Ishik University / Sulaimani
Civil Engineering Department

# Engineering Mechanics I

## Chapter -6-

## Structural Analysis

## Chapter Objectives

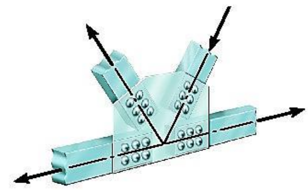
- To show how to determine the forces in the members of a truss using the method of joints and the method of sections.
- To analyze the forces acting on the members of frames and machines composed of pin-connected members.

# Chapter Outline

- Simple Trusses
- The Method of Joints
- Zero-Force Members
- The Method of Sections

# 6.1 Simple Trusses

- A truss is a structure composed of slender members joined together at their end points.
- Joint connections are formed by bolting or welding the ends of the members to a common plate, called a gusset plate, or by simply passing a large bolt or pin through each of the members



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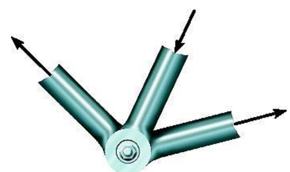

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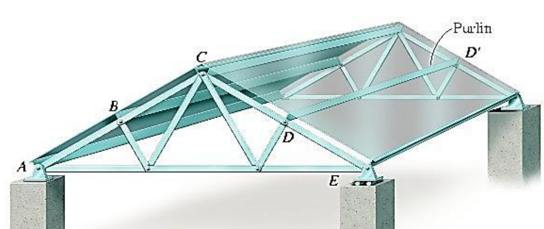
# 6.1 Simple Trusses

## Planar Trusses

- Planar trusses lie on a single plane and are used to support roofs and bridges.
- The truss ABCD shows a typical roof-supporting truss.
- Roof load is transmitted to the truss at joints by means of a series of purlins, such as DD’

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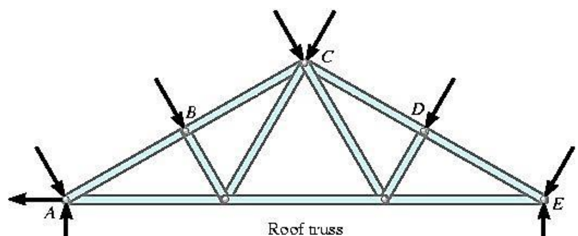
# 6.1 Simple Trusses

## Planar Trusses

- The analysis of the forces developed in the truss members is 2D.

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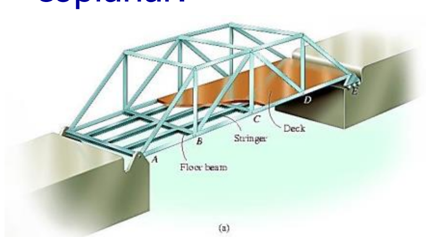
# 6.1 Simple Trusses

## Planar Trusses

- For a bridge, the load on the deck is first transmitted to the stringers, then to the floor beams, and finally to the joints B, C and D of the two supporting trusses.
- Like the roof truss, the bridge truss loading is also coplanar.

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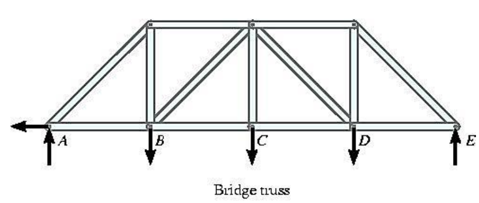


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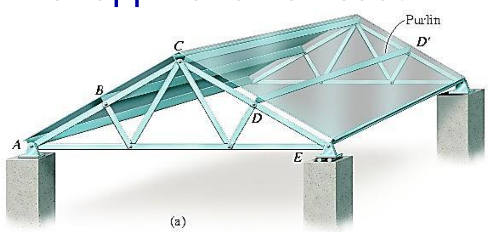
# 6.1 Simple Trusses

## Planar Trusses

- When bridge or roof trusses extend over large distances, a rocker or roller is commonly used for supporting one end, Eg: joint E.
- This type of support allows freedom for expansion or contraction of the members due to temperature or application of loads.



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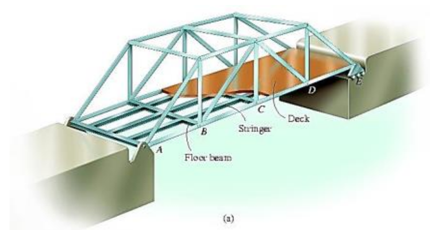


(a)

# 6.1 Simple Trusses

## Assumptions for Design

1. "All loadings are applied at the joint".

- Assumption true for most applications of bridge and roof trusses.
- Weight of the members neglected since forces supported by the members are large in comparison.
- If member's weight is considered, apply it as a vertical force, half of the magnitude applied at each end of the member.

# 6.1 Simple Trusses

## Assumptions for Design

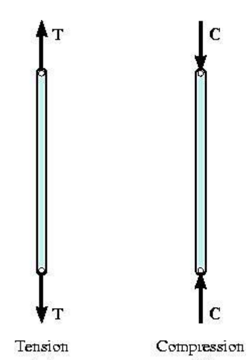
2. "The members are joined together by smooth pins".

- Assumption true when bolted or welded joints are used, provided the center lines of the joining members are concurrent.


# 6.1 Simple Trusses

## Assumptions for Design

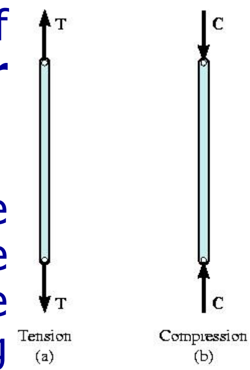

- Each truss member acts as a two force member, therefore the forces at the ends must be directed along the axis of the member.
- If the force tends to elongate the member, it is a **tensile force**.
- If the force tends to shorten the member, it is a **compressive force**.



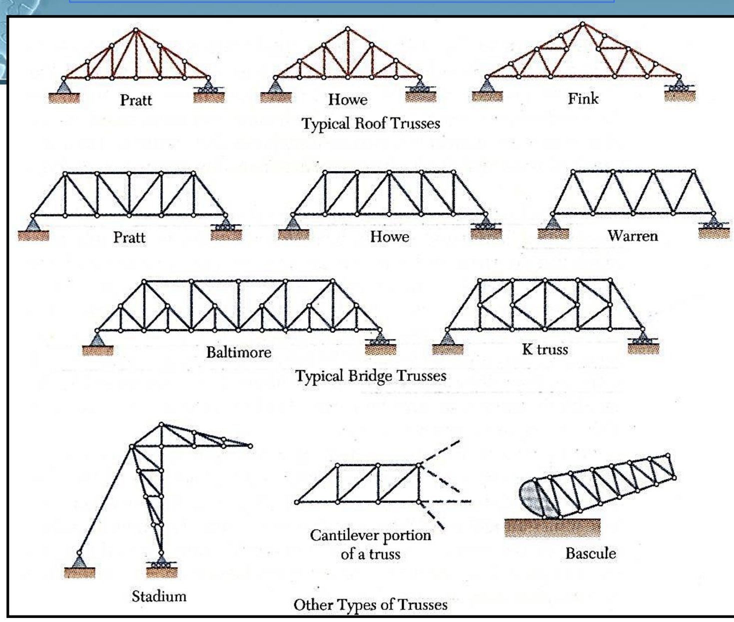
# 6.1 Simple Trusses

## Assumptions for Design

- Important to state the nature of the force in the actual design of a truss – **tensile or compressive**.
- Compression members must be made thicker than tensile member to account for the buckling or column effect during compression.



