} & \text{"Newton's second law"} \\ \text{"E"} & \text{"Newton's first law"} \end{pmatrix}$$

4. (3 points) The RF transmitter and receiver used for the maze challenge
in class must be paired to function properly. This pairing was
accomplished by...

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"programming the arduino to correctly select the frequency"} \\ \text{"B"} & \text{"soldering jumper connections on both transmitter and receiver"} \\ \text{"C"} & \text{"adjusting the antenna length on the receiver"} \\ \text{"D"} & \text{"adjusting the antenna length on the transmitter"} \\ \text{"E"} & \text{"soldering jumper connections on the receiver only"} \\ \text{"F"} & \text{"helpful gnomes that live inside the transmitter"} \\ \text{"G"} & \text{"an auto-connect function from a key-press sequence"} \end{pmatrix}$$

5. (3 points) When evaluating design alternatives, the basic Pugh method is used
when _____ and a decision matrix is used when _____.

Fill in the appropriate blanks using the list shown below:

I. only baseline design criteria are considered

II. only weights for design criteria are considered

III. only scores for design criteria are considered

IV. both weights and scores for design criteria are considered
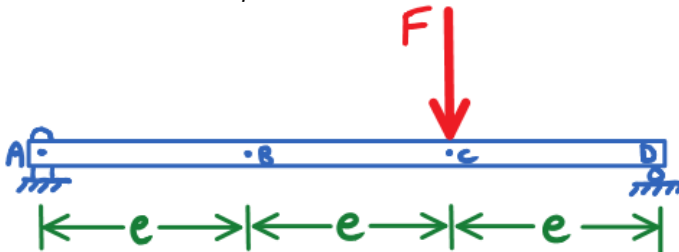
V. no criteria are considered

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"II ; IV"} \\ \text{"B"} & \text{"II ; V"} \\ \text{"C"} & \text{"I ; IV"} \\ \text{"D"} & \text{"I ; III"} \\ \text{"E"} & \text{"II ; III"} \\ \text{"F"} & \text{"I ; II"} \\ \text{"G"} & \text{"III ; IV"} \\ \text{"H"} & \text{"III ; V"} \end{pmatrix}$$

6. (3 points) Force F (with a positive magnitude) is applied to beam ABCD, which is
simply supported as shown. The ΣM_B (the sum of the moments about point B) is
closest to:

Assume counter-clockwise is positive.

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"2*F*e"} \\ \text{"B"} & \text{"-2*F*e"} \\ \text{"C"} & \text{"-3*F*e"} \\ \text{"D"} & \text{"-F*e"} \\ \text{"E"} & \text{"0"} \\ \text{"F"} & \text{"F"} \\ \text{"G"} & \text{"F*e"} \\ \text{"H"} & \text{"not enough information"} \\ \text{"I"} & \text{"3*F*e"} \end{pmatrix}$$

7. (3 points) Consider the gear train shown (note: gears C & D are stacked, i.e., joined). You want to use a low-RPM input (i.e., motor) to drive a high RPM piece of equipment (i.e., output). Which of the following would be true if the intended action is to be accomplished?
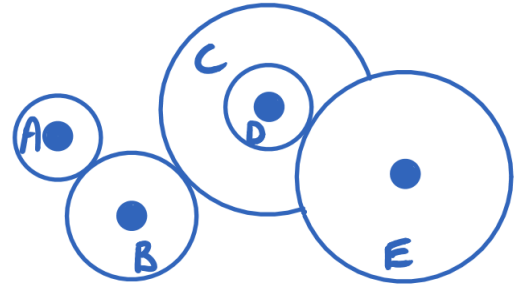

I. The input motor should be connected to gear A and the output should be connected to gear E.

II. The input motor should be connected to gear E and the output should be connected to gear A.

III. The torque of gear A will be smaller than the torque of gear E.

IV. The torque of gear A will be larger than the torque of gear E.

V. The direction of the rotation of the motor will be the same as the direction of the rotation of the equipment.

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"I and III"} \\ \text{"B"} & \text{"II, III and V"} \\ \text{"C"} & \text{"I, III and V"} \\ \text{"D"} & \text{"II, IV and V"} \\ \text{"E"} & \text{"II and IV"} \\ \text{"F"} & \text{"II and III"} \\ \text{"G"} & \text{"I, IV and V"} \\ \text{"H"} & \text{"I and IV"} \end{pmatrix}$$

