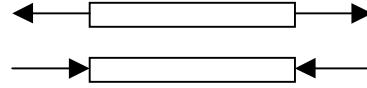


Truss Structures

- A truss is made up of straight two-force members connected at its ends. The triangular arrangement produces stable geometry. Loads on a truss are applied at the joints only.
- Joints are pin-type connections (resist translation, not rotation).
- Forces of action and reaction on a joint must be equal and opposite.
- Members in TENSION are being pulled.
- Members in COMPRESSION are being squeezed.
- External forces act on the joints.

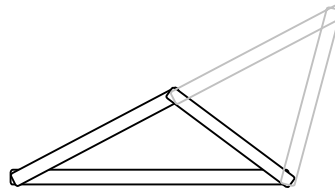


- Truss configuration:

Three members form a rigid assembly with **3 (three)** connections.

To add members and still have a rigid assembly, **2 (two)** more must be added with one connection between.

For rigidity: $b = 2n - 3$, where b is number of members and n is number of joints



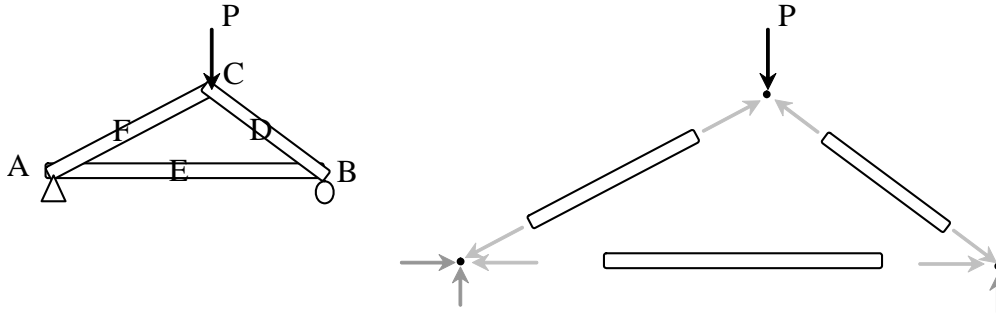
Method of Joints

- The method takes advantage of the conditions of equilibrium at each joint.
1. Determine support reaction forces.
 2. Draw a FBD of each member AND each joint
 3. Identify geometry of angled members
 4. Identify zero force members and other special (easy to solve) cases
 5. Each pin is in equilibrium ($\sum F_x = 0$ and $\sum F_y = 0$ for a concurrent force system)
 6. Total equations = $2n = b+3$ (one force per member + 3 support reactions)

Advantages: Can find every member force

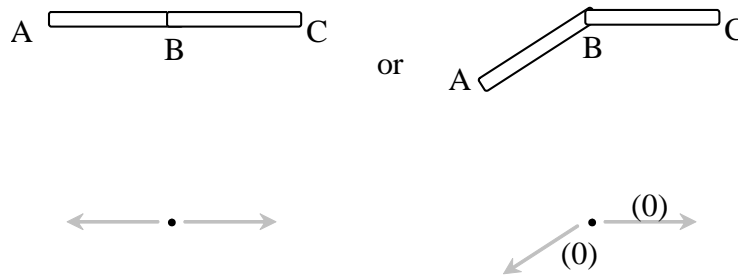
Disadvantages: Lots of equations, easy to lose track of forces found.

Tools available: Tip-to-tail method for 3 joint forces must close
Analytically, there will be at most 2 unknowns with 2 equilibrium equations.



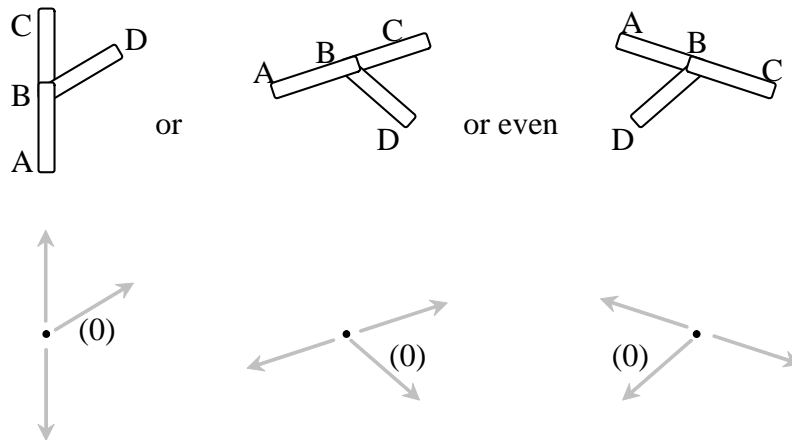
Joint Configurations (special cases to recognize for faster solutions)

