## To do …

- Go to discussion – 8% of your grade!
- Check your grades on compass $(-- \neq 0)$
- Sign up for Quiz 4 (CBTF next week)


- HW 13 ME due **Thurs**
- WA 2 due **Fri**
  - **Read instructions!!**

# 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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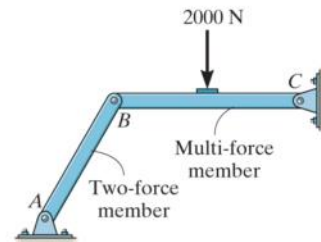


**Machines** contain **moving parts** and are designed to alter the effect of forces

Q: 2-force members?

PROPERLY CONNECTED MEMBERS!

= AWESOME!

# Frames and machines

The members can be <u>truss elements</u>, <u>beams</u>, <u>pulleys</u>, <u>cables</u>, and other components. The general solution method is the same:

2000 N

Multi-force member

Two-force member

2000 N

$F_{AB}$

$F_{AB}$

Action–reaction

$C_x$

$C_y$

$F_{AB}$

— DRAW FBD of entire FRAME or MACHINE
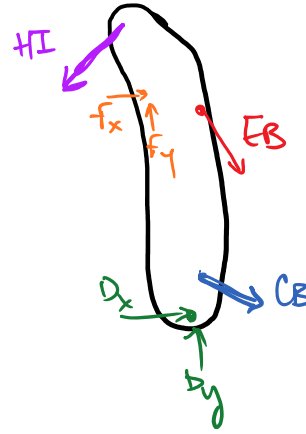
└> then of EACH subsystem (members)
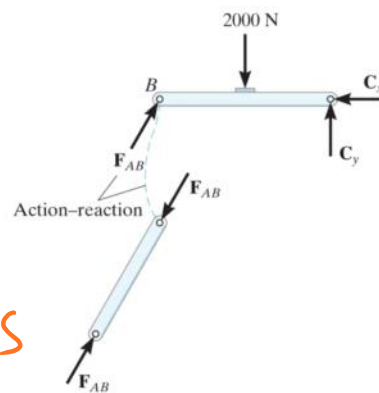
— REPRESENT All interactions

— identify two-force members

— Do NOT include internal forces on FBD

— Count unknowns, check if possible to Solve

— Choose subsystem that lEADS to the MOST Direct Solution

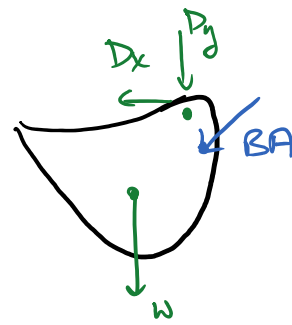— Efficiently impose equilibrium equations And Solve
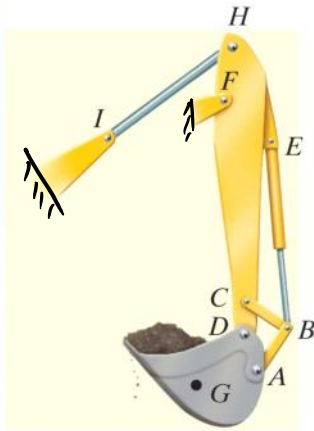
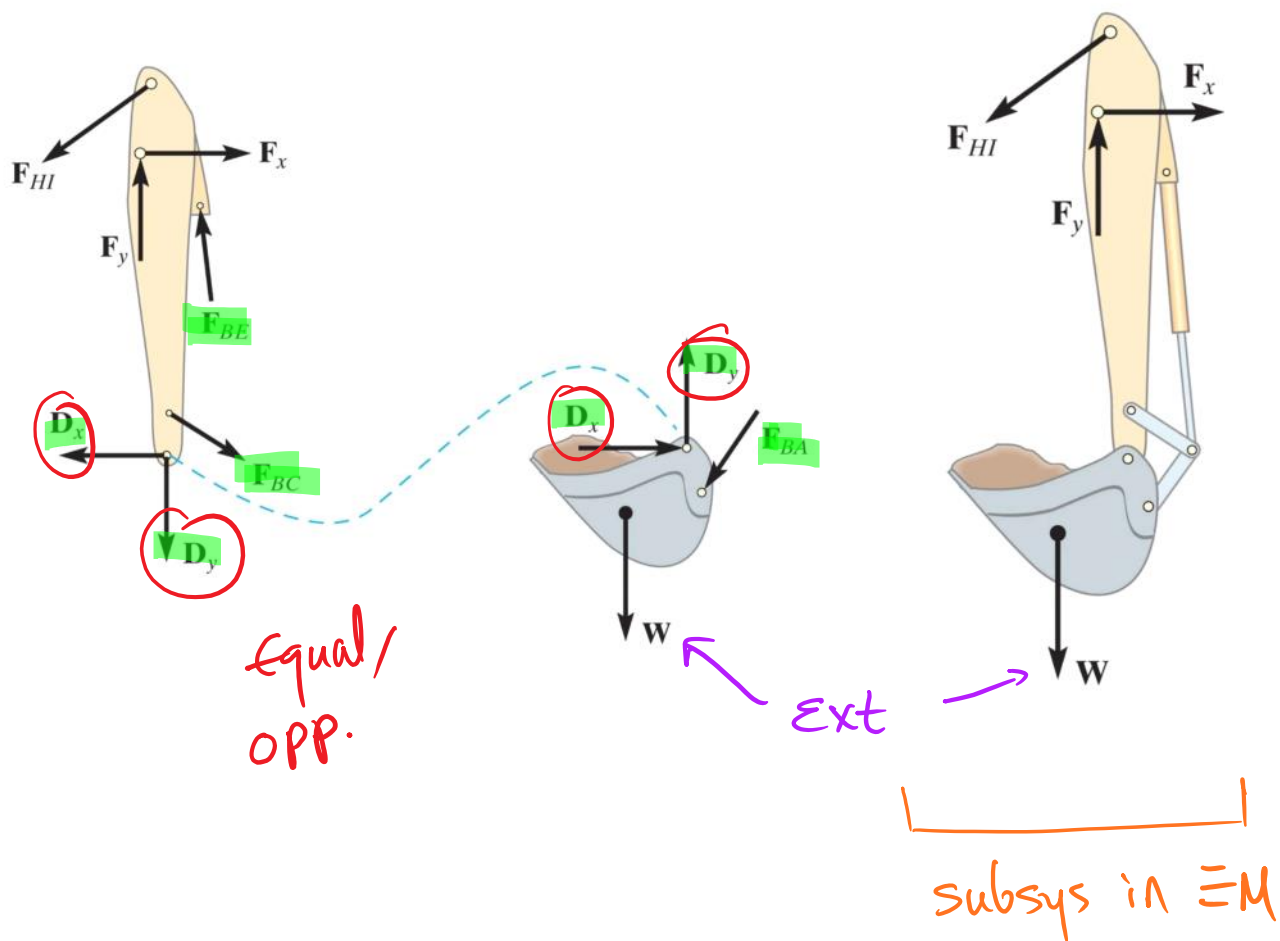Draw the FBD of the members of the backhoe. The bucket and its contents have a weight $W$.

