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THAPAR INSTITUTE
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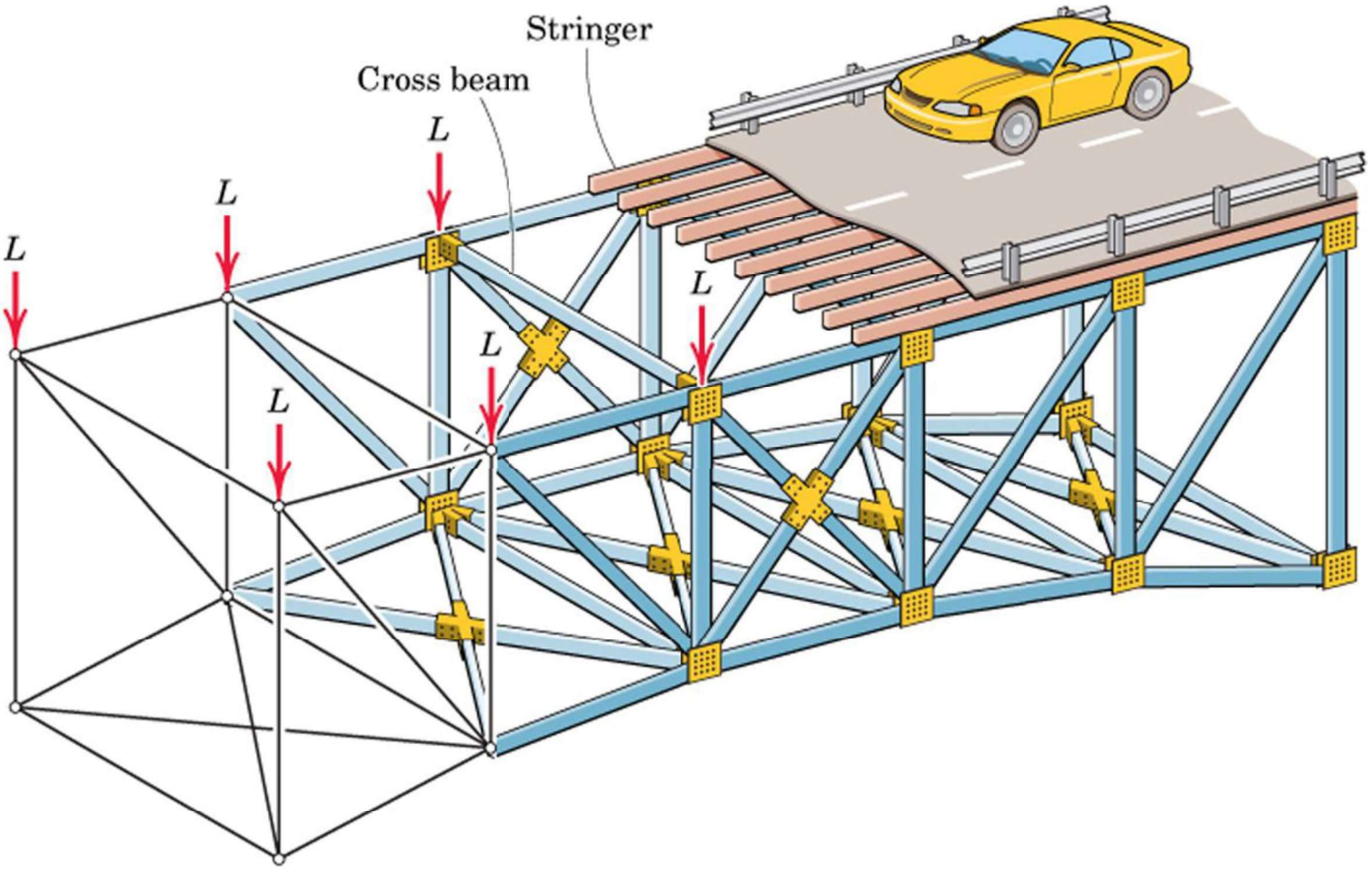
Analysis of TRUSS

Truss

Truss: is a structure composed of **slender members** (two-force members) joined together at their **end points** to support stationary or moving load.

- Each member of a truss is usually of uniform cross section along its length.


