Announcements

- Visual representation study consent form in PL HW
  ~ 10% overall final grade extra credit

- Upcoming deadlines:
  - Friday (10/12)
    - Written Assignment
  - Tuesday (10/16)
    - PL HW
Objective

- Truss Analysis – Method of Sections
- Frame & Machine Analysis
Example

Determine the force in member $EF$ for the truss below.

- Top piece has 3 unknowns $F_B, F_E, F_E$
- Bottom piece has 6 unknowns $F_B, F_E, F_E, A_x, A_y, G$

$\sum M_B = -10 \text{kN}(4\text{m}) - 5 \text{kN}(8\text{m})$
$- 5 \text{kN}(4\text{m})$
$- F_E(4\text{m}) = 0$

$F_E = -25 \text{kN}$

Compression
Frames and machines

Frames and machines are two common types of structures that have at least one multi-force member (Recall that trusses have nothing but two-force members).

Frames are generally stationary and used to support various external loads.
Frames and machines

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Machines contain moving parts and are designed to alter the effect of forces.
Frames and machines

The members can be truss elements, beams, pulleys, cables, and other components. The general solution method is similar to rigid body at equilibrium analysis:

1.) Use FBD to find support reactions to the whole structure

\[ \text{FBD} \]

\[ A_y \uparrow \quad A_x \quad C_x \quad C_y \]

2.) Identify/isolate the member to find forces of interest

\[ \text{FBD: BC} \]

3.) Use EoE to solve for F.

Important Tools:
1.) ID 2-force members
2.) Remember Newton’s 3rd Law.

\[ \text{FBD: AB} \quad B \swarrow \quad \text{equal & opposite to } \overrightarrow{B} \text{ on member BC.} \]
\[ \overrightarrow{FBD} = \overrightarrow{AB} \quad \text{equal & opposite to } \overrightarrow{B} \text{ on member } BC. \]
Draw the FBD of the members of the backhoe. The bucket and its contents have a weight $W$. 

4 2-force members: HI, EB, AB, BC
Find support force at $E$.

1) **Structure Analysis**

- $\Sigma F_x = A_x = 0$
- $\Sigma F_y = A_y - 9\text{kN} - 10\text{kN} + C + E = 0$
- $\Sigma M_a = M_a - (9\text{kN})(1.5\text{m}) + C(4.5\text{m}) - (10\text{kN})(7.5\text{m}) + E(9\text{m})$
  
  $-10\text{kNm} = 0$

2) **Isolate a member**

- $\Sigma F_x = D_x = 0$
- $\Sigma F_y = D_y + E - 10\text{kN} = 0$
- $\Sigma M_D = (10\text{kN})(1.5\text{m}) + E(3\text{m}) = 0$

  $E = 5\text{kN}$ → $D_y = 5\text{kN}$

~ **To many unknowns to solve for $E$.**

~ If we were to find support at $C$, use member $BD$ for analysis
\[ \text{EoE} \]
\[ \sum M_B = C(1.5\text{m}) - (10\text{kN} \cdot \text{m}) - D_y(3\text{m}) = 0 \]
\[ C = 16.7 \text{kN} \]