Method of Joints

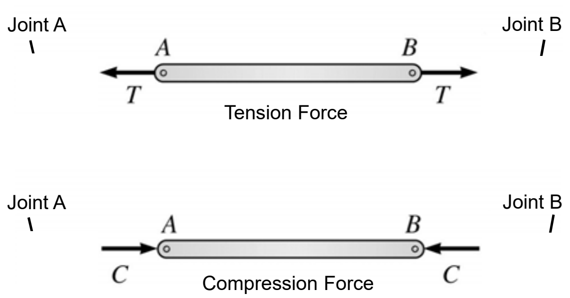
- If a truss is in equilibrium, then each of its joints must be in equilibrium.
- The **method of joints** consists of satisfying the equilibrium equations for forces acting on each joint.

$$\sum F_x = 0 \qquad \sum F_y = 0$$

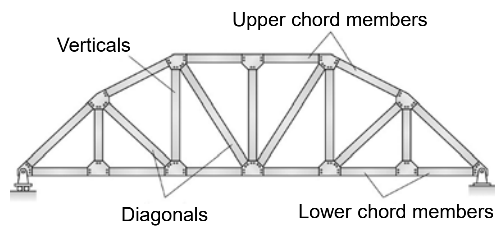
Method of Joints

- Recall, that the line of action of a force acting on a joint is determined by the geometry of the truss member.
- The *line of action* is formed by connecting the two ends of each member with a straight line.
- Since direction of the force is known, the remaining unknown is the magnitude of the force.

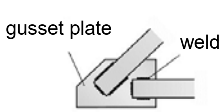
Method of Joints

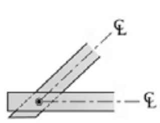


Method of Joints



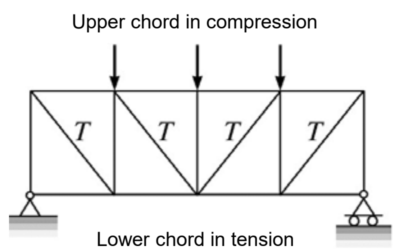
Method of Joints





Idealized joint – members connected by a frictionless pin

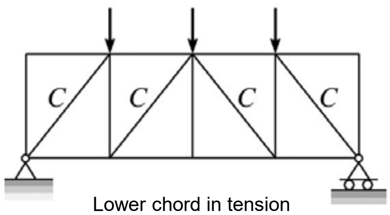
Method of Joints



This is a Pratt truss

Method of Joints

Upper chord in compression



Lower chord in tension

This is a Howe truss

Method of Joints

Procedure for analysis - the following is a procedure for analyzing a truss using the method of joints:

1. If possible, determine the support reactions
2. Draw the free body diagram for each joint. In general, assume all the force member reactions are **tension** (this is not a rule, however, it is helpful in keeping track of tension and compression members).

Method of Joints

Procedure for analysis - the following is a procedure for analyzing a truss using the method of joints:

3. Write the equations of equilibrium for each joint,

$$\sum F_x = 0 \qquad \sum F_y = 0$$

Method of Joints

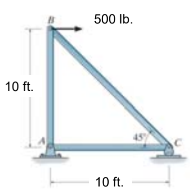
Procedure for analysis - the following is a procedure for analyzing a truss using the method of joints:

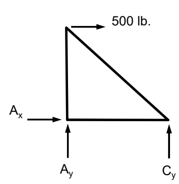
4. If possible, begin solving the equilibrium equations at a joint where only two unknown reactions exist. Work your way from joint to joint, selecting the new joint using the criterion of two unknown reactions.
5. Solve the joint equations of equilibrium simultaneously, typically using a computer or an advanced calculator.

Method of Joints

Example - Consider the following truss

First, determine the support reactions for the truss





Method of Joints

Example - Consider the following truss

First, determine the support reactions for the truss

$$\circlearrowleft^{+} \sum M_A = 0 = -500 \text{ lb.}(10 \text{ ft.}) + C_y(10 \text{ ft.})$$

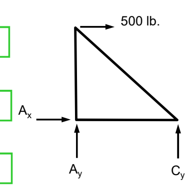
C_y = 500 lb.

$$^{+}\uparrow \sum F_y = 0 = A_y + C_y$$

A_y = -500 lb.

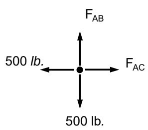
$$\xrightarrow{+} \sum F_x = 0 = A_x + 500 \text{ lb.}$$

A_x = -500 lb.



Method of Joints

The equations of equilibrium for Joint A

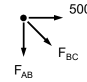


$\xrightarrow{+} \sum F_x = 0 = F_{AC} - 500 \text{ lb.}$ F_{AC} = 500 lb.

$+\uparrow \sum F_y = 0 = F_{AB} - 500 \text{ lb.}$ F_{AB} = 500 lb.