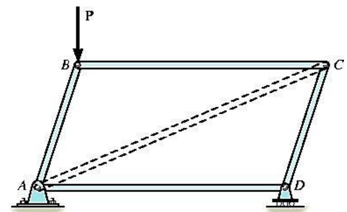

## A number of typical trusses

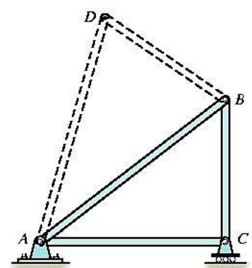


# 6.1 Simple Trusses

## Simple Truss

- To prevent collapse, the form of a truss must be rigid.
- The four bar shape ABCD will collapse unless a diagonal member AC is added for support.
- The simplest form that is rigid or stable is a triangle.

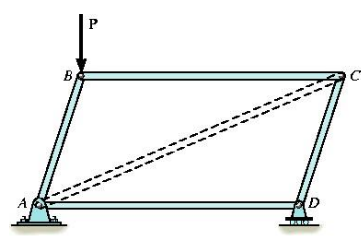


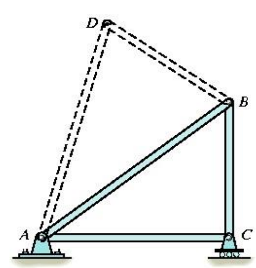




# 6.1 Simple Trusses

## Simple Truss

- A simple truss is constructed starting with a basic triangular element such as ABC and connecting two members (AD and BD) to form an additional element.



## 6.2 The Method of Joints

- For design analysis of a truss, we need to obtain the force in each of the members.
- Considering the FBD, the forces in the members are internal forces and could not be obtained from an equilibrium analysis.
- Considering the equilibrium of a joint of the truss, a member force becomes an external force on the joint's FBD and equations of equilibrium can be applied.
- This forms the basis for the method of joints.

## 6.2 The Method of Joints

- Truss members are all straight two force members lying in the same plane.
- The force system acting at each joint is coplanar and concurrent.
- Rotational or moment equilibrium is automatically satisfied at the pin.
- $\Sigma F_x = 0$ and $\Sigma F_y = 0$ must be satisfied for equilibrium.

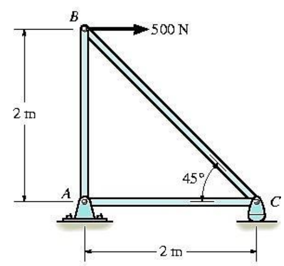
# 6.2 The Method of Joints

Method of Joints

- Draw FBD.
- Line of action of each member force acting on the joint is specified from the geometry of the truss since the force in a member passes along the axis of the member.

*Example*

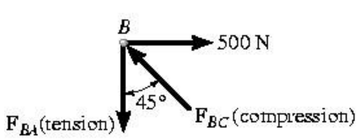
- Consider pin at joint B.
- Three forces: 500N force and forces exerted by members BA and BC.



(a)

# 6.2 The Method of Joints

- **F**$_{BA}$ is "pulling" on the pin, meaning the member BA is in tension.
- **F**$_{BC}$ is "pushing" on the pin, meaning the member BC is in compression.
- The pushing and pulling indicates the effect of the member being either in tension or compression.



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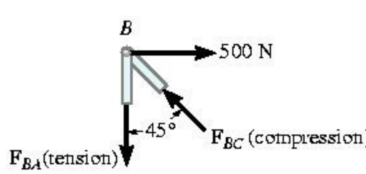

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# 6.2 The Method of Joints

Determining the Correct Sense of the Unknown Member

- Always assume the unknown member forces acting on the joint's FBD to be in tension.

  - The numerical solution of the equilibrium will yield positive scalars for members in tension and negative scalars for members in compression.

  - Use the correct magnitude and sense of the unknown member on subsequent FBD.

# 6.2 The Method of Joints

Determining the Correct Sense of the Unknown Member

- The correct sense of a direction of an unknown force can be determined by inspection.

  - $\mathbf{F}_{BC}$ must push on the pin (compression) since its horizontal component must balance the 500N force.

  - $\mathbf{F}_{BA}$ is a tensile force since it balances the vertical component of $\mathbf{F}_{BC}$ .

## 6.2 The Method of Joints

Determining the Correct Sense of the Unknown Member

- The correct sense of a direction of an unknown force can be determined by inspection.

  - In more complicated problems, the sense of the member can be assumed.

  - A positive answer indicates that the assumed sense is correct and a negative answer indicates that the assumed sense must be reversed.

## 6.2 The Method of Joints

### Procedure for Analysis

- Draw the FBD of a joint having at least one known force and at most two unknown forces.
- If this joint is at one of the supports, determine the external reactions at the truss support.
- Use one of two methods for determining the correct sense of the member.
- Orient the x and y axes so that the forces on the FBD can be easily resolved into x and y components.

# 6.2 The Method of Joints

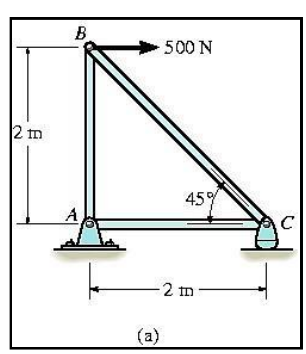
## Procedure for Analysis

- Apply $\Sigma F_x = 0$ and $\Sigma F_y = 0$ .
- Solve for unknown members forces and verify their correct sense.
- Continue to analyze each of the other joints.
- Once the force in a member is found from the analysis of the joint at one of its end, the result is used to analyze the forces acting on the other end.

# 6.2 The Method of Joints

## Example 6.1

Determine the force in each member of the truss and indicate whether the members are in tension or compression.



## 6.2 The Method of Joints

Solution

- Two unknown member forces at joint B.
- One unknown reaction force at joint C.
- Two unknown member forces and two unknown reaction forces at point A.

