Housekeeping

- Thursday
  - ME HW 11
- Saturday
  - Last quiz day
- Sunday
  - WA due
- Tuesday
  - PL HW 12
- Thursday
  - ME HE 13
Chapter 6: Structural Analysis

Main goals and learning 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
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?

Silver creek in urbana
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.
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

Procedure for analysis:

1. Draw FBD of truss (solve for reactions) /look for 2FMUs
2. FBD of joint
3. Start with joint with at least 1 known, 1-2 unknown
4. Use EoE \( EF, EM \) (2D, \( \therefore \) we have 3 EoE)
5. Assume unknowns are in tension (positive) /Draw F towards the member
**Given:** Loads as shown on the truss

**Find:** The forces in each member of the truss. Determine if members are in tension or compression.
SLIDE 10

1. FBD entire truss (introduces more knowns!)

\[ \sum F_x : C_x + 600N = 0 \]
\[ C_x = -600N \]

\[ \sum M_c : -A_y (6m) + (400N)(3m) - (600N)(4m) = 0 \]
\[ (6m)(A_y) = 1200Nm + 2400Nm \]
\[ (6m)(A_y) = 3600Nm \]
\[ A_y = 600N \]

\[ \sum F_y : A_y - 400N + C_y = 0 \]
\[ C_y = 400N - 600N = -200N \]
② Analyze each joint

FBD A

\[ \sum F_y: \quad \frac{4}{5} F_{AB} + 600N = 0 \quad : \quad F_{AB} = -750N \]

\[ \sum F_x: \quad \frac{3}{5} F_{AB} + F_{AD} = 0 \]

\[ F_{AD} = -\frac{3}{5}(-750N) = 450N \]
\[ F_{BC} \rightarrow -600N = F_{BC} \rightarrow 600N \]
\[ \sum F_x : -600N - F_{BC} = 0 \]
\[ F_{BC} = -600N \] cmp!

\[ \sum F_y : -200N - F_{CD} = 0 \]
\[ F_{CD} = -200N \] cmp

\[ \sum F_y : F_{CD} + \frac{4}{5} F_{BD} = 0 \]
\[ F_{BD} = -\frac{5}{4} F_{CD} \]
\[ F_{BD} = -\frac{5}{4} (-200N) \]
\[ F_{BD} = 250N \]
Zero-force members (ZFM's)

- 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.

- "CORNERS" w/o external loads
- 0° collinear members w/ only one non-collinear member attached
Slide 7

Corner: $2FM$

FBD: Truss

$F_x \rightarrow y \rightarrow x$

$F_{B_y}$

$F_{B_y} \rightarrow x$

$F_{AB}$

$\varepsilon F_x: F_{AB} = 0!$

$\varepsilon F_y: F_{BA} = 0!$

FBD: $y \rightarrow x$

$F_{D_y} \rightarrow x$

$F_{DE} \leftarrow F_{DC}$

$\varepsilon F_x: -F_{DE} \sin \theta = 0$

$F_{DE} = 0!$
Colinear zFM

FBD of Truss

FBD of D

FBD of DC

\[ \sum F_x: \quad -F_{DA} = 0! \]
\[ \theta \neq 90^\circ \]

\[ \sum F_x: \quad -F_{CA} \sin \theta = 0 \quad \therefore F_{CA} = 0! \]
**Given:** Loads as shown on the truss

**Find:** The forces in each member of the truss.