8. (3 points) The process shown in the picture results in an angled piece of sheet metal. The name for the appropriate portion of the tool used in this process is:
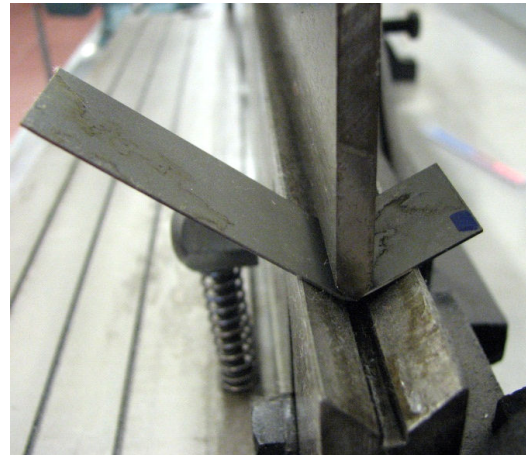
$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"roll"} \\ \text{"B"} & \text{"bender"} \\ \text{"C"} & \text{"guard"} \\ \text{"D"} & \text{"trough"} \\ \text{"E"} & \text{"shear"} \\ \text{"F"} & \text{"brake"} \\ \text{"G"} & \text{"press"} \\ \text{"H"} & \text{"controller"} \end{pmatrix}$$

9. (3 points) According to the 10 Faces of Innovation, there are 3 major types of personas. They are:

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"organizing, learning and building"} \\ \text{"B"} & \text{"experimenting, building and directing"} \\ \text{"C"} & \text{"learning, teaching and observing"} \\ \text{"D"} & \text{"experimenting, observing and organizing"} \\ \text{"E"} & \text{"following, leading and observing"} \\ \text{"F"} & \text{"observing, experimenting and building"} \\ \text{"G"} & \text{"building, hurdling and directing"} \\ \text{"H"} & \text{"teaching, organizing and giving"} \end{pmatrix}$$

10. (3 points) Over a few years, you have deposited a total of $800 (note: arrow length is proportional to amount deposited for individual years). Which cash flow diagram will most likely result in the largest future amount F given an annually compounded interest rate?

Option 1	Option 2
<in> arrows at 0,1,2,3; F=? at 4	<in> arrows at 0,1,2,3; F=? at 4
Option 3	Option 4
<in> arrows at 0,1,2,3; F=? at 4	<in> arrows at 0,1,2,3; F=? at 4
Option 5	Option 6
<in> arrows at 0,1,2,3,4; F=? at 4	<in> arrows at 1,2,3,4; F=? at 4
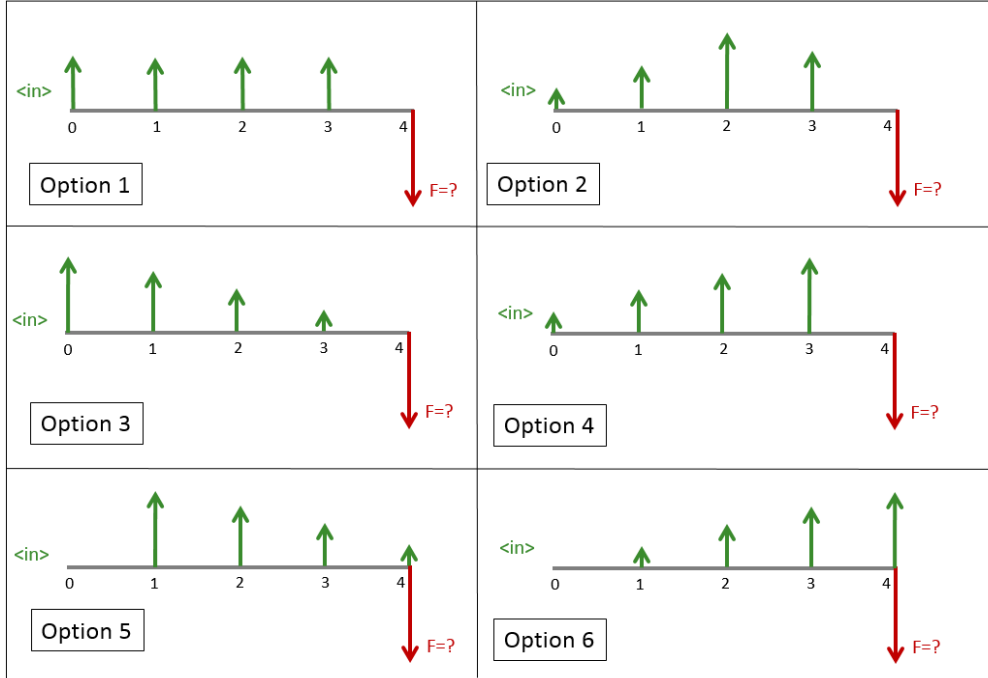
$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"Option 6"} \\ \text{"B"} & \text{"Option 3"} \\ \text{"C"} & \text{"Option 5"} \\ \text{"D"} & \text{"Option 2"} \\ \text{"E"} & \text{"all options equal"} \\ \text{"F"} & \text{"Option 4"} \\ \text{"G"} & \text{"Option 1"} \end{pmatrix}$$

