wc15lect

# Announcements

- Happy Mid-Autumn Festival! (Aug. 15 lunar calender)

❑ Upcoming deadlines:

- Thursday (10/5)
  - ME HW11
- CATME Mid-course Survey (10/6)
- Tuesday (10/10)
  - PL HW12

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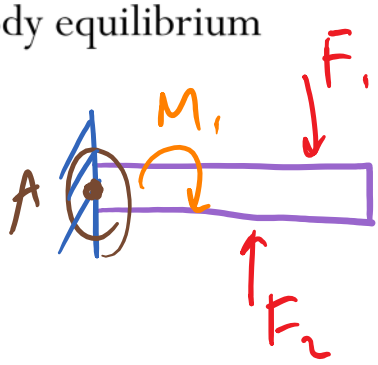
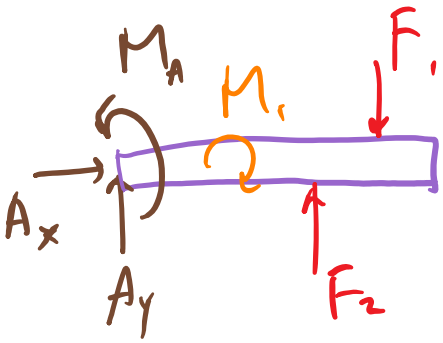
# Recap

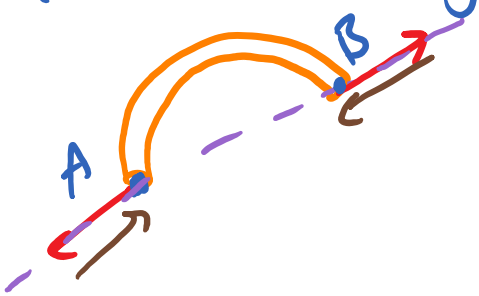
- Rigid body equilibrium




- Two force member

(Assume mass is negligible)




$\Sigma F_x = 0$

$\Sigma F_y = 0$

$\Sigma M_A = 0$.

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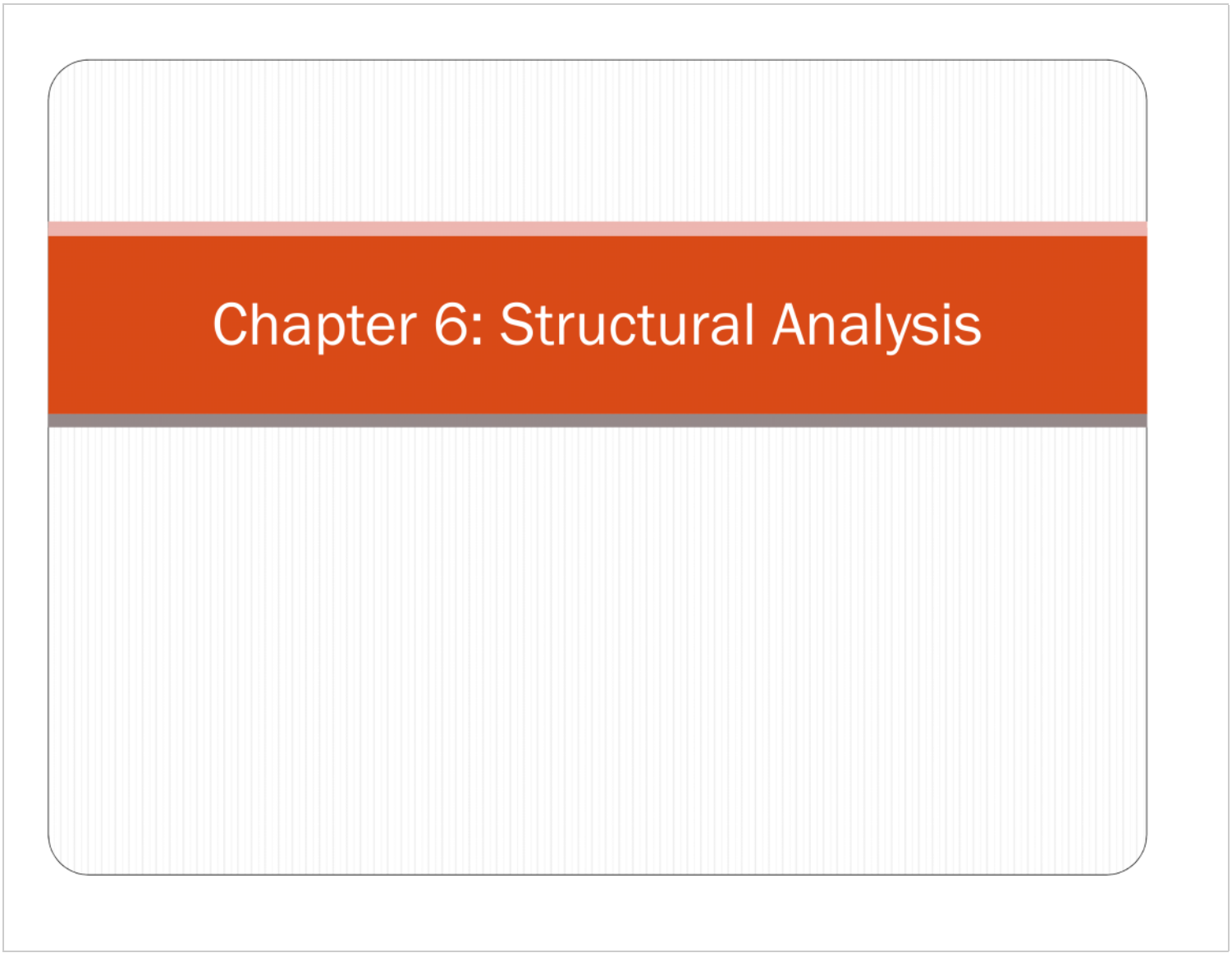