## 6.2 The Method of Joints

Solution

Joint B

$$+\rightarrow \sum F_x = 0;$$

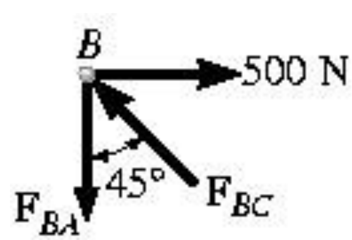
$$500N - F_{BC}\sin 45^\circ N = 0$$

$$F_{BC} = 707.1N(C)$$

$$+\uparrow \sum F_y = 0;$$

$$F_{BC}\cos 45^\circ N - F_{BA} = 0$$

$$F_{BA} = 500N(T)$$




(b)

# 6.2 The Method of Joints

Solution

Joint C

$$+\rightarrow \sum F_x = 0;$$

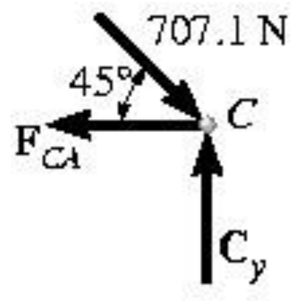
$$-F_{CA} + 707.1\cos 45^\circ\, N = 0$$

$$F_{CA} = 500N(T)$$

$$+\uparrow \sum F_y = 0;$$

$$C_y - 707.1\sin 45^\circ\, N = 0$$

$$C_y = 500N$$




(c)

# 6.2 The Method of Joints

Solution

Joint A

$$+\rightarrow \sum F_x = 0;$$

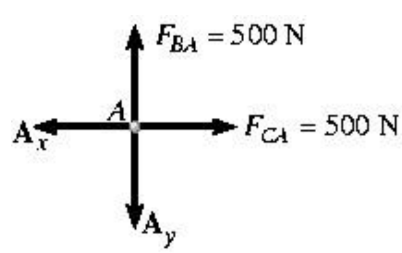
$$500N - A_x = 0$$

$$A_x = 500N$$

$$+\uparrow \sum F_y = 0;$$

$$500N - A_y = 0$$

$$A_y = 500N$$

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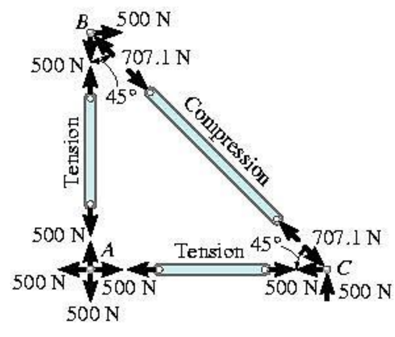
# 6.2 The Method of Joints

## Solution

- FBD of each pin shows the effect of all the connected members and external forces applied to the pin.
- FBD of each member shows only the effect of the end pins on the member.



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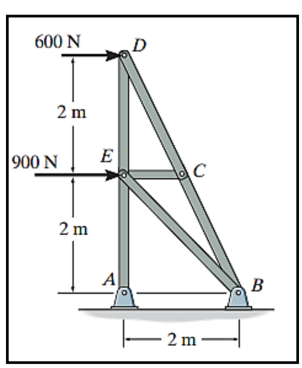
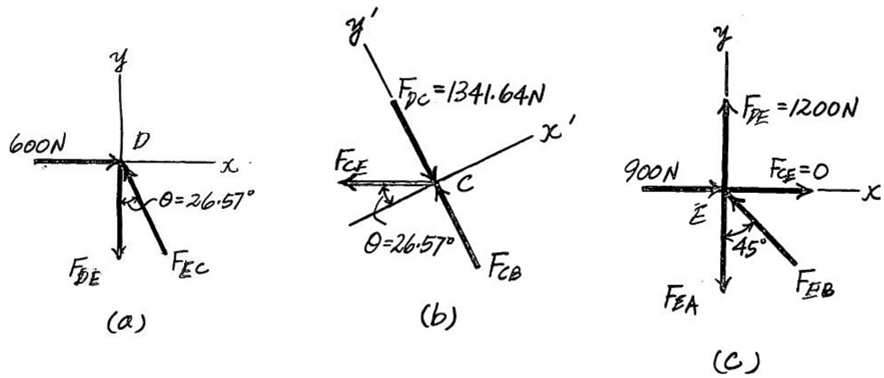
# 6.2 The Method of Joints

## Example 6.2

Determine the force in each member of the truss, and state if the members are in tension or compression.



# 6.2 The Method of Joints




# 6.2 The Method of Joints

**Method of Joints:** We will begin by analyzing the equilibrium of joint *D*, and then proceed to analyze joints *C* and *D*.

**Joint *D*:** From geometry, $\theta = \tan^{-1}\left(\frac{1}{2}\right) = 26.57°$. Thus, from the free-body diagram in Fig. *a*,

$\overset{+}{\rightarrow}\Sigma F_x = 0;$ $\quad 600 - F_{DC}\sin 26.57° = 0$

$F_{DC} = 1341.64\text{ N} = 1.34\text{ kN (C)}$ **Ans.**

$+\uparrow\Sigma F_y = 0;$ $\quad 1341.64\cos 26.57° - F_{DE} = 0$

$F_{DE} = 1200\text{ N} = 1.20\text{ kN (T)}$ **Ans.**

# 6.2 The Method of Joints

Joint $C$: From the free-body diagram in Fig. $b$,

$+\nearrow \Sigma F_{x'} = 0; \; -F_{CE} \cos 26.57° = 0$

$F_{CE} = 0$ **Ans.**

$+\nwarrow \Sigma F_{y'} = 0; \; F_{CB} - 1341.64 = 0$

$F_{CB} = 1341.64 \text{ N} = 1.34 \text{ kN (C)}$ **Ans.**

Joint $E$: From the free-body diagram in Fig. $c$,

$\overset{+}{\rightarrow} \Sigma F_x = 0; \quad 900 - F_{EB} \sin 45° = 0$

$F_{EB} = 1272.79 \text{ N} = 1.27 \text{ kN (C)}$ **Ans.**

$+\uparrow \Sigma F_y = 0; \quad 1200 + 1272.79 \cos 45° - F_{EA} = 0$

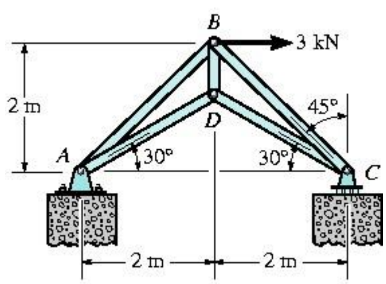
$F_{EA} = 2100 \text{ N} = 2.10 \text{ kN (T)}$ **Ans.**

*Note*: The equilibrium analysis of joint $A$ can be used to determine the components of support reaction at $A$.

# 6.2 The Method of Joints

Example 6.3

Determine the forces acting in all the members of the truss.

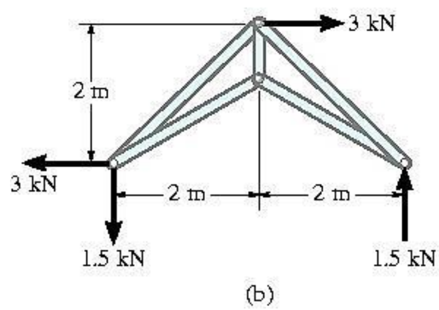



(a)

# 6.2 The Method of Joints

## Solution

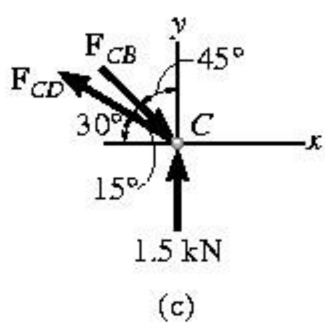
- Two unknowns at each joint.
- Support reactions on the truss must be determined.