11. (3 points) You have several options for fastening two pieces of sheet metal together while installing your rivets. If you wish the exterior to be aesthetically most pleasing (look the nicest) and use the rivets as intended, you should use:

Exterior (viewable side)

Option 1

Option 2

Option 3

Option 4

Interior (hidden side)
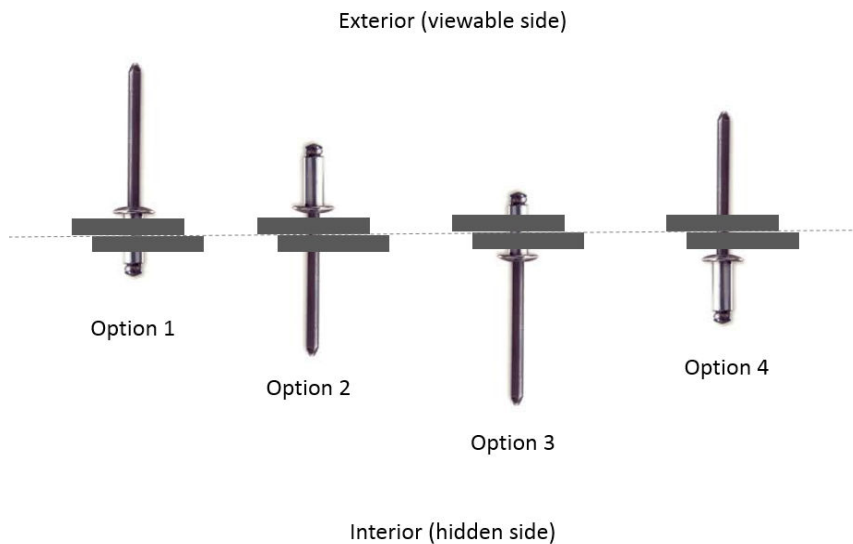
$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"Option 2 only"} \\ \text{"B"} & \text{"Option 1 or 4"} \\ \text{"C"} & \text{"Option 3 only"} \\ \text{"D"} & \text{"Option 1 only"} \\ \text{"E"} & \text{"Option 2 or 4"} \\ \text{"F"} & \text{"Option 2 or 3"} \\ \text{"G"} & \text{"Option 1 or 3"} \\ \text{"H"} & \text{"Option 4 only"} \end{pmatrix}$$

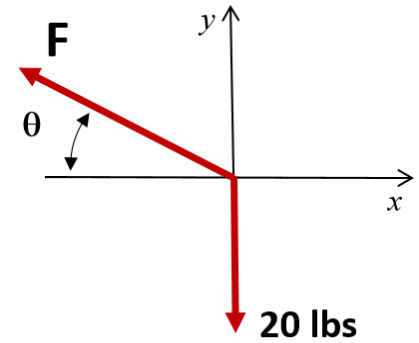**12.** (5 points) The resultant of the force system shown is closest to:

$$Choices = \begin{pmatrix} "A" & 6.50 \\ "B" & 12.99 \\ "C" & 18.03 \\ "D" & 25.00 \\ "E" & 25.49 \end{pmatrix} \cdot lbf$$

