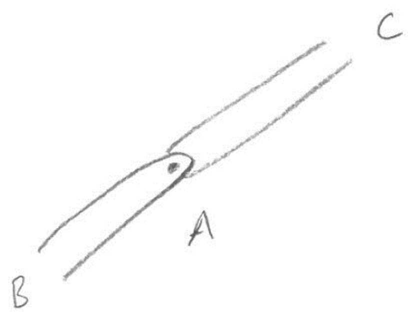
Lecture 18
GEN_ENG 205-2: Engineering Analysis 2
Winter Quarter 2018
Prof. James P. Hambleton
Chapters 6: §6.2 The Method of Joints; §6.3 The Method of Sections[1]

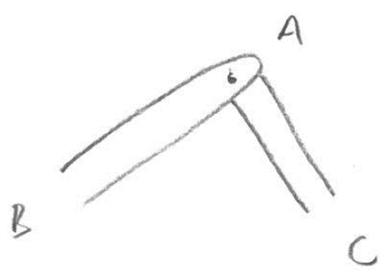
Acknowledgements

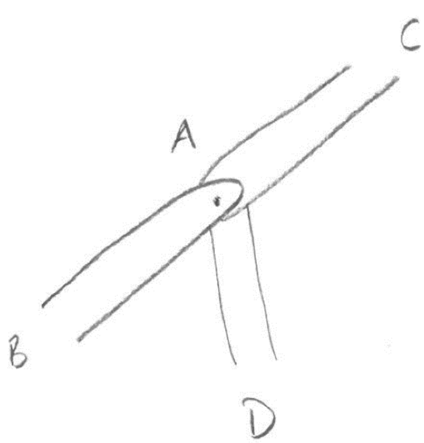
Portions of these lecture notes are taken from those of Prof. Jeff Thomas.

Method of Joints (continued)

Special joints, including zero-force members[2]







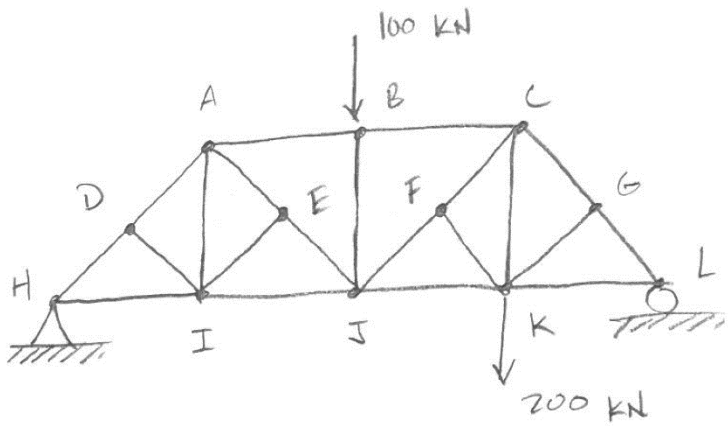
[1] Bedford, A., & Fowler, W. (2008). *Engineering Mechanics: Statics and Dynamics* (5th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.
[2] Consider adding other joints to this section for clarity (see notes by Jeff Thomas).

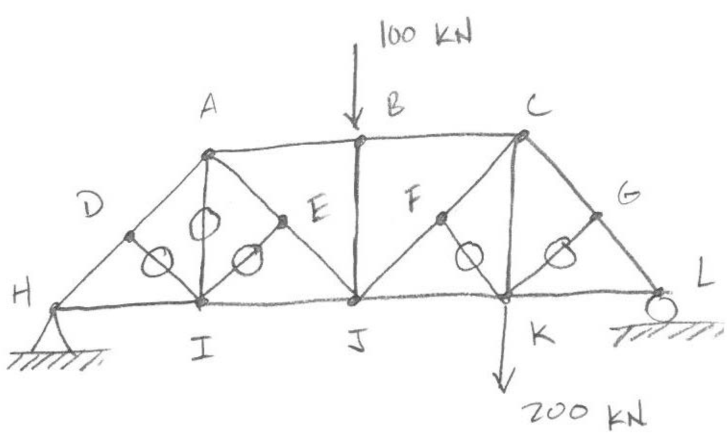
These are 3 special cases:

1. Two collinear members: If there are no external forces, the axial forces are equal.
2. Two noncollinear members: If there are no external forces, the axial forces are zero in both members (i.e., the member is a "zero-force member").
3. Three members, two of which are collinear: If there no external forces, the axial forces in the collinear members are equal and the axial force in the third member is zero.