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# Goals and Objectives

- Determine the forces in members of a truss using the method of joints
- Determine zero-force members
- Determine the forces in members of a truss using the method of sections

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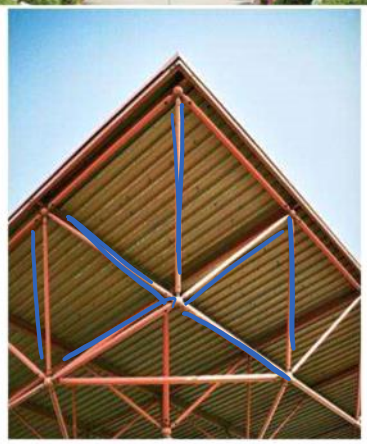
# Simple trusses

Trusses are commonly used to support roofs.



A more challenging question is, that for a given load, how can we design the trusses' geometry to minimize cost?

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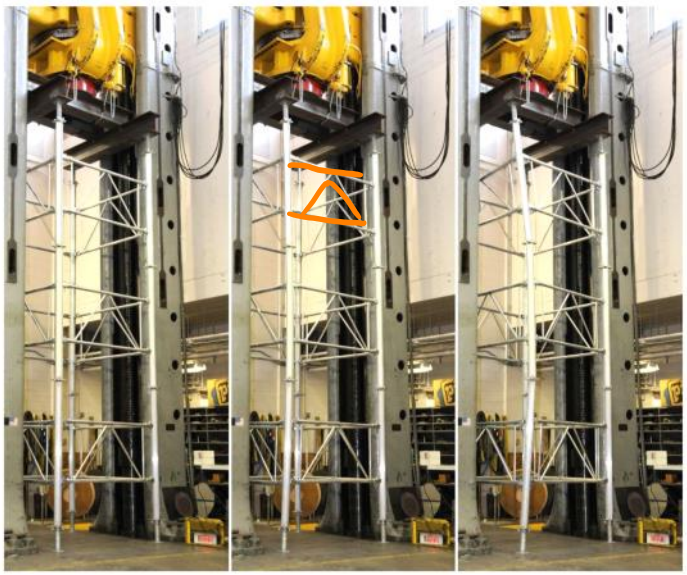
# Scaffolding



An understanding of statics is critical for predicting and analyzing possible modes of failure.

Buckling of slender members in compression is always a consideration in structural analysis.

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# Truss Structure Failure

On August 13, 2011, an outdoor concert by Sugarland at the Indiana State Fair had wind gust from an approaching severe thunderstorm hit the stage's temporary roof structure and caused it to collapse.