$F = 15 \cdot lbf$

$\theta = 30 \cdot deg$

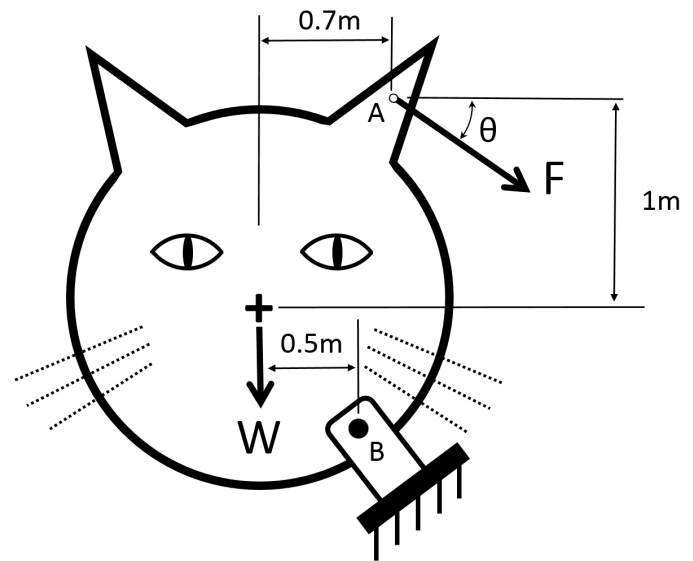**F**

y

θ

x

20 lbs

---

13 & 14. Two forces W and F act on a giant cat that is pinned at point B. The net moment of these two forces about point B is closest to: (4 points)

$$Choices13 = \begin{pmatrix} "A" & 10.46 \\ "B" & 10.89 \\ "C" & 11.31 \\ "D" & 11.74 \\ "E" & 12.16 \\ "F" & 12.59 \\ "G" & 13.01 \\ "H" & 13.43 \end{pmatrix} \cdot N \cdot m$$

$F = 50 \, N$

$W = 120 \, N$

$\theta = 25 \cdot deg$

0.7m

A

θ

F

1m

0.5m

W

B

The direction of the net moment is: (1 point)

$$Choices14 = \begin{pmatrix} "A" & "Clockwise" \\ "B" & "Counter-clockwise" \end{pmatrix}$$

15. (5 points) Based on the diagram and information provided, the system will only be in equilibrium when angle ϕ is closest to:

$$\text{Choices} = \begin{pmatrix} \text{"A"} & 48.9 \\ \text{"B"} & 52.4 \\ \text{"C"} & 55.9 \\ \text{"D"} & 59.4 \\ \text{"E"} & 63.0 \\ \text{"F"} & 66.6 \\ \text{"G"} & 70.1 \\ \text{"H"} & 73.7 \\ \text{"I"} & 77.2 \\ \text{"J"} & 80.8 \end{pmatrix} \cdot \text{deg}$$
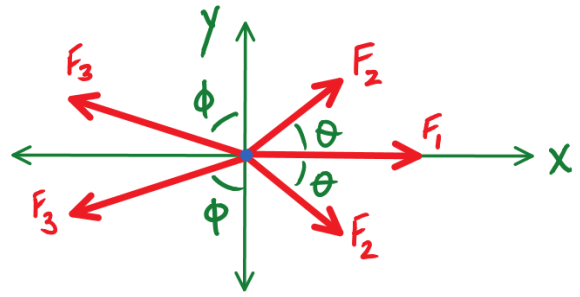
$$F_1 = 145 \cdot N \qquad F_2 = 102 \cdot N \qquad F_3 = 167 \cdot N \qquad \theta = 34 \cdot \text{deg}$$

Note: The drawing is not to scale.

16. (5 points) A cat face with a weight of W is supported by two forces as shown. Force F is also pulling on the face. The value of F_1 is closest to:

$$\text{Choices} = \begin{pmatrix} \text{"A"} & 128.4 \\ \text{"B"} & 135.0 \\ \text{"C"} & 141.6 \\ \text{"D"} & 148.2 \\ \text{"E"} & 154.7 \\ \text{"F"} & 161.3 \\ \text{"G"} & 167.9 \\ \text{"H"} & 174.4 \end{pmatrix} \cdot \text{lbf}$$