We can use this to solve problems, or parts of problems, very quickly.

Example:





Members *DI*, *EI*, *AI*, *FK*, and *GK* are all zero-force members.

Also, $T_{HI} = T_{IJ}$, $T_{DH} = T_{AD}$, and $T_{CG} = T_{GL}$.

We can also see quickly that T_{BJ} = 100 kN (compression) and T_{CK} = 200 kN (tension).

Why would one include members *DI*, *EI*, *FK*, and *GK* if they are all zero-force members.

Answer: These will prevent buckling[3] of members in compression (e.g., members *AH* and *CL*).

Method of Sections

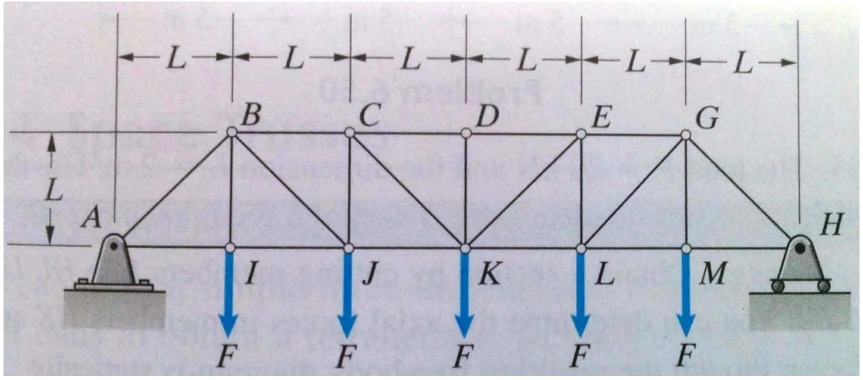
As an alternative to the method of joints, the method of sections is useful when we are interested in the axial forces in certain members.

Analysis steps:

1. If necessary, draw the free-body diagram for the whole structure to determine reactions.
2. Pass a plane (i.e., consider an imaginary cut) through selected members, whose axial forces are to be determined, and draw the free-body diagram for that part, or *section*, of the truss.
3. Solve for the unknown forces using $\sum F_x = 0$, $\sum F_y = 0$, and $\sum M_P = 0$.
4. Repeat Steps (2)-(3) as necessary.

[3] Demonstrate buckling using a ruler and discuss Euler's solution.

Example: Problem 6.41



The Pratt bridge truss supports five forces F = 340 kN. The dimension L = 8 m. Determine the axial force in member JK.

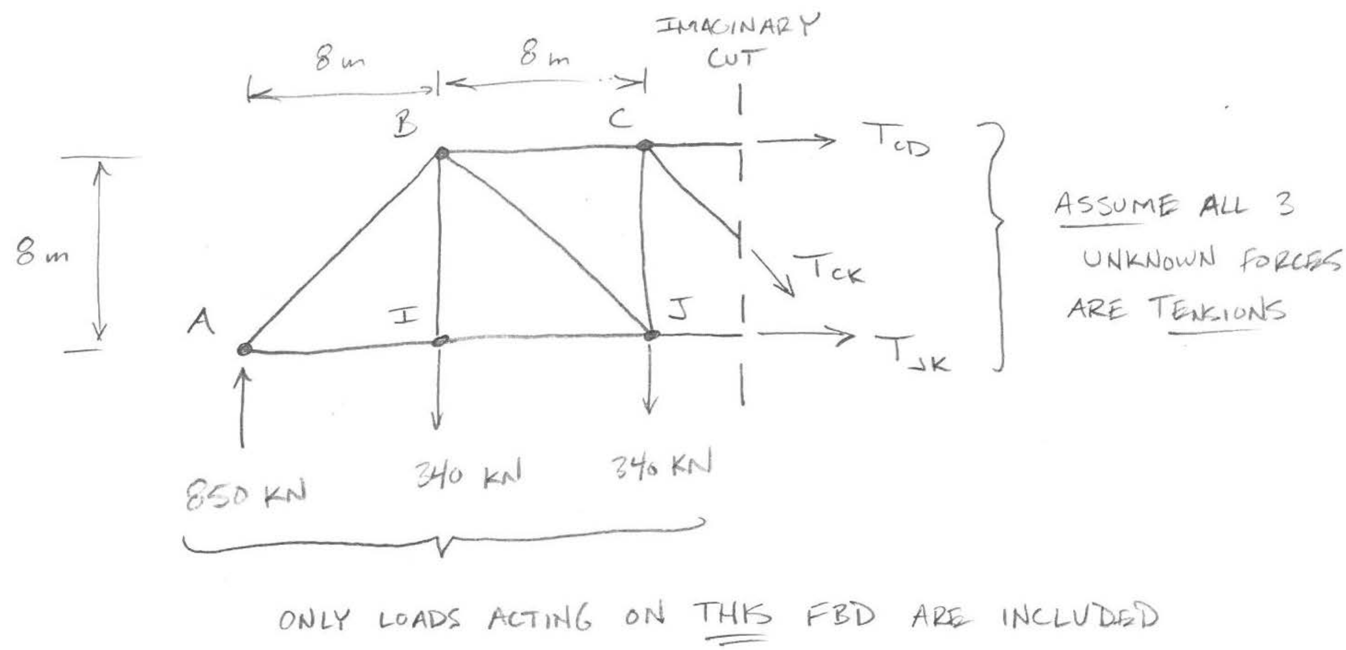
Strategy: Clearly, the method of joints would be onerous, so we will use the method of sections. Draw the free-body diagram for the whole structure to determine the reactions, and then pass a plane vertically through section JK, considering equilibrium of the resulting part (section) of the structure to the left.