# 6.2 The Method of Joints

## Solution

Joint C




$$+\rightarrow \sum F_x = 0;$$

$$-F_{CD}\cos 30^\circ\, kN + F_{CB}\sin 45^\circ\, kN = 0$$

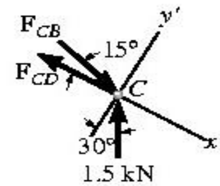
$$+\uparrow \sum F_y = 0;$$

$$1.5kN + F_{CD}\sin 30^\circ\, kN - F_{CB}\cos 45^\circ\, kN = 0$$

# 6.2 The Method of Joints

Solution

Joint C



(d)

$$\sum F_{x'} = 0;$$

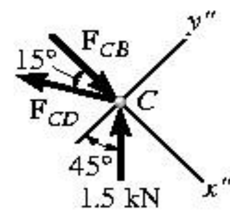
$$1.5\cos 30^\circ kN - F_{CB}\sin 15^\circ kN = 0$$

$$F_{CB} = 5.02kN$$

$$\sum F_{y''} = 0;$$

$$1.5\cos 30^\circ kN - F_{CD}\sin 15^\circ kN = 0$$

$$F_{CD} = 4.10kN$$



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# 6.2 The Method of Joints

Solution

Joint D

$$+\rightarrow \sum F_x = 0;$$

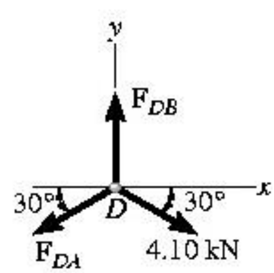
$$-F_{DA}\cos 30^\circ kN + 4.10\cos 30^\circ kN = 0$$

$$F_{DA} = 4.10kN(T)$$

$$+\uparrow \sum F_y = 0;$$

$$F_{DB} - 2(4.10\sin 30^\circ kN) = 0$$

$$F_{DB} = 4.10kN(T)$$



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# 6.2 The Method of Joints

Solution

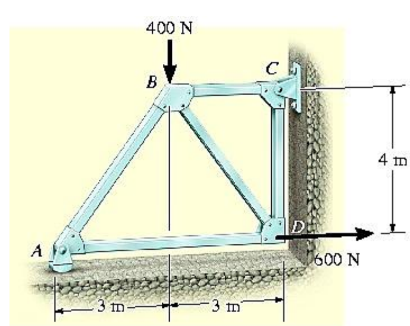
- From the FBD of joint B, sum the forces in the horizontal direction.

$F_{BA} = 0.776kN\ (C)$

# 6.2 The Method of Joints

Example 6.4

Determine the force in each member of the truss. Indicate whether the members are in tension or compression.

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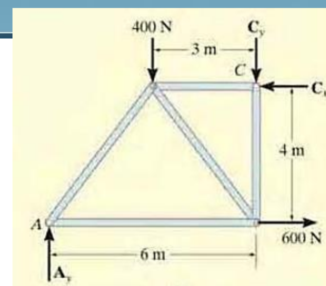
# 6.2 The Method of Joints




Solution

Support Reactions

$$+\rightarrow \sum F_x = 0; 600N - C_x = 0$$

$$C_x = 600N$$

$$\sum M_C = 0; -A_y(6m) + 400N(3m) + 600N(4m) = 0$$

$$A_y = 600N$$

$$+\uparrow \sum F_y = 0; F_{DB} - 2(4.10\sin 30^\circ) = 0$$

$$F_{DB} = 4.10kN(T)$$

# 6.2 The Method of Joints

Solution

Joint A

$$+\rightarrow \sum F_x = 0;$$

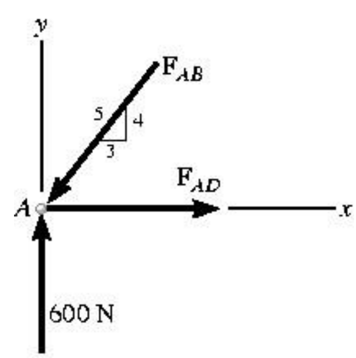
$$F_{AD} - \frac{3}{5}(750N) = 0$$

$$F_{AD} = 450N(T)$$

$$+\uparrow \sum F_y = 0;$$

$$600N - \frac{4}{5}F_{AB} = 0$$

$$F_{AB} = 750N(C)$$

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# 6.2 The Method of Joints

Solution

Joint D

$$+\rightarrow \sum F_x = 0;$$

$$-450N + \frac{3}{5}F_{DB} + 600N = 0$$

$$F_{DB} = -250N$$

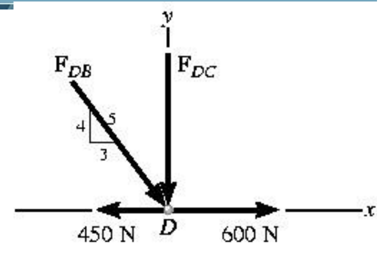
Negative sign: reverse sense of $\mathbf{F}_{DB}$

$$F_{DB} = 250N(T)$$

$$+\uparrow \sum F_y = 0;$$

$$-F_{DC} - \frac{4}{5}(-250N) = 0$$

$$F_{DC} = 200N(C)$$



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# 6.2 The Method of Joints

Solution

Joint C

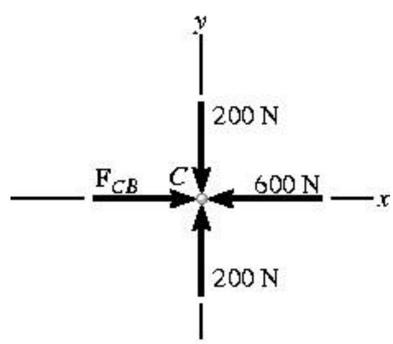
$$+\rightarrow \sum F_x = 0;$$

$$F_{CB} - 600N = 0$$

$$F_{CB} = 600N(C)$$

$$+\uparrow \sum F_y = 0;$$

$$200N - 200N \equiv 0(check)$$



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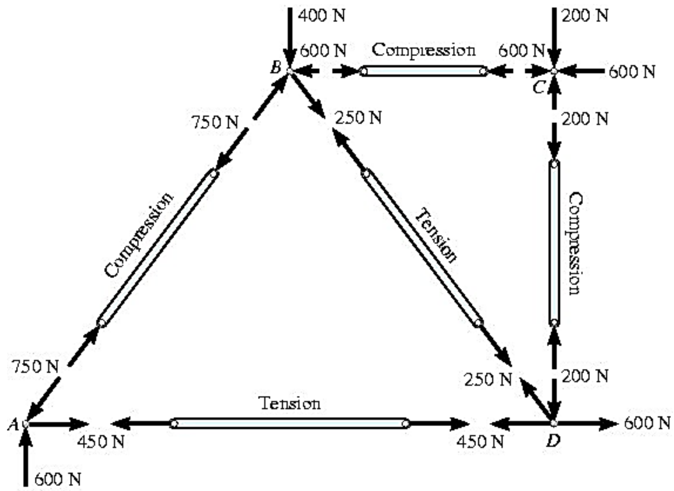
# 6.2 The Method of Joints