Stringer
Cross beam
L
L
L
L
L
L


HomeWrap

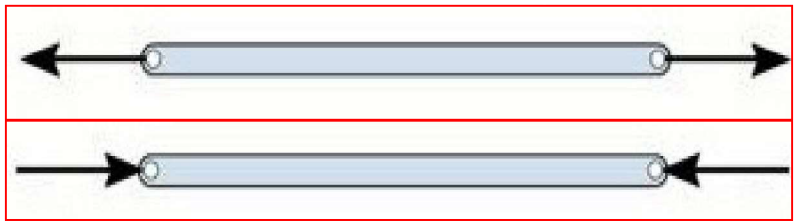
Assumptions

Calculation are usually based on following assumption:

- The loads and reactions act only at the joint.
- Weight of the individual members can be neglected.
- Members are either under **tension** or **compression** (*one force at a time*).

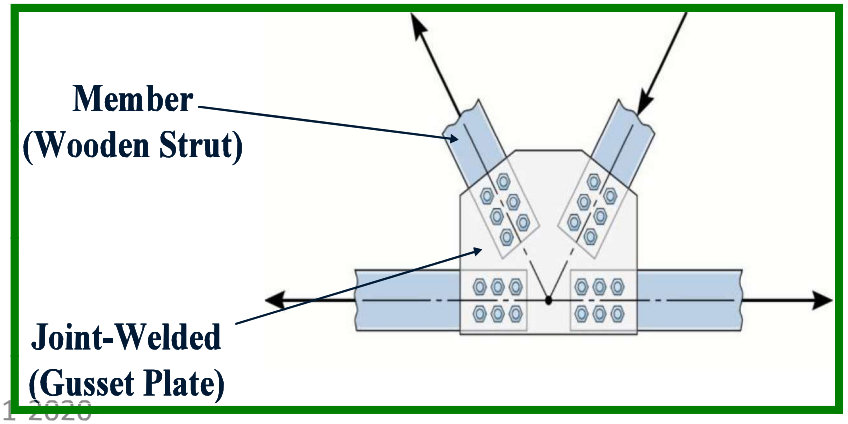
Tension

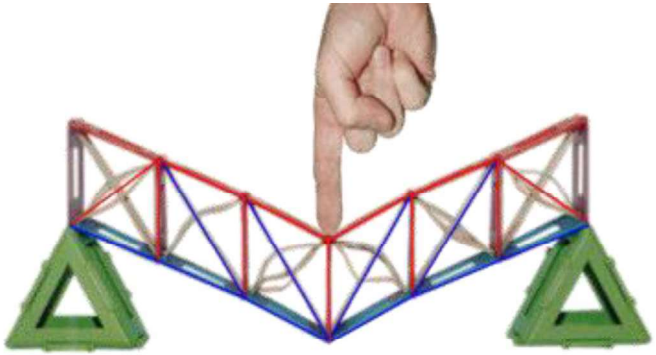
Compression



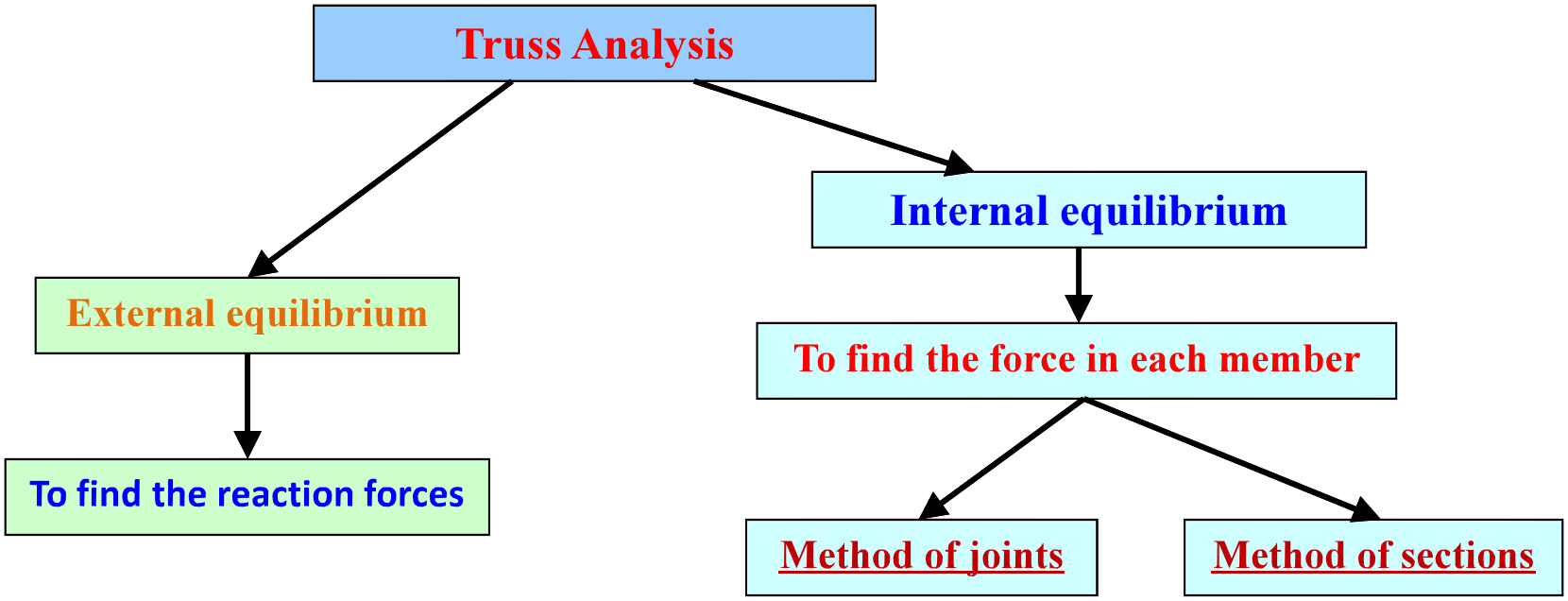