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# 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. Members joined by smooth pins

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

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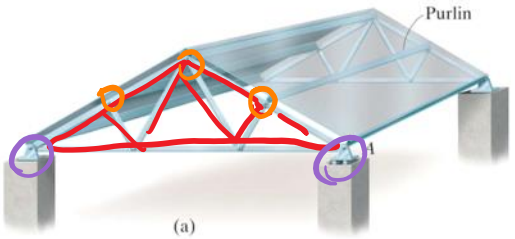


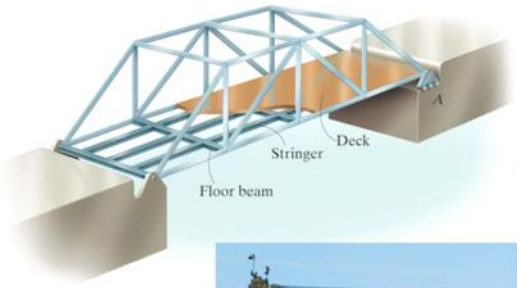


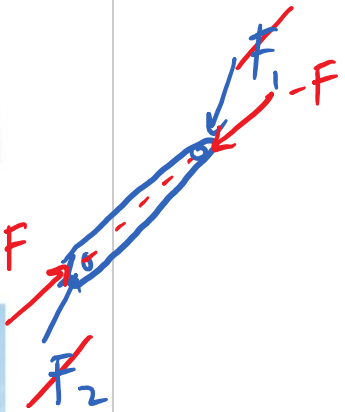

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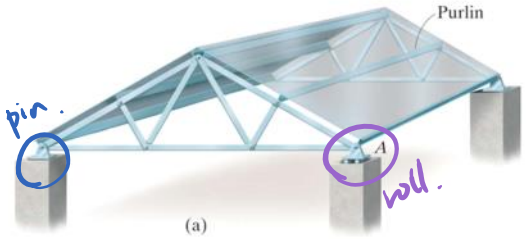
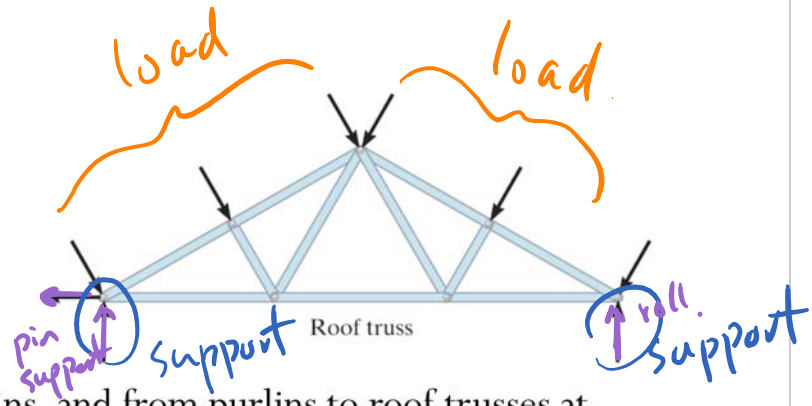
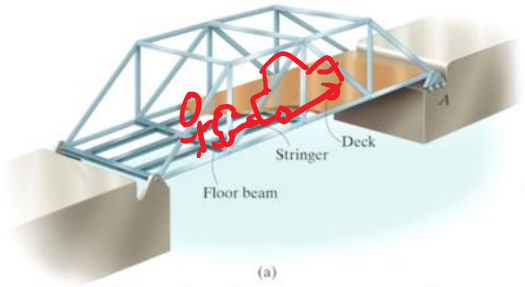
# Roof trusses

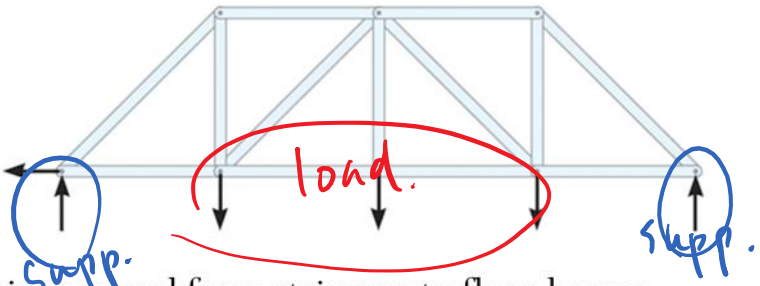



Load on roof transmitted to purlins, and from purlins to roof trusses at joints.