Solution

FBD

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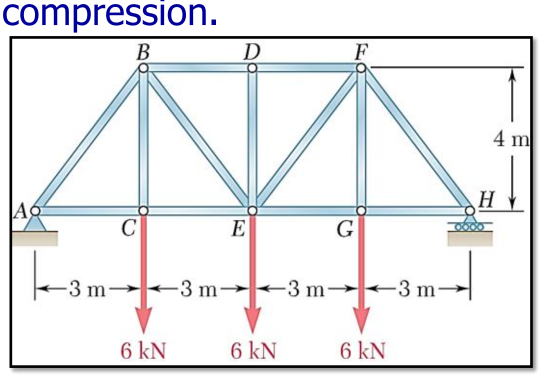
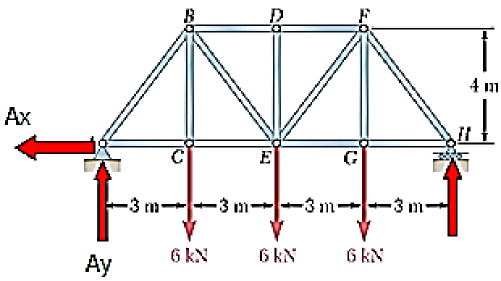
## Problem 6.5

Determine the force in each member of the Pratt bridge truss shown. State whether each member is in tension or compression.






$\rightarrow \Sigma F_x = 0: \quad \mathbf{A}_x = 0$

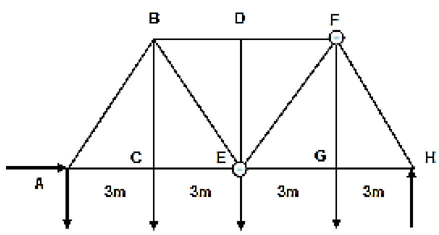
By symmetry: $\mathbf{A}_y = \mathbf{H}_y = 9\text{ kN} \uparrow$

and

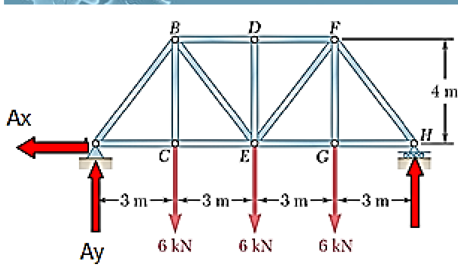
$F_{AB} = F_{FH};\ F_{AC} = F_{GH}$

$F_{BC} = F_{FG};\ F_{BD} = F_{DF}$

$F_{BE} = F_{EF};\ F_{CE} = F_{EG}$




By inspection of joint $D$: $F_{DE} = 0$

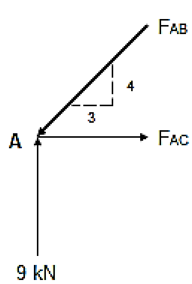



$\rightarrow \Sigma F_x = 0: \quad \mathbf{A}_x = 0$

By symmetry: $\mathbf{A}_y = \mathbf{H}_y = 9\text{ kN} \uparrow$

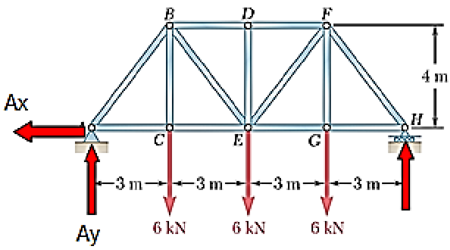
and

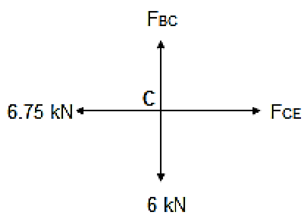
**FBDs Joints:**




$\uparrow \Sigma F_y = 0: 9\text{ kN} - \frac{4}{5}F_{AB} = 0 \qquad F_{AB} = 11.25\text{ kN C}$

$\rightarrow \Sigma F_x = 0: F_{AC} - \frac{3}{5}F_{AB} = 0 \qquad F_{AC} = 6.75\text{ kN T}$



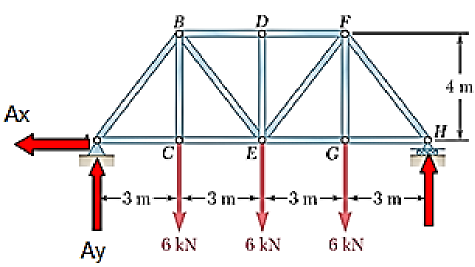




$$\xrightarrow{+} \Sigma F_x = 0: F_{CE} - 6.75 \text{ kN} = 0 \qquad F_{CE} = 6.75 \text{ kN T}$$

$$+\uparrow \Sigma F_y = 0: F_{BC} - 6 \text{ kN} = 0 \qquad F_{BC} = 6.00 \text{ kN T}$$

$$+\uparrow \Sigma F_y = 0: \frac{4}{5}(11.25 \text{ kN}) - 6 \text{ kN} + \frac{4}{5}F_{BE} = 0$$

$$F_{BE} = 3.75 \text{ kN C}$$

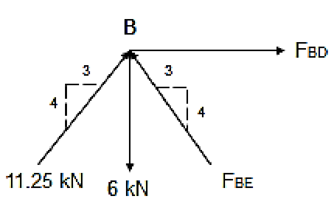



$$\boxed{\begin{aligned} F_{AB} &= F_{FH};\ F_{AC} = F_{GH} \\ F_{BC} &= F_{FG};\ F_{BD} = F_{DF} \\ F_{BE} &= F_{EF};\ F_{CE} = F_{EG} \end{aligned}}$$

$$\xrightarrow{+} \Sigma F_x = 0: F_{BD} - \frac{3}{5}(11.25 \text{ kN}) - \frac{3}{5}(3.75 \text{ kN}) = 0$$

$$F_{BD} = 9.00 \text{ kN T}$$

From symmetry conditions above




$F_{FH} = 11.25 \text{ kN C}$

$F_{GH} = 6.75 \text{ kN T}$

$F_{EG} = 6.75 \text{ kN T}$

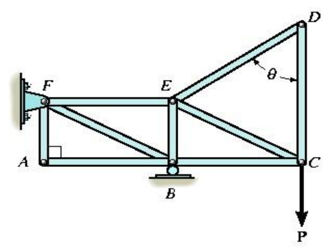
$F_{FG} = 6.00 \text{ kN T}$

$F_{EF} = 3.75 \text{ kN C}$

$F_{DF} = 9.00 \text{ kN T}$

## 6.3 Zero-Force Members

- Method of joints is simplified when the members which support no loading are determined.
- Zero-force members (support no loading) are used to increase the stability of the truss during construction and to provide support if the applied loading is changed.

