To do ...

- HW 12 due **Wed**  
  - Due **Friday (Feb 26)**
- HW 13 (Prairie Learn) due **Friday**
- WA5 posted – due **Sunday Feb 28th**
Rapid Refresh ...

- i
- <3
- c
- l
- i
- c
- k
- e
- r
Mean score = 77.2%
<table>
<thead>
<tr>
<th>Question</th>
<th>Mean score</th>
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</thead>
<tbody>
<tr>
<td>1. equivalentforcecouple6</td>
<td>74%</td>
</tr>
<tr>
<td>Equivalent force-moment</td>
<td></td>
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<tr>
<td>2. fbdEquil01</td>
<td>95%</td>
</tr>
<tr>
<td>Normal force</td>
<td></td>
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<tr>
<td>3. moment1b</td>
<td>74%</td>
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<tr>
<td>Moment of a force</td>
<td></td>
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<tr>
<td>4. momentRHR2</td>
<td>66%</td>
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<tr>
<td>Moment - RHR</td>
<td></td>
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<tr>
<td>5. particleEquilibrium03</td>
<td>76%</td>
</tr>
<tr>
<td>Equilibrium</td>
<td></td>
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Question moment Rhef2

Given the position vector \( \vec{r} \) and force vector \( \vec{F} \) as shown below.

Note that the vector \( \vec{r} \) is in the y-z plane with origin on the y axis and intersecting with the z axis.

\[
\vec{r}_B = \langle 0, 0, z \rangle \\
\vec{r}_A = \langle 0, -y, 0 \rangle
\]

\[
\vec{r}_{AB} = \vec{r}_B - \vec{r}_A = \langle 0, y, -z \rangle
\]

\[
\vec{F} = \langle 0, 0, F \rangle
\]

About which axis is the resulting moment vector, \( \vec{M} \)?

Answer options:
1. + x
2. - x
3. + y
4. - y
5. + z
6. - z

\[
\vec{M} = \vec{r} \times \vec{F} = \begin{vmatrix}
\hat{i} & \hat{j} & \hat{k} \\
0 & y & -z \\
0 & 0 & F \\
\end{vmatrix}
\]

\[
\vec{M} = (yF) \hat{z}
\]

\[
\vec{M} = (yF) \hat{z}
\]
iQ>clicker

On a scale of 1 to 10, how would you rate your pain so far?

Y Y Y Y Y Y Y Y Y
A B C D E

Dad, it's cold in here!
Go stand in the corner.
Why?
The corner is 90 degrees.
How many unknown reactions does the system have?

A) 3
B) 4
C) 5
D) 6
E) 7

Q: Statically determinate?
A-Y B-N

Q: Stable for all loading?
A-Y B-N
How many two-force members does the system have?
(Neglect the weight of the members)

A) none  
B) 1  
C) 2  
D) 3  
E) 4

forces act along body . . . we know the direction but not the magnitude (1 unknown)
How many unknown reactions act on beam $AB$?

A) 2  
B) 3  
C) 4  
D) 5

1. DRAW FBD of beam

2. FBD of cable

$C_y = \frac{2}{5}C$  
$C_x = \frac{4}{5}C$  
($1$ unknown, magnitude)

CABLE is a two force member and under tension.

We know direction but not the magnitude!  
OH NOOOOO...
How many unknown reactions act on beam BC?

A) 2  
B) 3  
C) 4  
D) 5

1. FBD of BEAM BC

2. FBD of link

the link is a two-force member and under compression we know direction but not magnitude
Simple trusses

**Truss:**
- Structure composed of slender members joined together at end points
- Transmit loads to supports

**Assumption of trusses**
- Loading applied at joints, with negligible weight (if weight included, vertical and split at joints)
- Members joined by smooth pins

**Result:** all truss members are two-force members, and therefore the force acting at the end of each member will be directed along the axis of the member.

*truss* - structure that consists of two force members only
- behaves as a single object
- the simplest truss is one triangle.
At a BRIDGE NEAR YOU!
Q: Why?