# Bridge trusses




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

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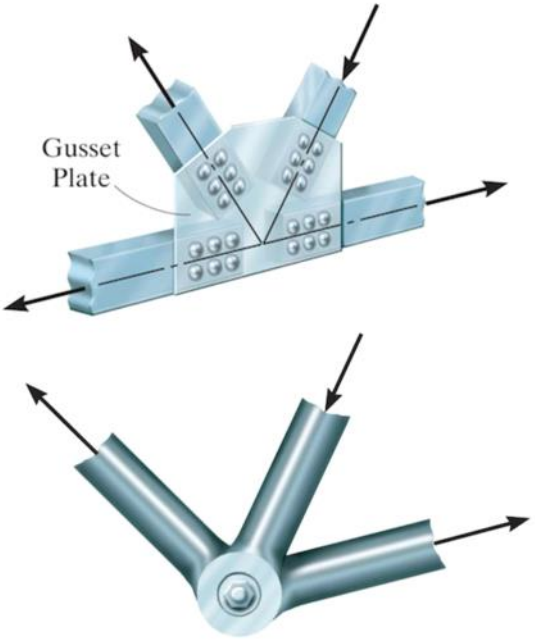
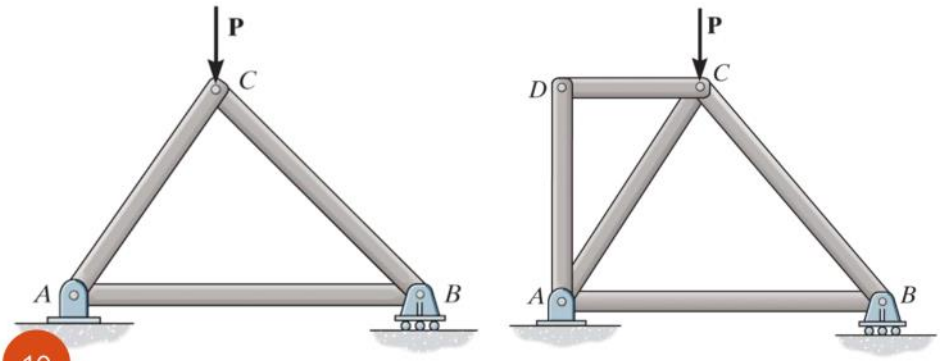
# Truss joints

- Bolting or welding of the ends of the members to a gusset plates or passing a large bolt through each of the members
- Properly aligned gusset plates equivalent to pins (i.e., no moments) from coplanar, concurrent forces
- Simple trusses built from triangular members

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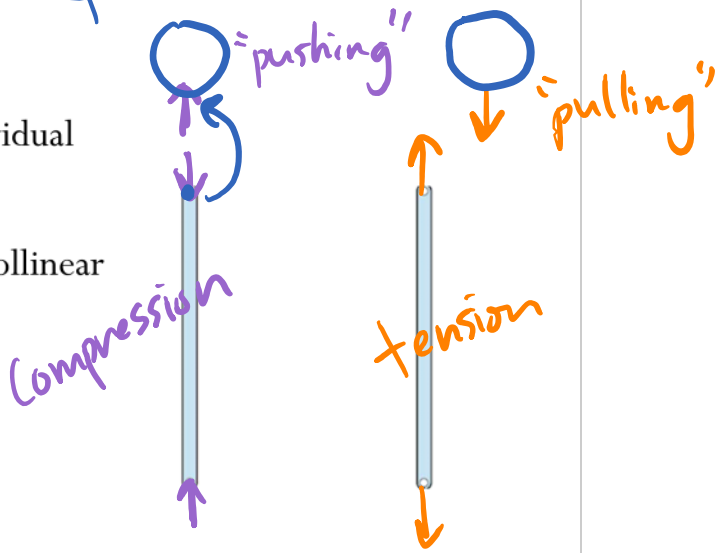
# Method of joints / pins.

- 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

(particle)




**Procedure for analysis:**

1.) Draw FBD of the truss.

2.) Select a joint/pin to draw FBD.

~ Pick one with least number of unknowns (1)

3.) Apply EoE on the joint/pin to solve.