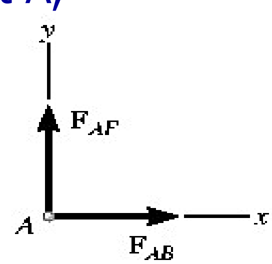



(a)

## 6.3 Zero-Force Members

- Consider the truss shown
- From the FBD of the pin at point A, members AB and AF become zero force members

*Note: Consider the FBD of joints F or B, there are five unknowns and the above conclusion would not be reached

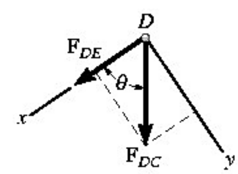



$$\xrightarrow{+} \Sigma F_x = 0; \quad F_{AB} = 0$$
$$+\uparrow \Sigma F_y = 0; \quad F_{AF} = 0$$

(b)

# 6.3 Zero-Force Members

- Consider FBD of joint D
- DC and DE are zero-force members.
- As a general rule, if only two members form a truss joint and no external load or support reaction is applied to the joint, the members must be zero-force members.

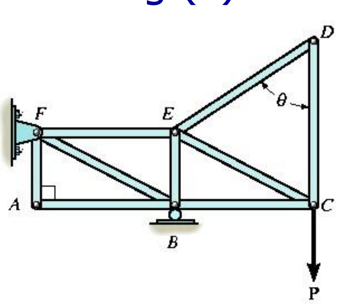



$$+\searrow \Sigma F_y = 0;\ F_{DC}\sin\theta = 0;\quad F_{DC} = 0 \text{ since } \sin\theta \neq 0$$
$$+\swarrow \Sigma F_x = 0;\ F_{DE} + 0 = 0;\quad F_{DE} = 0$$

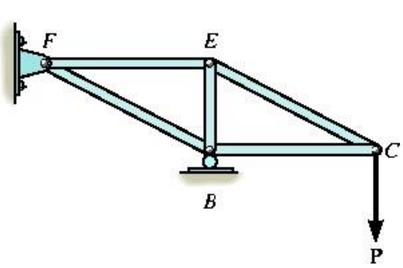
(c)

# 6.3 Zero-Force Members

- The load on the truss shown in fig (a) is therefore supported by only five members as shown in fig (d)



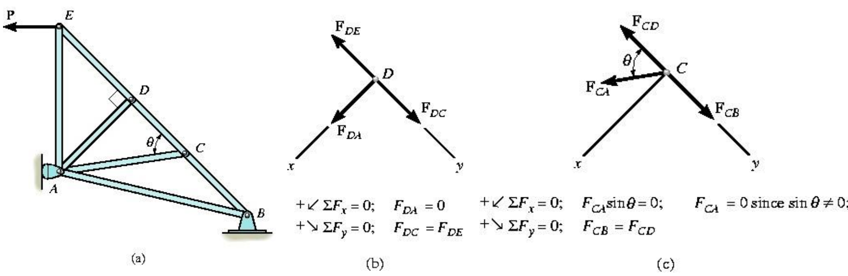

(a)




(d)

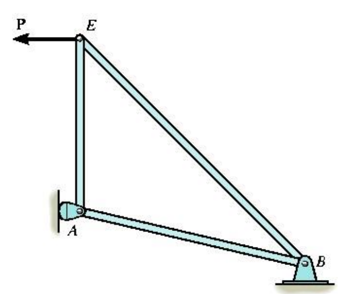
# 6.3 Zero-Force Members

- Consider the truss shown.
- From the FBD of the pin of the joint D, DA is a zero-force member.
- From the FBD of the pin of the joint C, CA is a zero-force member.




# 6.3 Zero-Force Members

- In general, if three members form a truss joint for which two of the members are collinear, the third member is a zero-force member provided no external force or support reaction is applied to the joint
- The truss shown is suitable for supporting the load P

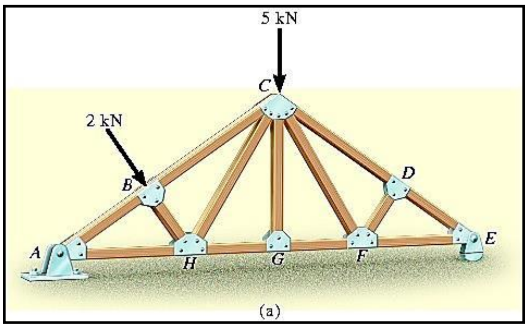


(d)

# 6.3 Zero-Force Members

Example 6.6

Using the method of joints, determine all the zero-force members of the Fink roof truss. Assume all joints are pin connected.



(a)

# 6.3 Zero-Force Members

Solution

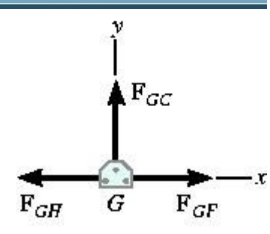
Joint G

$$+\uparrow \sum F_y = 0; F_{GC} = 0$$

GC is a zero-force member

meaning the 5kN load at C

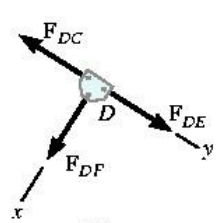
must be supported by CB, CH, CF and CD



(b)

Joint D

$$\sum F_x = 0; F_{DF} = 0$$



(c)

# 6.3 Zero-Force Members

Solution

Joint F

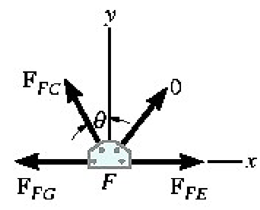
$$+\uparrow \sum F_y = 0; F_{FC} \cos\theta = 0$$

$$\theta \neq 90^\circ, F_{FC} = 0$$

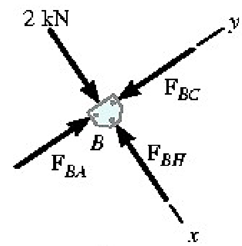
Joint B

$$\sum F_x = 0; 2kN - F_{BH} = 0$$

$$F_{BH} = 2kN(C)$$




(d)

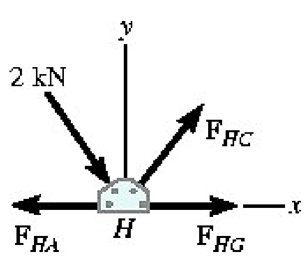



(e)

# 6.3 Zero-Force Members

Solution

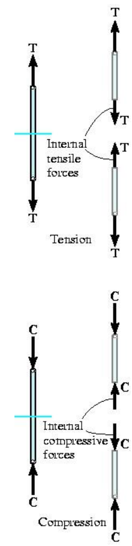
$F_{HC}$ satisfy $\sum F_y = 0$ and therefore HC is not a zero-force member.