Case 1) Two Bodies Connected



F_{AB} has to be **equal (=)** to F_{BC}

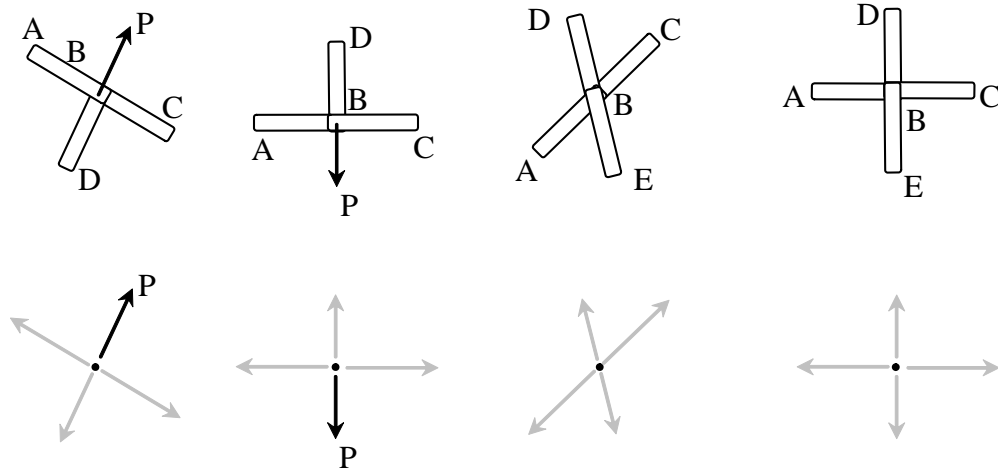
Case 2) Three Bodies Connected with Two Bodies in Line



F_{AB} and F_{BC} have to be equal, and F_{BD} has to be **0 (zero)**.

Case 3) Three Bodies Connected and a Force – 2 Bodies aligned & 1 Body and a Force are Aligned

Four Bodies Connected - 2 Bodies Aligned and the Other 2 Bodies Aligned



F_{AB} has to equal F_{BC} , and $[F_{BD}$ has to equal $P]$ or $[F_{BD}$ has to equal $F_{BE}]$

Graphical Analysis

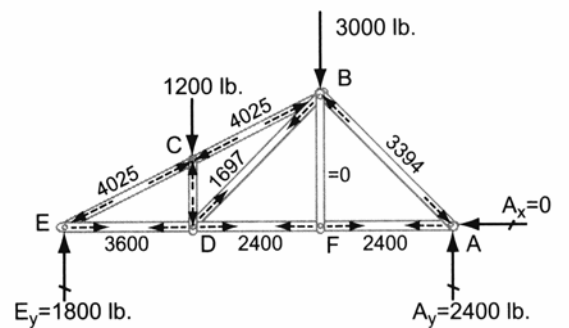
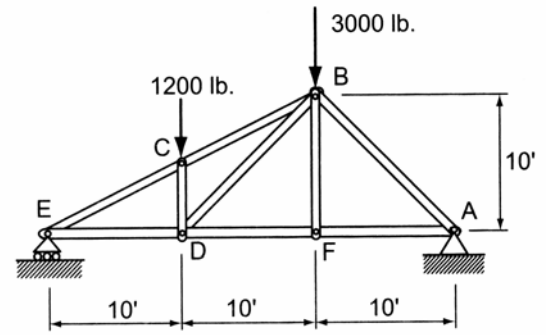
The method utilizes what we know about force triangles and plotting force magnitudes *to scale*.

1. Draw an accurate form diagram of the truss at a convenient scale with the loads and support reaction forces.
2. Determine the support reaction forces.
3. Working clockwise and from left to right, apply interval notation to the diagram, assigning capital letters to the spaces between external forces and numbers to internal spaces.
4. Construct a load line to a convenient scale of length to force by using the interval notation and working clockwise around the truss from the upper left plotting the lengths of the vertical and horizontal loads.
5. Starting at a left joint where we know there are fewer than three forces, we draw reference lines in the direction of the unknown members so that they intersect. Label the intersection with the number of the internal space.
6. Go to the next joint (clockwise and left to right) with two unknown forces and repeat for all joints. The diagram should close.
7. Measure the line segments and apply interval notation to determine their sense: Proceeding clockwise around the joint, follow the notation. The direction toward the joint is compressive. The direction away from the joint is tensile.