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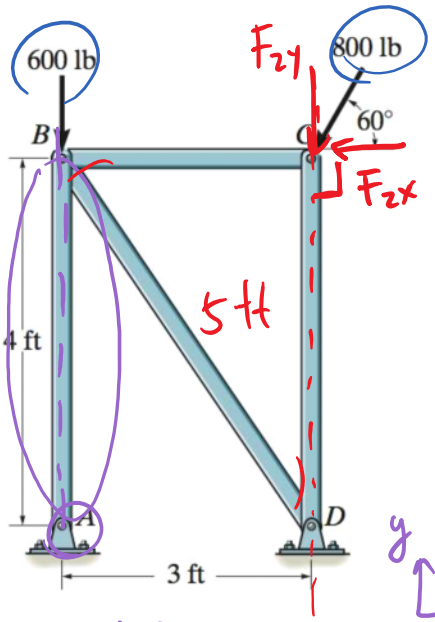
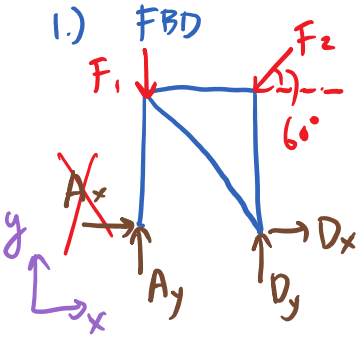
Note: Assume that truss member is under tension (+) at start.




Find the forces in each member of the truss. Determine if members are in tension or compression.

Find: $F_{AB}, F_{BC}, F_{CD}, F_{DB}$




EoE

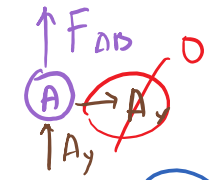
$\Sigma F_x = D_x - F_2 \cos 60° = 0$

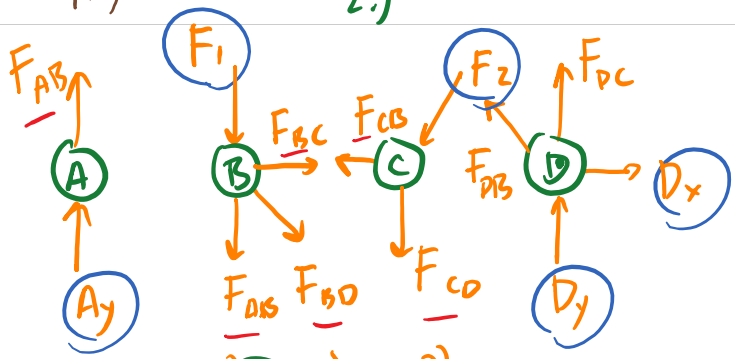
$\Rightarrow D_x = F_2 \cos 60° = 400\,lb$

$\Sigma F_y = -F_1 - F_2 \sin 60° + A_y + D_y = 0$

$\Sigma M_D = -A_y(3\,ft) + F_1(3\,ft) + (F_2 \cos 60°)(4\,ft) = 0$

$\Rightarrow A_y = \frac{3400}{3}\,lb$




Unknown: A) 1 ✓, B) 3, C) 2 ✓, D) 2 ✓

Pin A

$\Sigma F_y = A_y + F_{AB} = 0$

$F_{AB} = -A_y = -\frac{3400}{3}\,lb$ (C)

Pin B

$\Sigma F_x = F_{BC} + F_{BD}\left(\frac{3}{5}\right) = 0$

$F_{BD} = -\frac{5}{3} F_{BC}$ in (T)

$= \frac{2000}{3}\,lb$

Pin C

$\Sigma F_x = -F_2 \cos 60° - F_{CB} = 0$

$\Sigma F_y = -F_2 \sin 60° - F_{CD} = 0$

$F_{CB} = -F_2 \cos 60°$ in (C) $= -400\,lb$

$F_{CD} = -F_2 \sin 60°$ in (C)