Joints: are usually formed by bolting or welding the members to a common plate, called a gusset plate, or simply passing a large bolt through each member.

- ***Joints*** are modeled by **smooth pin connections**.





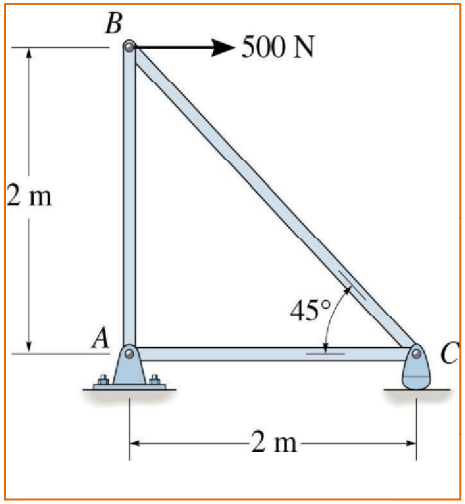
Analysis of Trusses

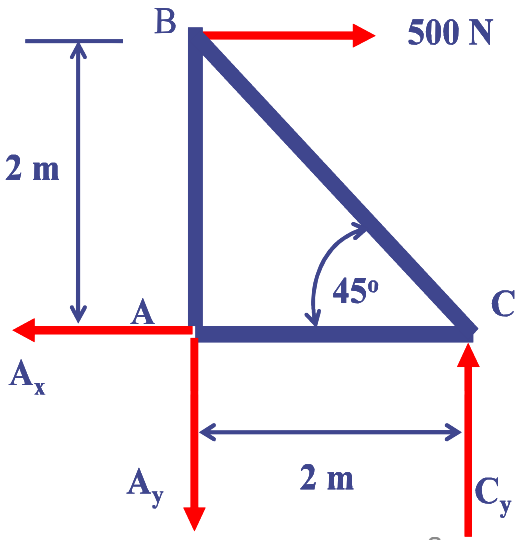


External Equilibrium: to find the ***reaction forces***, follow the below steps:

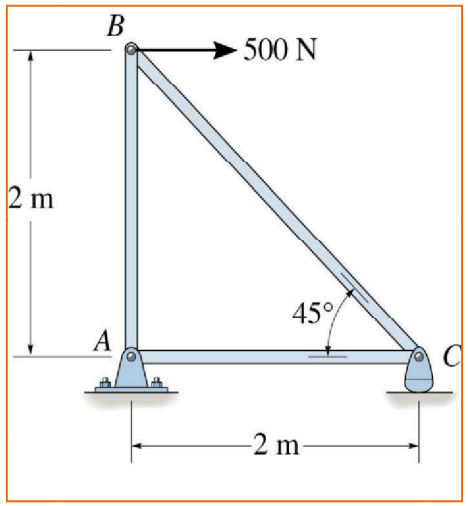
1. Draw the ***FBD*** for the entire truss system.
2. Determine the ***reactions***. Using the equations of (2 D) which states:

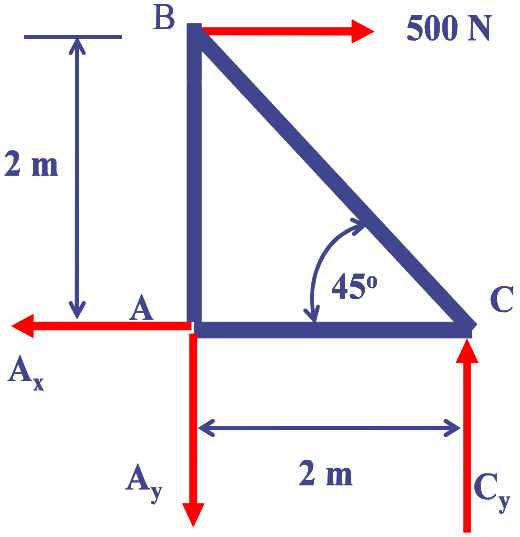
$$\sum F_x = 0, \quad \sum F_y = 0, \quad \sum M_o = 0$$

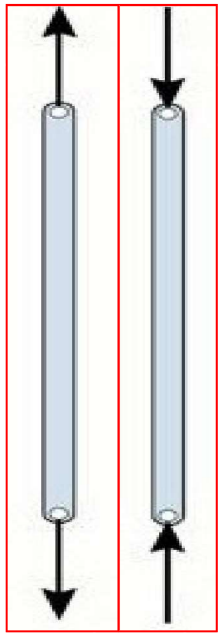


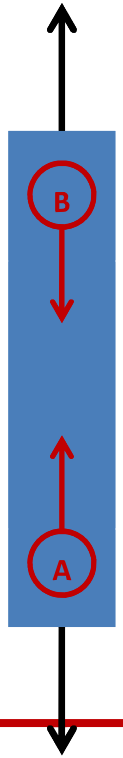


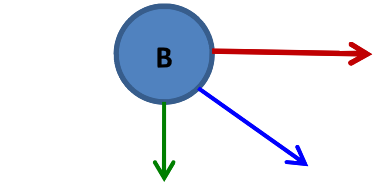
Concept: Nodes and Members

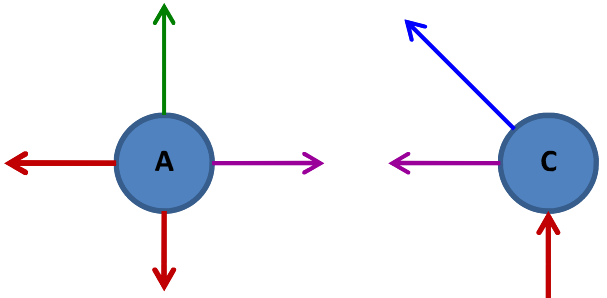






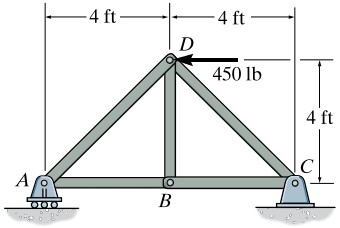






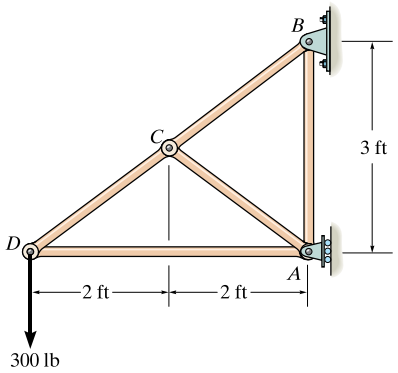
All problem solutions must include FBDs.

F6–1. Determine the force in each member of the truss. State if the members are in tension or compression.



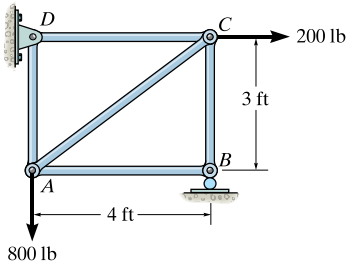
Prob. F6–1

F6–2. Determine the force in each member of the truss. State if the members are in tension or compression.