(f)

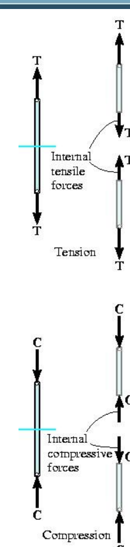
# 6.4 The Method of Sections

- Used to determine the loadings within a body
- If a body is in equilibrium, any part of the body is in equilibrium
- To determine the forces within the members, an imaginary section indicated by the blue line, can be used to cut each member into two and expose each internal force as external



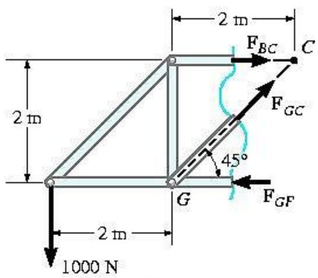

# 6.4 The Method of Sections

- It can be seen that equilibrium requires the member in tension (T) be subjected to a pull and the member in compression (C) be subjected to a push
- Method of section can be used to cut or section members of an entire truss
- Apply equations of equilibrium on that part to determine the members

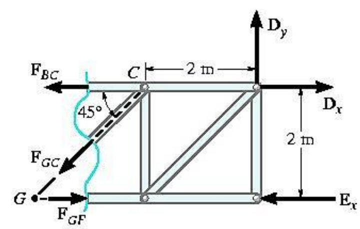


# 6.4 The Method of Sections

- Consider the truss shown
- To determine the force in the member GC, section aa would be considered



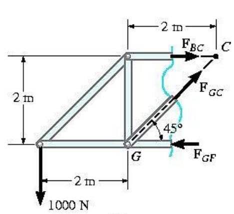
(b)



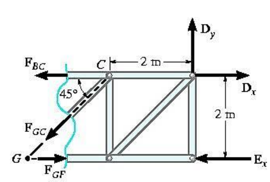
(c)

# 6.4 The Method of Sections

- Consider the FBD .
- Note the line of action of each member force is specified from the geometry of the truss.
- Member forces acting on one part of the truss are equal and opposite to those acting on the other part – Newton's Law.



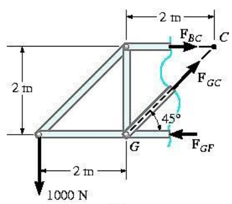
(b)



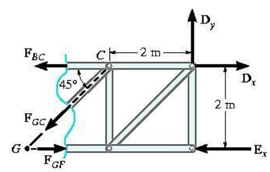
(c)

## 6.4 The Method of Sections

- Members assumed to be in tension (BC and GC) are subjected to a pull whereas the member in compression (GF) is subjected to a push.
- Apply equations of equilibrium.




(b)




(c)

## 6.4 The Method of Sections

Determining the Correct Sense of the Unknown Member

- Always assume the unknown member forces in the cut section are in tension.

  - The numerical solution of the equilibrium will yield positive scalars for members in tension and negative scalars for members in compression.

# 6.4 The Method of Sections

Determining the Correct Sense of the Unknown Member

- The correct sense of a direction of an unknown force can be determined by inspection

  - In more complicated problems, the sense of the member can be assumed

  - A positive answer indicates that the assumed sense is correct and a negative answer indicates that the assumed sense must be reversed

# 6.4 The Method of Sections

## Procedure for Analysis

- Draw the FBD of a joint having at least one known force and at most two unknown forces.
- If this joint is at one of the supports, it ma be necessary to know the external reactions at the truss support.
- Use one of two methods for determining the correct sense of the member.
- Orient the x and y axes so that the forces on the FBD can be easily resolved into x and y components.

# 6.4 The Method of Sections

## Procedure for Analysis

### Free-Body Diagram

- Decide how to cut or session the truss through the members where forces are to be determined.
- Before isolating the appropriate section, determine the truss's external reactions.
- Use the equilibrium equations to solve for member forces at the cut session.

# 6.4 The Method of Sections

## Procedure for Analysis

### Free-Body Diagram

- Draw the FBD of that part of the sectioned truss which has the least number of forces acting on it.
- Use one of the two methods for establishing the sense of an unknown member force.

# 6.4 The Method of Sections

## Procedure for Analysis

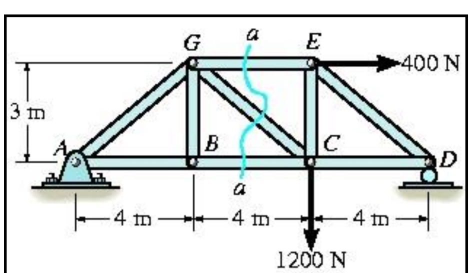
Equations of Equilibrium

- Moments are summed about a point that lies at the intersection of lines of action of the two unknown forces.
- The third unknown force is determined directly from moment equation.
- If two of the unknown forces are parallel, forces may be summed perpendicular to the direction of these unknowns to determine the third unknown force.

# 6.4 The Method of Sections

## Example 6.7

Determine the force in members GE, GC, and BC of the truss. Indicate whether the members are in tension or compression.

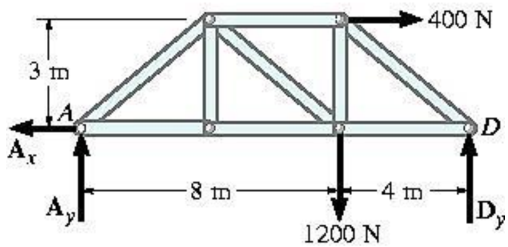


(a)

# 6.4 The Method of Sections

Solution

- Choose section aa since it cuts through the three members
- FBD of the entire truss




(b)

# 6.2 The Method of Joints

Solution

$$+\rightarrow \sum F_x = 0; 400N - A_x = 0$$

$$A_x = 400N$$

$$\sum M_A = 0;$$

$$-1200N(8m) - 400N(3m) + D_y(12m) = 0$$

$$D_y = 900N$$

$$+\uparrow \sum F_y = 0;$$

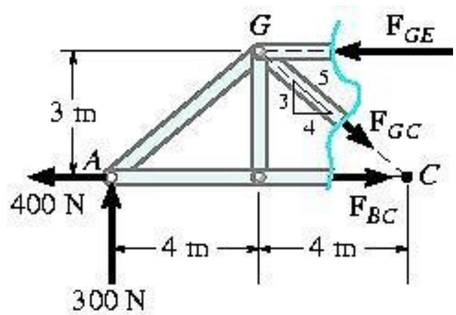
$$A_y - 1200N + 900N = 0$$

$$A_y = 300N$$

# 6.4 The Method of Sections

Solution

FBD of the sectioned truss




(c)

# 6.2 The Method of Joints

Solution

$\sum M_G = 0;$

$-300N(4m) - 400N(3m) + F_{BC}(3m) = 0$

$F_{BC} = 800N(T)$

$\sum M_C = 0;$

$-300N(8m) + F_{GE}(3m) = 0$

$F_{GE} = 800N(C)$

$+\uparrow \sum F_y = 0;$

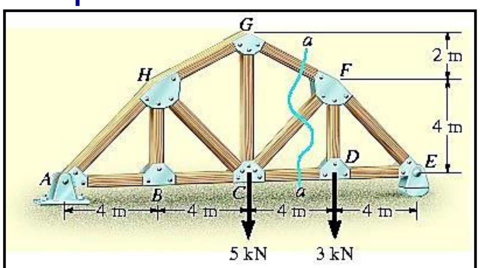
$300N - \frac{3}{5}F_{GC} = 0$

$F_{GC} = 500N(T)$

# 6.4 The Method of Sections

Example 6.8

Determine the force in member CF of the bridge truss. Indicate whether the member are in tension or compression. Assume each member is pin connected.