$= -400\sqrt{3}\,lb$

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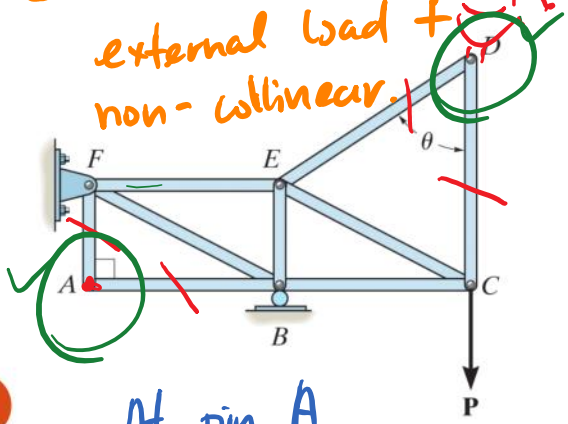
# Zero-force members

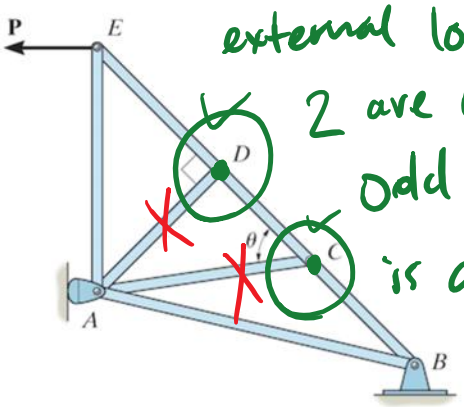
- Particular members in a structure may experience no force for certain loads.
- Zero-force members are used to increase stability
- Identifying members with zero-force can expedite analysis.

Pin Method:

① 2 members without external load + non-collinear.




② 3 member without external load + 2 are collinear. Odd one out is a zero-force member.

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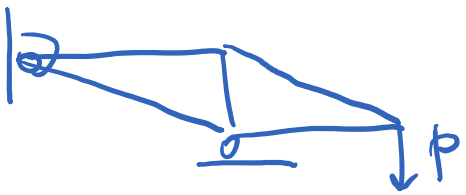
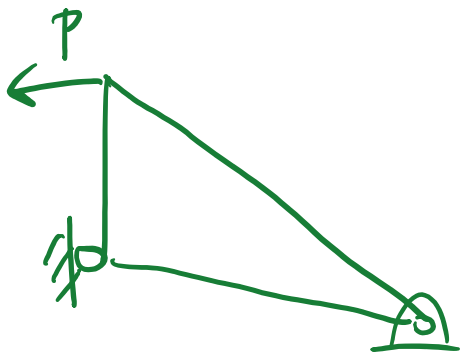
At pin A

$F_{AF}$

A → $\Sigma F_x = F_{AB} = 0$

$F_{AB}$ $\Sigma F_y = F_{AF} = 0$



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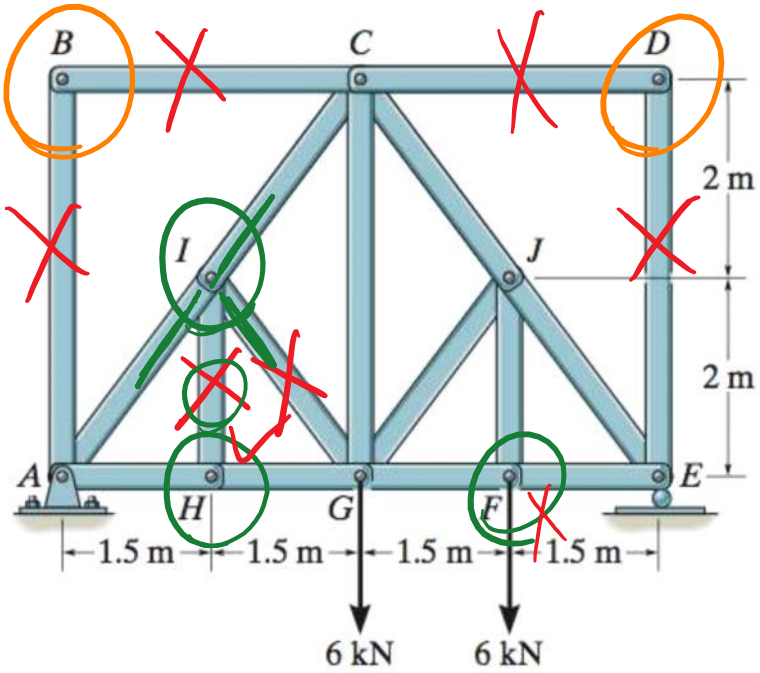
Identify all zero-force members in the truss.




① 2 member

② 3 member

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