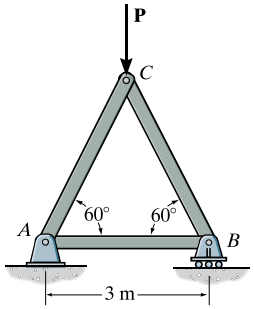
Prob. F6–2

F6–3. Determine the force in each member of the truss. State if the members are in tension or compression.



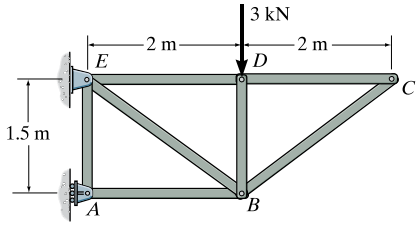
Prob. F6–3

F6–4. Determine the greatest load P that can be applied to the truss so that none of the members are subjected to a force exceeding either 2 kN in tension or 1.5 kN in compression.



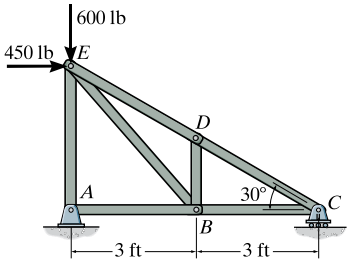
Prob. F6–4

F6–5. Identify the zero-force members in the truss.



Prob. F6–5

F6–6. Determine the force in each member of the truss. State if the members are in tension or compression.



Prob. F6–6

Analysis of Trusses: Method of Joint

Method of Joints: to find the *forces* in any *member*, choose a ***joint***, to which that member is connected, and follow the below steps:

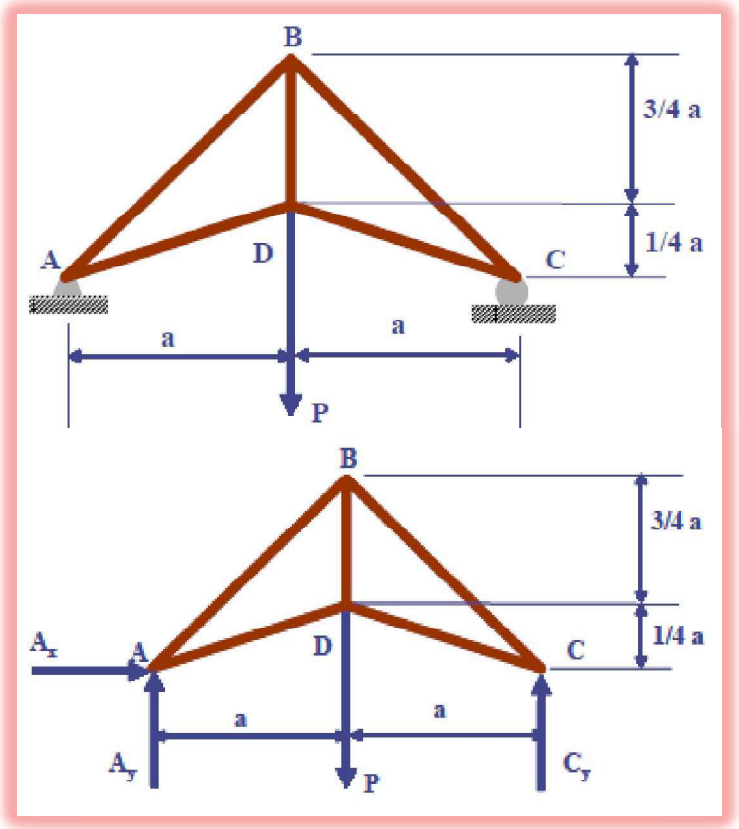
1. Draw the ***FBD*** for the entire truss system.
2. Determine the ***reactions***. Using the equations of (2 D) which states:

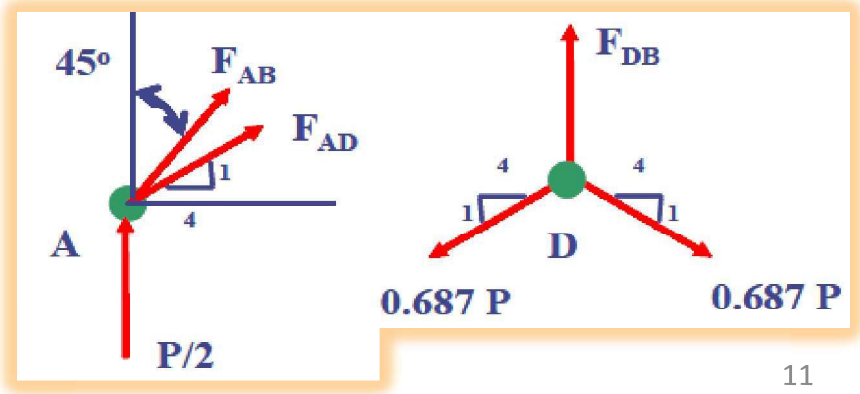
$$\sum F_x = 0, \quad \sum F_y = 0, \quad \sum M_o = 0$$

3. Choose the joint, and draw ***FBD*** of a ***joint*** with at least ***one known force*** and **at most *two unknown forces.***
4. Using the equation of (**2 D**) which states:

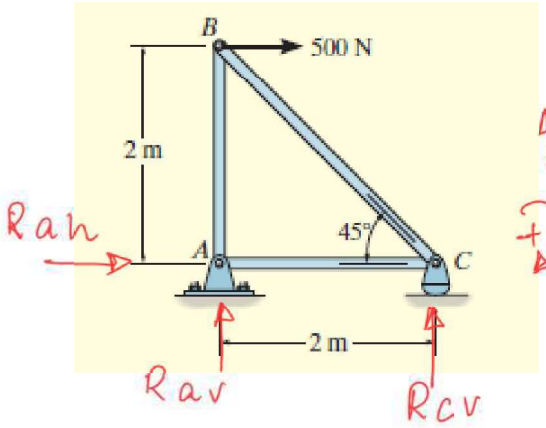
$$\sum F_x = 0, \quad \sum F_y = 0$$

5. The *internal forces* are determined.
6. Choose another ***joint***.





Problem Statement 1: Determine the force in each member of the truss shown in Figure and indicate whether the members are in tension or compression

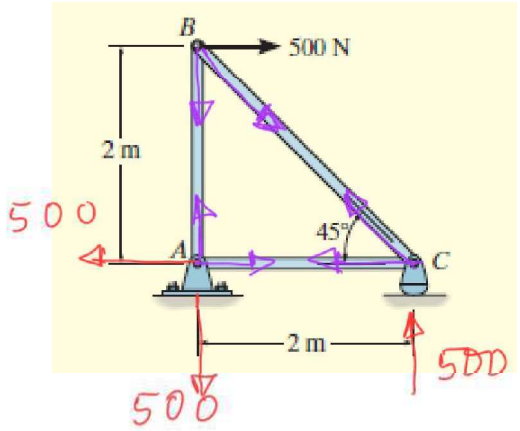


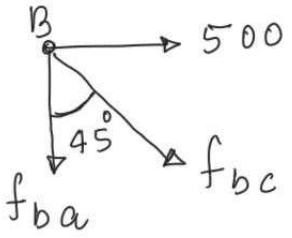
$\rightarrow \Sigma F_x = 0 \quad 500 + R_{ah} = 0 \quad \therefore R_{ah} = -500\,N$

$\uparrow \Sigma F_y = 0 \quad R_{av} + R_{cv} = 0 \quad \therefore R_{av} = -R_{cv}$

$+\circlearrowleft \Sigma M_A = 0 \quad -R_{cv} \times 2 + 500 \times 2 \quad \therefore R_{cv} = 500\,N$

$\therefore R_{ah} = -500\,N;\ R_{av} = -500\,N;\ R_{cv} = 500\,N$





+ve →

$\Sigma F_x = 0$

$+500 + f_{bc} \sin 45^\circ = 0$

$\therefore f_{bc} = -707.1\,N$ (C)

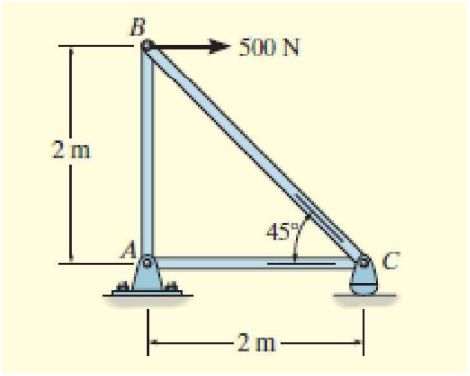
$+\uparrow \Sigma F_y = 0$

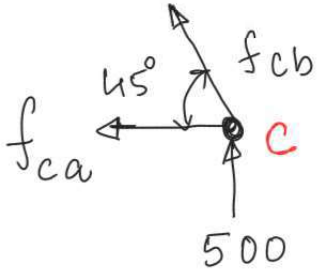
$-f_{ba} - f_{bc} \cos 45^\circ = 0$

$\Rightarrow -f_{ba} - (-707.1) \cos 45^\circ = 0$

$\therefore f_{ba} = 500\,N$ (T)