Method of Joints

The equations of equilibrium for Joint B



$\xrightarrow{+} \sum F_x = 0 = F_{BC} \cos 45^\circ + 500 \text{ lb.}$

F_{BC} = -707.2 lb.

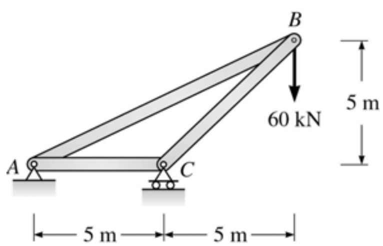
The forces in the truss can be summarized as:

F_{AB} = 500 lb. (T) F_{BC} = 707.2 lb. (C)

F_{AC} = 500 lb. (T)

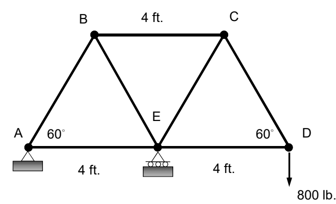
Method of Joints

Problem – Determine the force in each member of the truss shown below



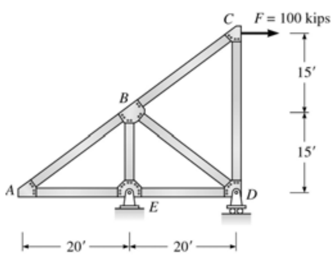
Method of Joints

Problem – Determine the force in each member of the truss shown below



Method of Joints

Problem – Determine the force in each member of the truss shown below

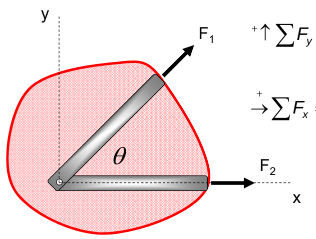


Zero Force Members

- Truss analysis may be simplified by determining members with no loading or zero-force.
- These members may provide stability or be useful if the loading changes.
- Zero-force members may be determined by inspection of the joints

Zero Force Members

Case 1: If two members are connected at a joint and there is no external force applied to the joint

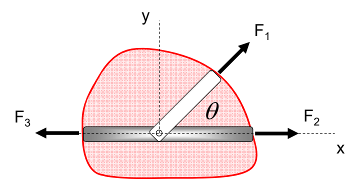


$$\overset{+}{\uparrow}\sum F_y = 0 = F_1 \sin\theta$$ $F_1 = 0$

$$\overset{+}{\rightarrow}\sum F_x = 0 = F_1 \cos\theta + F_2$$ $F_2 = 0$

Zero Force Members

Case 2: If three members are connected at a joint and there is no external force applied to the joint and two of the members are colinear

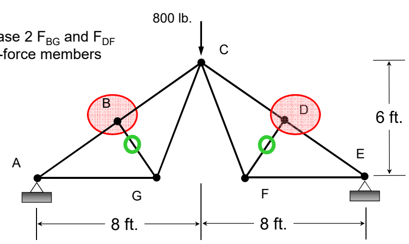


$$\overset{+}{\uparrow}\sum F_y = 0 = F_1 \sin\theta$$ $F_1 = 0$

Zero Force Members

Determine the force in each member of the truss shown below:

Using Case 2 F_{BG} and F_{DF} are zero-force members

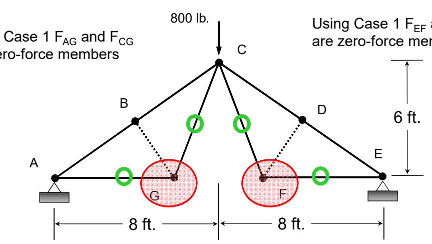


Zero Force Members

Determine the force in each member of the truss shown below:

Using Case 1 F_{AG} and F_{CG} are zero-force members

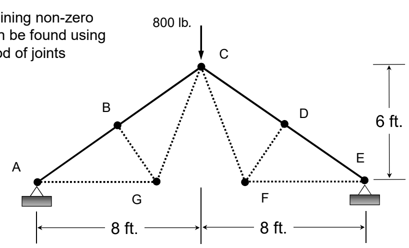
Using Case 1 F_{EF} and F_{CF} are zero-force members



Zero Force Members

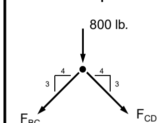
Determine the force in each member of the truss shown below:

The remaining non-zero forces can be found using the method of joints



Method of Joints

The equations of equilibrium for Joint C



$$\overset{+}{\rightarrow}\sum F_x = 0 = -\frac{4}{5}F_{BC} + \frac{4}{5}F_{CD}$$ $F_{BC} = F_{CD}$

$$\overset{+}{\uparrow}\sum F_y = 0 = -\frac{3}{5}F_{BC} - \frac{3}{5}F_{CD} - 800 \text{ lb.}$$

F_{BC} = -666.7 lb.

F_{BC} = 666.7 lb. (C)

End of Trusses - Part 2

Any questions?