$$F = 15 \cdot \text{lbf}$$

$$W = 250 \cdot \text{lbf}$$

$$\theta_1 = 55 \cdot \text{deg}$$

$$\theta_2 = 40 \cdot \text{deg}$$
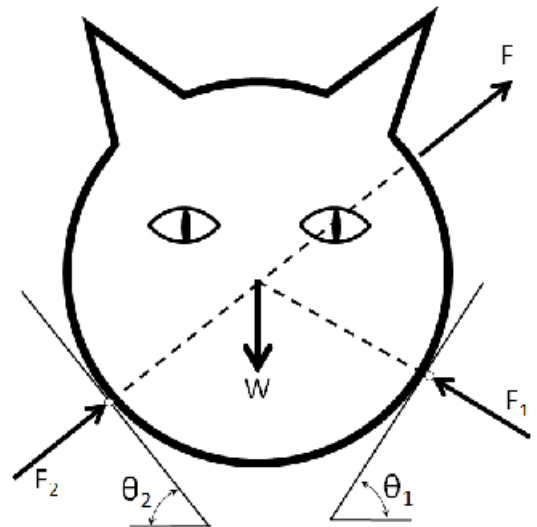
17. (5 points): The person doing pushups holds the position shown. Given the distances identified and the assumption that his weight of 200 lbs acts at the point identified, the **total force** exerted by the floor on **both feet** is closest to …
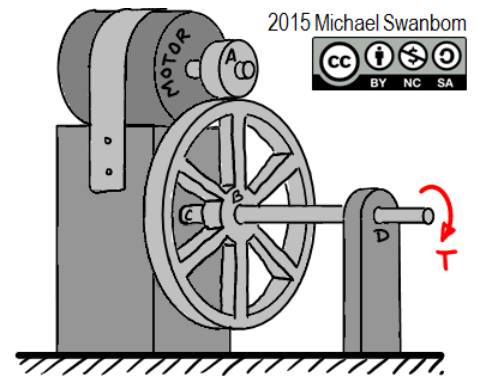

$W = 200$ lbs

a b
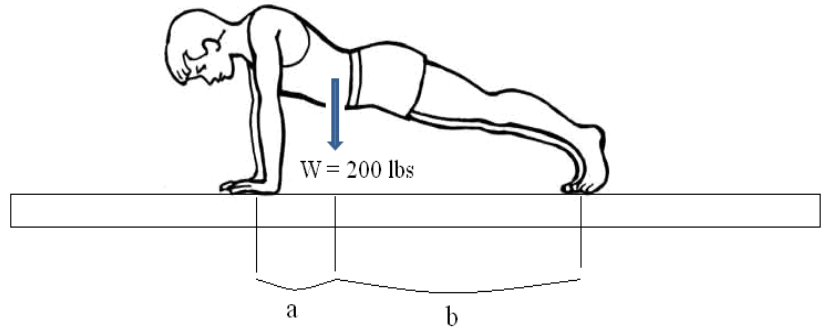
$a = 1.5 \cdot ft$
$b = 3.6 \cdot ft$

$$\text{Choices} = \begin{pmatrix} "A" & 55.8 \\ "B" & 58.8 \\ "C" & 61.8 \\ "D" & 64.8 \\ "E" & 67.8 \\ "F" & 70.7 \\ "G" & 73.7 \\ "H" & 76.7 \\ "I" & 79.7 \\ "J" & 82.8 \end{pmatrix} \cdot lbf$$

---

18. (5 points) Pinion A on the motor shown has $N_A = 24 \cdot$ teeth. The output torque of the $motor = 400 \cdot N \cdot cm$. If this device must produce a torque of $T = 13 \cdot N \cdot m$ at D, the number of teeth required on gear B is closest to:

$$\text{Choices} = \begin{pmatrix} "A" & 69 \\ "B" & 72 \\ "C" & 75 \\ "D" & 78 \\ "E" & 81 \\ "F" & 84 \\ "G" & 87 \\ "H" & 91 \end{pmatrix} \cdot teeth$$

Note: assume frictionless bearings and lossless gears.