Problem Statement 1: Determine the force in each member of the truss shown in Figure and indicate whether the members are in tension or compression





+ve →

$\sum F_x = 0$

$-f_{ca} - f_{cb}\cos 45^\circ = 0$

$-f_{ca} - (-707.1)\cos 45^\circ = 0$

$\therefore f_{ca} = 500\ N\ (T)$

+ve ↑ $\sum F_y = 0$

$+f_{cb}\sin 45^\circ + 500 = 0$

$\therefore f_{cb} = -707.10\ (C)$

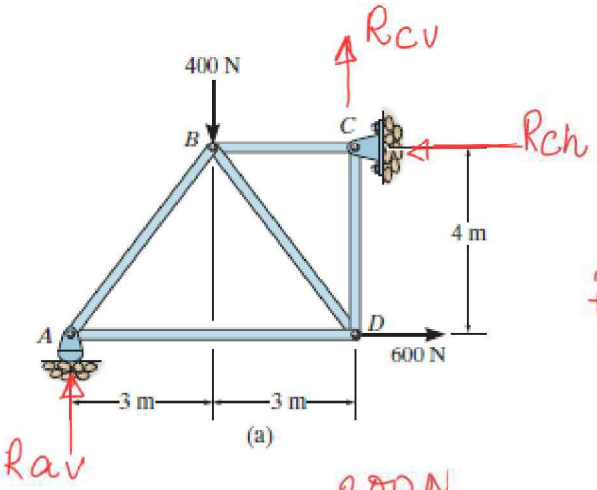
∴ Answers ∴

$f_{bc} = -707.1\ N\ (C)$

$f_{ba} = 500\ N\ (T)$

$f_{ca} = 500\ N\ (T)$

Problem Statement 2: Determine the force in each member of the truss shown in Figure and indicate whether the members are in tension or compression



R_{cv}, R_{ch}, R_{av}

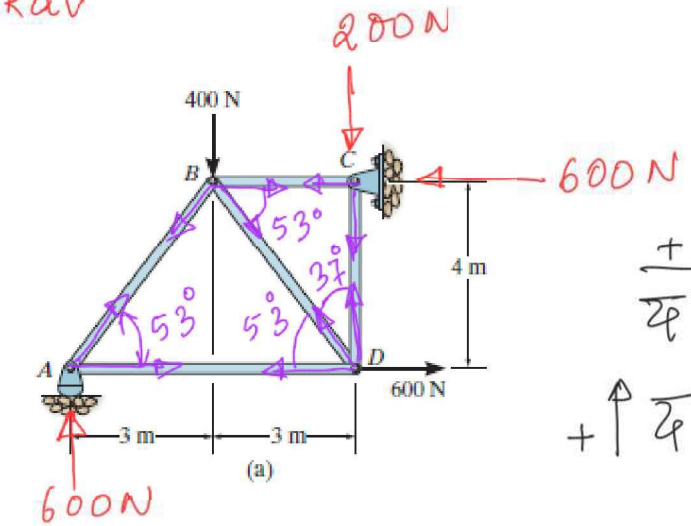
$\overrightarrow{+}\ \Sigma F_x = 0 \;|\; +600 - R_{ch} = 0 \;\Rightarrow\; R_{ch} = 600\ N$

$+\uparrow \Sigma F_y = 0 \;|\; +R_{cv} + R_{av} - 400 = 0$

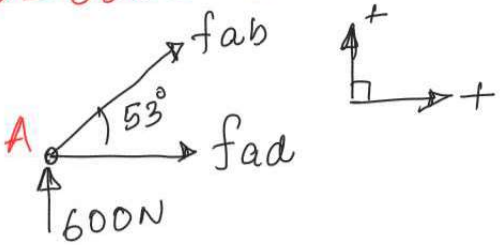
$+\circlearrowright \Sigma M_C = 0 \;|\; -600 \times 4 - 400 \times 3 + R_{av} \times 6 = 0$