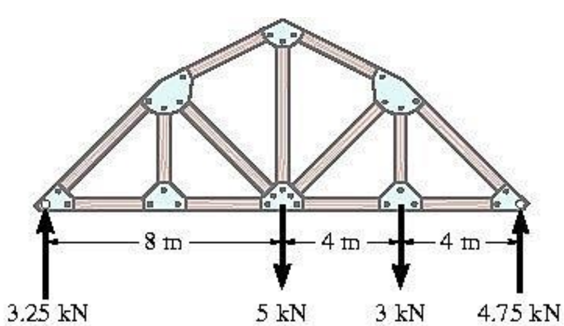


(a)

# 6.4 The Method of Sections

Solution

FBD of the entire truss



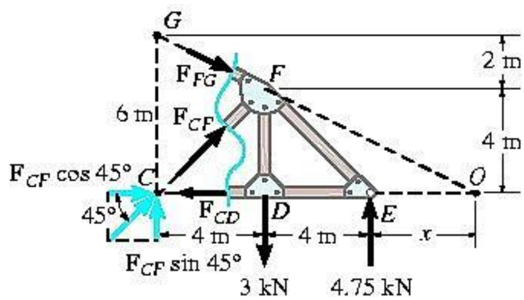
(b)

# 6.4 The Method of Sections

Solution

FBD of the sectioned truss

- Three unknown $F_{FG}$, $F_{CF}$, $F_{CD}$



(c)

6.4 The Method of Sections

Solution

Equations of Equilibrium

- For location of O measured from E

  4 / (4 + x) = 6 / (8 + x)

  x = 4m

- Principle of Transmissibility

$$\sum M_O = 0;$$

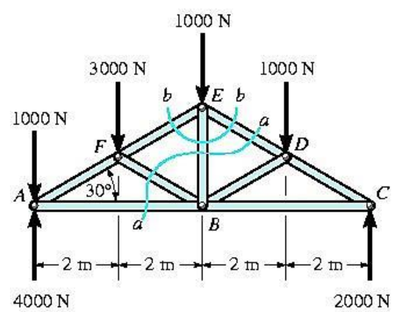
$$-F_{CF} \sin 45^\circ (12m) + (3kN)(8m) - (4.75kN)(4m) = 0$$

$$F_{CF} = 0.589 kN (C)$$

# 6.4 The Method of Sections

Example 6.9

Determine the force in member EB of the roof truss. Indicate whether the member are in tension or compression.

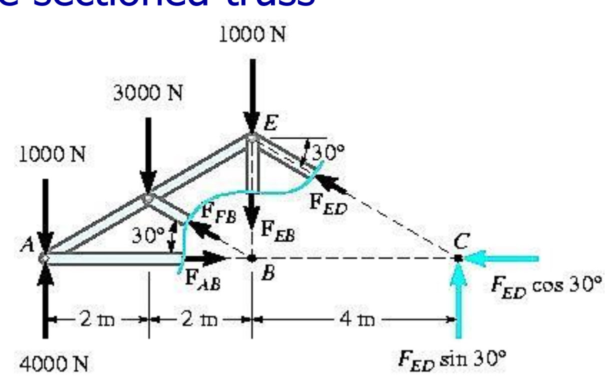



(a)

# 6.4 The Method of Sections

Solution

FBD of the sectioned truss

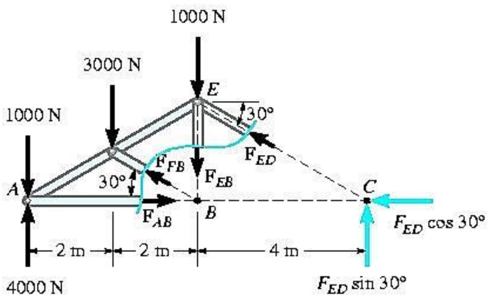



(b)

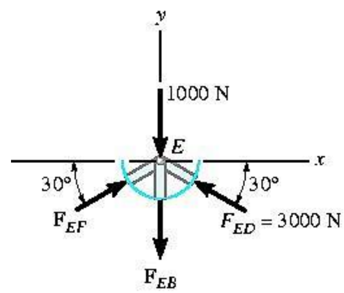
# 6.4 The Method of Sections

## Solution

- Force system is concurrent.
- Sectioned FBD is same as the FBD for the pin at E (method of joints).



(b)



(c)

# 6.4 The Method of Sections

## Solution

$$\sum M_B = 0;$$

$$1000N(4m) - 3000N(2m) - 4000N(4m) + F_{ED}\sin 30^\circ(4m) = 0$$

$$F_{ED} = 3000N(C)$$

$$+\rightarrow \sum F_x = 0;$$

$$F_{EF}\cos^\circ - 3000\cos 30^\circ N = 0$$

$$F_{EF} = 3000N(C)$$

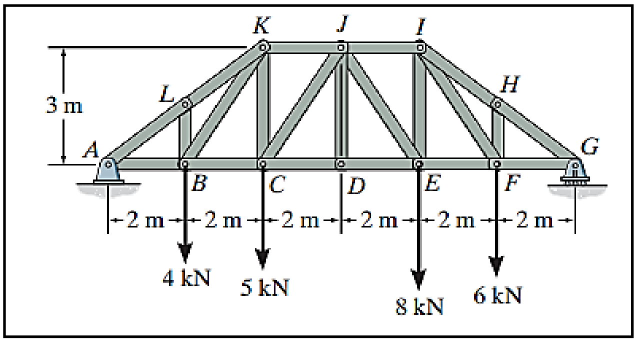
$$+\uparrow \sum F_y = 0;$$

$$2(3000\sin 30^\circ N) - 1000N - F_{EB} = 0$$

$$F_{EB} = 2000N(T)$$

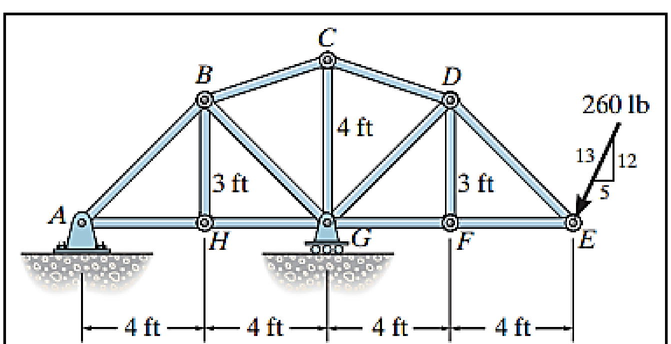
# Homework 1

Determine the force in members *HI*, *FI*, and *EF* of the truss, and state if the members are in tension or compression.




# Homework 2

Determine the force in members *BG*, *BC*, and *HG* of the truss and state if the members are in tension or compression.



# Homework 3

Determine the force in members *IC* and *CG* of the truss and state if these members are in tension or compression. Also, indicate all zero-force members.