idealized model

≠ 2 force members?

HI

$f_x$  $f_y$

EB

$D_x$

$D_y$

CB

subsys in ΞM

$D_x$  $D_y$

BA

W

subsys in ΞM

$F_{HI}$    $F_x$    $F_y$    $F_{BE}$    $D_x$    $F_{BC}$    $D_y$

Equal/ opp.

$D_x$    $D_y$    $F_{BA}$    W

Ext

$F_{HI}$    $F_x$    $F_y$    W

subsys in ΞM

400 N

800 N · m

|←1 m→|←2 m→|

1 m
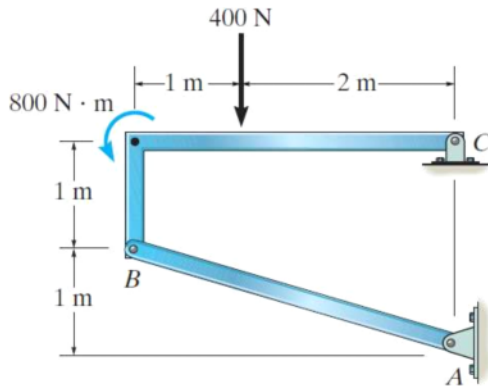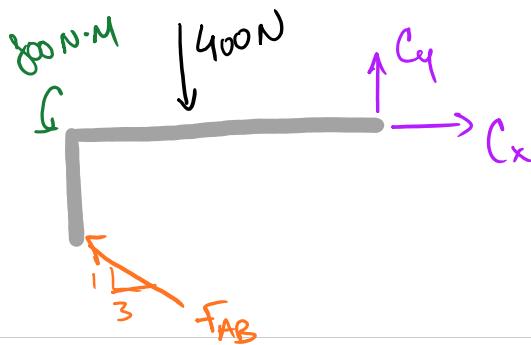
B

1 m

A

C

Find the horizontal and vertical components of the pin reactions at C and the magnitude of reaction at B.

— DRAW FBD of BC

— Identify 2-force member

800 N·M

400 N

$C_y$

$C_x$

$F_{AB}$

1
3

3 unknowns!

Sum Moments About C:

$$\Sigma M_C: \quad 2(400) + 800 - 3\left(\frac{1}{\sqrt{10}}F_B\right) - 1\left(\frac{3}{\sqrt{10}}F_B\right) = 0$$

$$F_B = \frac{\sqrt{10}}{6}(1600) = \underline{843\,N}$$

Sum forces in x And y:

$$\Sigma F_x: \qquad C_x - \frac{3}{\sqrt{10}}F_B = 0 \quad \therefore \quad C_x = \frac{-3}{\sqrt{10}}F_B = \underline{800\,N}$$

$$\Sigma f_y: \qquad C_y + \frac{1}{\sqrt{10}}f_B - 400 = 0 \qquad \therefore \; \underline{C_y = 400 - \frac{1}{\sqrt{10}}f_B = \underline{133\,N}}$$