19. (5 points) Dr. Reeves is weighing his wife's pet parrot using the lever system shown. Before placing the fowl creature on the lever system, he has found that the empty Solo cup perfectly balances the system, so the weights of the levers and cup do not need to be considered. Dr. Reeves has also found that once he has added the bird and the number of pennies shown below, the system remains in equilibrium. If the typical penny weighs 0.088 ounce, then the weight of the bird is closest to...

$$
\text{Choices} = \begin{pmatrix}
\text{"A"} & 3.308 \\
\text{"B"} & 3.660 \\
\text{"C"} & 4.024 \\
\text{"D"} & 4.372 \\
\text{"E"} & 4.722 \\
\text{"F"} & 5.066 \\
\text{"G"} & 5.420 \\
\text{"H"} & 5.770 \\
\text{"I"} & 6.122 \\
\text{"J"} & 6.471
\end{pmatrix} \cdot \text{oz}
$$
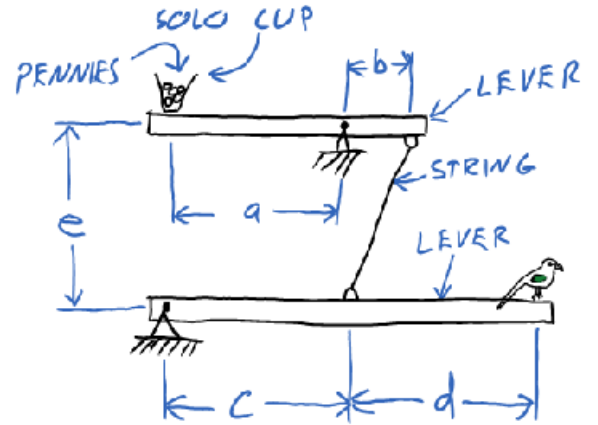
Note: The drawing is not to scale.

Pennies = 30   a = 70·in   b = 15·in

c = 74·in   d = 84·in   e = 100·in

20. (5 points) A battery supplies a $voltage = 12 \cdot V$ to a motor that lifts the two weights given, such that w_1 has a $velocity = 3 \cdot \frac{ft}{s}$. The diameter of $spool\_1 = 5 \cdot in$, and the diameter of $spool\_2 = 8 \cdot in$. Under this load, the ammeter placed in the circuit gives a $reading = 19 \cdot A$. The overall efficiency of the system is closest to:
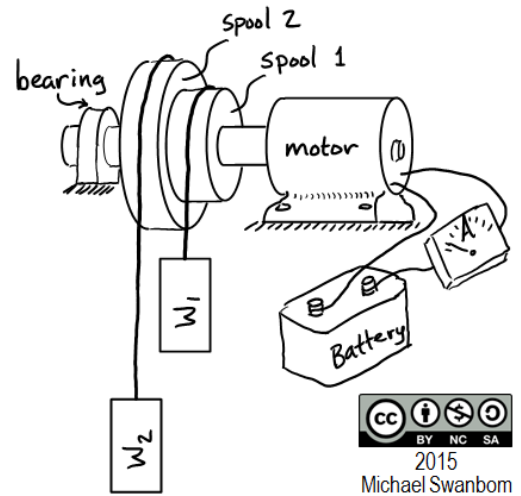
$$Choices = \begin{pmatrix} "A" & 58.41 \\ "B" & 61.64 \\ "C" & 64.80 \\ "D" & 67.92 \\ "E" & 71.09 \\ "F" & 74.27 \\ "G" & 77.42 \\ "H" & 80.56 \\ "I" & 83.76 \\ "J" & 86.90 \end{pmatrix} \cdot \%$$

$w_1 = 13 \cdot lbf$

$w_2 = 19 \cdot lbf$

Spool 2
Spool 1
bearing
motor
Battery
2015
Michael Swanbom

21. (5 points) You made two investments in two different accounts on the same day. The first investment (Principal = $P1 = 2000 \cdot dollars$) earned a total of $1,200 in interest over five years. The second investment earned a total of $I2 = 1.2 \times 10^3 \cdot dollars$ in interest over a three year period. If these investments were earning the same annual (simple) interest rate, the second investment (Principal) was closest to:

$$Choices = \begin{pmatrix} "A" & 3130.85 \\ "B" & 3333.33 \\ "C" & 3535.48 \\ "D" & 3736.73 \\ "E" & 3940.36 \\ "F" & 4142.71 \\ "G" & 4346.56 \\ "H" & 4547.32 \end{pmatrix} \cdot dollars$$