Allows bridge to move and undergo small deformations due to heavy loads or expansion/contraction due to extreme temperature changes (Hot/Cold)
Roof trusses

Load on roof transmitted to purlins, and from purlins to roof trusses at joints.

Bridge trusses

Load on deck transmitted to stringers, and from stringers to floor beams, and from floor beams to bridge trusses at joints.

Q: How many members and joints?

1. Forces act at joints
2. In plane

11 members
7 joints

13 members
8 joints

Relation between members and joints:

\[ M = 2J - 3 \]

if \( M = 11 \) then \( \frac{11 + 3}{2} = 7 \) joints

if \( M = 13 \) then \( \frac{13 + 3}{2} = 8 \) joints.
Method of joints

- Truss is in equilibrium ONLY if ALL individual pieces are in equilibrium
- Truss members are two-force members: equilibrium satisfied by equal, opposite, collinear forces

\[
\begin{align*}
\text{Tension: } & \text{ Elongate / pull} \\
\text{Compression: } & \text{ Shorten / push}
\end{align*}
\]

Procedure for analysis:

1. Draw FBD for truss and each joint.
2. Start w/ joints w/ at least 1 known and 1-2 unknown.
3. Use equations of equilibrium:
   \[
   \begin{align*}
   \Sigma F_x &= 0 \\
   \Sigma F_y &= 0 \\
   \Sigma M &= 0
   \end{align*}
   \]
4. Assume unknown forces are in tension.
   - Positive forces \( \rightarrow \) tension
   - Negative forces \( \rightarrow \) compression

Remember: the beam and link

Q: Was the link in compression or tension?
Determine the force in each member of the truss. 
Indicate whether the members are in tension or compression.

1. DRAW FBD of truss
7. LABEL external forces and reaction forces
3. DRAW FBD of joints
4. USE Equations of Equilibrium

Q: How many members/joints?
\[ N = 5 \implies \frac{5+3}{2} = 4 \text{ joints. (4FBD)} \]
- Equilibrium of truss and support reactions has to be determined first!

\[ \begin{align*}
\sum F_x: \quad & 600 - C_x = 0 \implies C_x = 600 \text{ N} \\
\sum F_y: \quad & A_y - 400 - C_y = 0 \implies C_y = A_y - 400 = 200 \text{ N} \\
\sum (M)_C: \quad & (3)(400) + (4)(600) - (6)(A_y) = 0 \\
& A_y = \frac{3600}{6} = 600 \text{ N}
\end{align*} \]

Now, analyze each joint:

**FBD of joint A**
\[ \begin{align*}
\sum F_x: \quad & F_{AD} + \frac{3}{5} F_{AB} = 0 \implies F_{AD} = -\frac{3}{5}(-750) = 450 \text{ N} \quad (\text{r}) \\
\sum F_y: \quad & A_y + \frac{4}{5} F_{AB} = 0 \implies F_{AB} = -\frac{5}{4} A_y = -750 \text{ N} \quad (\text{c})
\end{align*} \]

**FBD of joint D**
\[ \begin{align*}
\sum F_x: \quad & 600 - F_{AD} - \frac{3}{5} F_{BD} = 0 \implies F_{AD} = \frac{5}{3}(600 - 450) = 250 \text{ N} \quad (r) \\
\sum F_y: \quad & F_{CD} + \frac{4}{5} F_{BD} = 0 \implies F_{CD} = -\frac{4}{5} F_{BD} = -200 \text{ N} \quad (c)
\end{align*} \]
FBD of joint C

\[ \Sigma F_x: \quad F_{CB} - C_x = 0 \quad \Rightarrow \quad F_{CB} = C_x = 600 \text{ N} \quad (C) \]

\[ \Sigma F_y: \quad F_{CB} - C_y = 0 \quad \Rightarrow \quad F_{CB} = C_y = 200 \text{ N} \quad (\text{Check}) \quad (C) \]

Now, determine if members are in tension or compression.