Example 1 (pg 90)

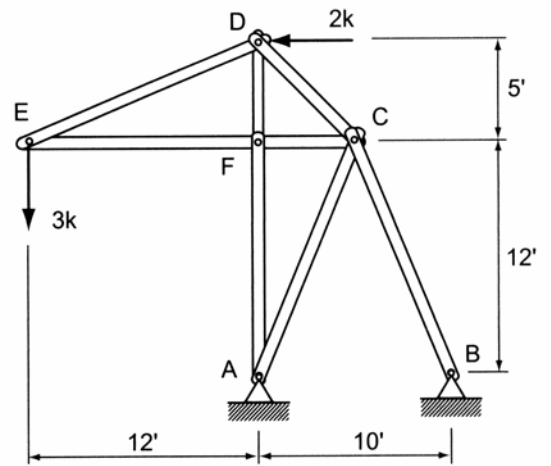
Example Problem 4.1 (Method of Joints)

An asymmetrical roof truss, shown in Figure 4.4, supports two vertical roof loads. Determine the support reactions at each end, then, using the method of joints, solve for all member forces. Summarize the results of all member forces on a FBD (this diagram is referred to as a *force summation diagram*).



Example 2 (pg 93)**Example Problem 4.2 (Method of Joints)**

A simple stadium truss (Figure 4.12) is loaded with two forces as shown. Solve for the support reactions at *A* and *B*, then, using the method of joints, determine all of the member forces.

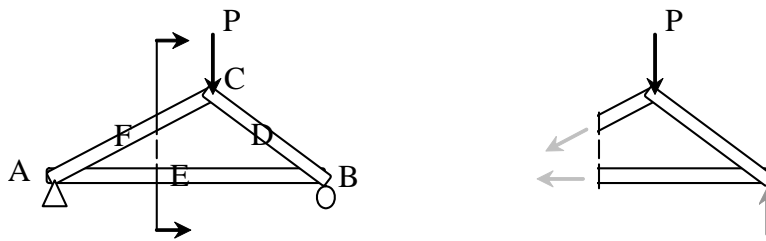


Method of Sections (relies on internal forces being in equilibrium with external forces on a section)

1. Determine support reaction forces.
2. Cut a section in such a way that force action lines intersect and no more than 3 members are cut.
3. Solve for equilibrium. Sum moments about an intersection of force lines of action

Advantages: Quick when you only need one or two forces (only 3 equations needed)

Disadvantages: Not always easy to find a place to cut a section or see where force lines intersect



- Compound Truss: A truss assembled of simple trusses and additional links. It has $b=2n-3$, is statically determinate, rigid and completely constrained with a pin and roller. It can be identified by triangles with pins in the middle of some sides.

• Statically Indeterminate Trusses:

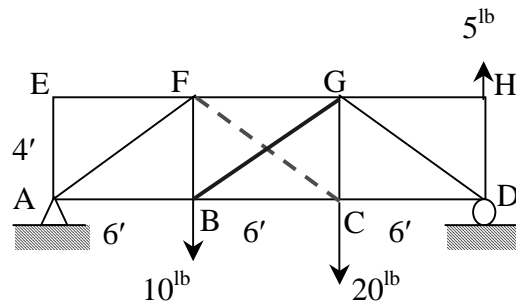
Occur if there are more members than equations for all the joints

OR if there are more reaction supports unknowns than 3

- Diagonal Tension Counters: Crossed bracing of cables or slender members is commonly used in bridge trusses, buildings and towers. These trusses look indeterminate, but can be solved statically because the bracing cannot hold a compressive force. The members are excluded in the analysis.

Method:

1. Determine support reaction forces.
2. Cut a section in such a way that the tension counters are exposed.
3. Solve for force equilibrium in y with one counter. If the value is positive (in tension), this is the solution.
4. Solve for force equilibrium in y with the other counter.



Example 3 (pg 99)**Example Problem 4.3 (Method of Sections)**

A 64-foot parallel chord truss (Figure 4.30) supports horizontal and vertical loads as shown. Using the method of sections, determine the member forces BC , HG , and GD .