22. (5 ponts) If you deposit a Principal amount of $P = 8000 \cdot \text{dollars}$ into an account paying a $\text{rate} = 7 \cdot \%$ annual interest compounded quarterly, the cumulative amount of interest earned by the account after 10 years is closest to:

$$\text{Choices} = \begin{pmatrix} \text{"A"} & 7524.24 \\ \text{"B"} & 8012.78 \\ \text{"C"} & 8499.89 \\ \text{"D"} & 8982.61 \\ \text{"E"} & 9476.88 \\ \text{"F"} & 9957.35 \\ \text{"G"} & 10440.78 \\ \text{"H"} & 10926.21 \end{pmatrix} \cdot \text{dollars}$$

23. (5 points) If you deposit a Principal amount of $P = 800 \cdot \text{dollars}$ into an account paying an annual interest $\text{rate} = 3 \cdot \%$ compounded monthly, the account will be worth \$1500 in closest to: (how many months in the future)

$$\text{Choices} = \begin{pmatrix} \text{"A"} & 236 \\ \text{"B"} & 252 \\ \text{"C"} & 267 \\ \text{"D"} & 282 \\ \text{"E"} & 298 \\ \text{"F"} & 313 \\ \text{"G"} & 328 \\ \text{"H"} & 343 \end{pmatrix} \cdot \text{months}$$

24. (5 points) Joe has a small, part-time business that generates sales $\text{revenue} = 8000 \cdot \text{dollars}$ per year. Joe's business requires $\text{expenses} = 1000 \cdot \text{dollars}$ per year. If Joe invests his gains over a ten year period and earns $\text{interest} = 4 \cdot \%$ per year, compounded annually, the future worth of his investments after ten years (i.e., at the time of his tenth investment) is closest to …

$$\text{Choices} = \begin{pmatrix} \text{"A"} & 58509 \\ \text{"B"} & 63598 \\ \text{"C"} & 68755 \\ \text{"D"} & 73853 \\ \text{"E"} & 78926 \\ \text{"F"} & 84043 \\ \text{"G"} & 89129 \\ \text{"H"} & 94258 \end{pmatrix} \cdot \text{dollars}$$

25. (5 points) Billy asks Jake for a $\text{loan} = 8000 \cdot \text{dollars}$ and agrees to pay monthly payments based on an annual interest $\text{rate} = 5 \cdot \%$, compounded monthly. If Billy agrees to pay Jake a $\text{payment} = 381.31 \cdot \text{dollars}$ per month, the number of months necessary to **_fully_** repay Jake is closest to …
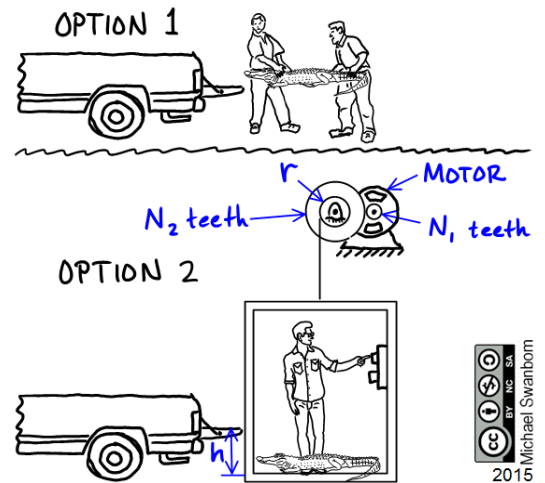
$$\text{Choices} = \begin{pmatrix} \text{"A"} & 17 \\ \text{"B"} & 18 \\ \text{"C"} & 19 \\ \text{"D"} & 21 \\ \text{"E"} & 22 \\ \text{"F"} & 23 \\ \text{"G"} & 25 \\ \text{"H"} & 26 \end{pmatrix} \cdot \text{months}$$

26. (5 points) Dr. Easley is looking for ways to save money at his small-scale alligator distribution center. He currently has two laborers that load sedated alligators into delivery vehicles. He thinks he may be able to save money by going to only one laborer, and installing an electric lift. Each laborer costs him 1200 dollars per month, paid at the end of each month.