Determine reactions:

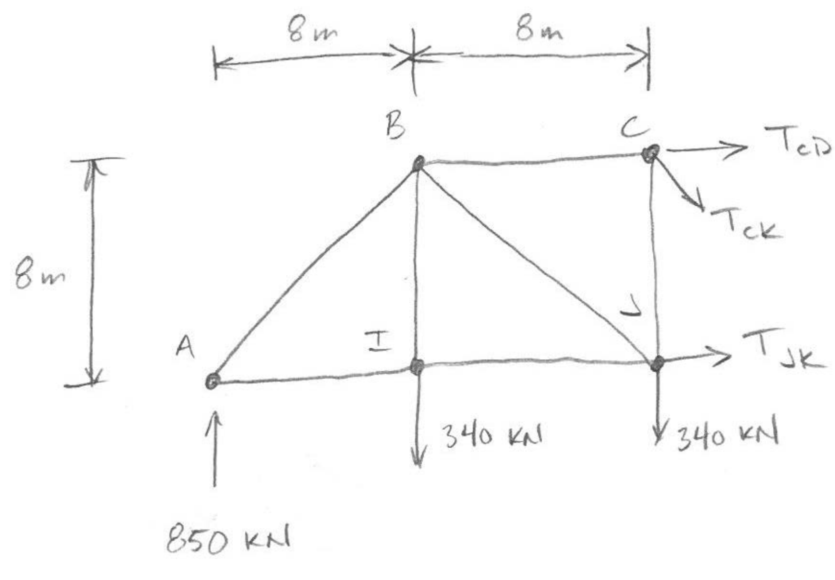
By symmetry, $A_x = 0$, $A_y = H_y$.

$$\sum F_y = 0: A_y + H_y = 5F \quad \Rightarrow \quad \boxed{A_y = H_y = 850\,\text{kN}}$$

Make a cut through members CD, CK, and JK.



Since we can move the forces along their respective lines of action, we can also draw this more simply as follows:



Observe that there are three equilibrium equations (including moment equilibrium) and three unknowns, so we can solve for the unknown forces.

Furthermore, observe the two of the three unknown forces pass through point C[4].

$$\sum M_C = 0:$$

$$\sum M_C = 0: T_{JK}\left(8\,\mathrm{m}\right) - \left(850\,\mathrm{kN}\right)\left(16\,\mathrm{m}\right) + \left(340\,\mathrm{kN}\right)\left(8\,\mathrm{m}\right) = 0 \quad \Rightarrow \quad \boxed{T_{JK} = 1360\,\mathrm{kN}}$$

Remarks:

- Method of joints is more systematic and often preferable.
- Never "cut" something that is not a two-force member (we will see this momentarily when looking at frames)!

Go through Examples 6.3 and 6.4 in class.

3D Trusses

We are skipping Section 6.4 on 3D trusses.

[4] Experience suggests that students struggle with computing moments using force components and perpendicular distances. Be sure to go through this slowly and carefully.