The lift that Dr. Easley is considering uses an electric motor that drives a winch through a set of gears. The lift converts electrical energy to lifting energy with an $\text{efficiency} = 32 \cdot \%$. Dr. Easley anticipates the system will have to lift an average total $\text{weight} = 8.6 \cdot \text{kN}$ (the lifting cab plus the payload) an average of 1000 times per month. (The design of the winch is such that it does not use energy when it is lowered.) The initial cost of the lift including $\text{installation} = 13000 \cdot \text{dollars}$. Dr. Easley plans to use it for 4 years, and at the end of 4 years, he anticipates it will have a scrap $\text{value} = 1200 \cdot \text{dollars}$.

Dr. Easley's options are to (1) continue to use his current system with two laborers, or (2) purchase the lift, reduce his laborer count by one, and pay for the energy to operate the lift for the next 48 months. Assume an energy $\text{cost} = 20 \cdot \dfrac{\text{cents}}{\text{kW} \cdot \text{hr}}$, that will have to be paid at the end of each month. Use an annual interest $\text{rate} = 4.7 \cdot \%$, compounded monthly. The present-day value of the cost savings Dr. Easley can achieve by choosing option 2 versus option 1 is closest to:

$$
\text{Choices} = \begin{pmatrix}
\text{"A"} & 35390.81 \\
\text{"B"} & 37049.53 \\
\text{"C"} & 38689.51 \\
\text{"D"} & 40322.95 \\
\text{"E"} & 41966.95 \\
\text{"F"} & 43627.06 \\
\text{"G"} & 45239.76 \\
\text{"H"} & 46879.13 \\
\text{"I"} & 48564.06 \\
\text{"J"} & \text{"option 2 does not reduce Dr. Easley's present cost"}
\end{pmatrix} \cdot \text{dollars}
$$

$N_1 = 23 \cdot \text{teeth} \quad N_2 = 95 \cdot \text{teeth} \quad r = 5 \cdot \text{cm} \quad h = 135 \cdot \text{cm}$

ExamForm = 22

1. *(2 point deduction for failure to complete this problem!)*

- Write in all of the indicated information in the boxes of your response form.
- Darken the appropriate circles to encode the corresponding information.
- Write your name on this exam and sign the Honor Statement.

Notes:
- If your last name is too long, just write the first 10 letters.
- "**F.I.**" and "**M.I.**" are your first and middle initials, respectively
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Exam Form		Program
		○ BIEN
		○ CMEN
		○ CVEN
		○ CVTE
⓪	⓪	○ CYEN
①	①	○ ELEN

Last Name										F.I.	M.I.	LA Tech Username						Course #				Section (last 2 digits)	
Ⓐ	Ⓐ	Ⓐ	Ⓐ	Ⓐ	Ⓐ	Ⓐ	Ⓐ	Ⓐ	Ⓐ	Ⓐ	Ⓐ	Ⓐ	Ⓐ	Ⓐ	⓪	⓪	⓪	⓪	⓪	⓪	⓪	⓪	

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"I properly completed all required items in problem 1, so I will not lose these points"} \\ \text{"B"} & \text{"I did not properly complete problem 1 because I am fine with losing these points."} \end{pmatrix}$$

Note: You may tear off this page after the exam begins to use for reference and/or extra paper. This page must be turned in with your exam.

$$I = Pni \qquad F = P \cdot (1 + ni) \qquad F = P \cdot (1 + i)^n$$

$$P = F \cdot (1 + i)^{-n} \qquad F = A \cdot \left[\frac{(1 + i)^n - 1}{i} \right] \qquad P = A \cdot \left[\frac{(1 + i)^n - 1}{i \cdot (1 + i)^n} \right]$$

$$1\,\text{lbf} = 4.448\,\text{N}$$
$$1\,\text{in} = 25.4 \cdot \text{mm}$$
$$1\,\text{m} = 3.281 \cdot \text{ft}$$
$$g = 9.81 \frac{\text{m}}{\text{s}^2}$$

ExamForm = 22

Key =

	1
1	"A"
2	"C"
3	"B"
4	"B"
5	"C"
6	"E"
7	"F"
8	"F"
9	"A"
10	"B"
11	"D"
12	"C"
13	"A"
14	"B"
15	"G"
16	"F"
17	"B"
18	"D"
19	"H"
20	"G"
21	"B"
22	"B"
23	"B"
24	"F"
25	"E"
26	"D"