$\therefore R_{av} = 600\ N$

So; $R_{cv} = 400 - 600 = -200\ N$



Joint A



$\overrightarrow{+}\ \Sigma F_x = 0 \;|\; f_{ab} \cdot \cos 53^\circ + f_{ad} = 0$

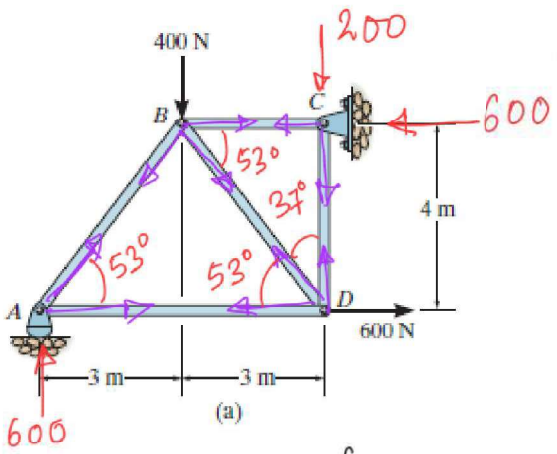
$+\uparrow \Sigma F_y = 0 \;|\; +600 + f_{ab} \sin 53^\circ = 0$

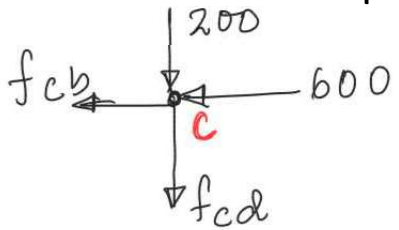
$\therefore f_{ab} = -751.28$ (C)

So, $f_{ad} = -f_{ab} \cos 53^\circ$

$= -(-751.28) \cos 53^\circ = 452.13\ N$ (T)

Problem Statement 2: Determine the force in each member of the truss shown in Figure and indicate whether the members are in tension or compression





$\overset{+}{\rightarrow}\ \Sigma F_x = 0$

$-f_{cb} - 600 = 0$

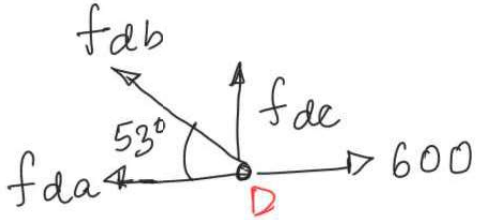
$\therefore f_{cb} = -600\,N\ (C)$

$\Sigma F_y = 0 \quad \uparrow +ve$

$-200 - f_{cd} = 0$

$\therefore f_{cd} = -200N\ (C)$

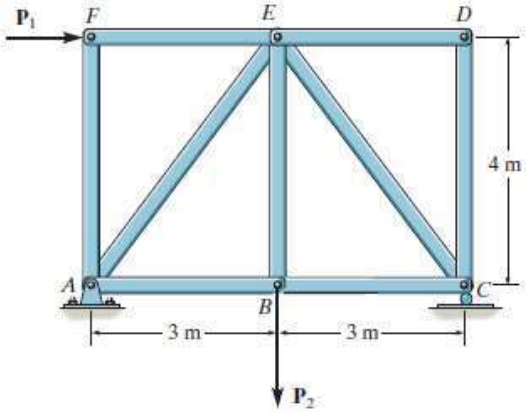
Joint 'D'

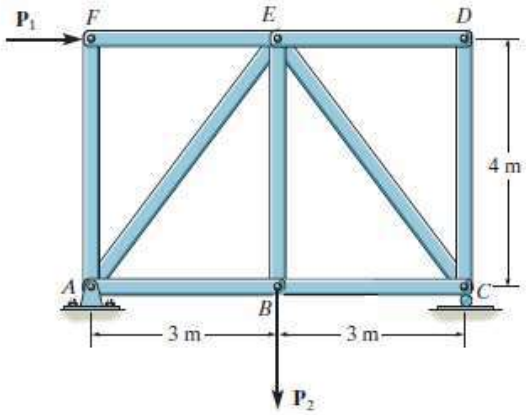


$\overset{+}{\rightarrow}\ \Sigma F_x = 0 \quad -f_{da} - f_{db}\cos 53^\circ + 600 = 0$

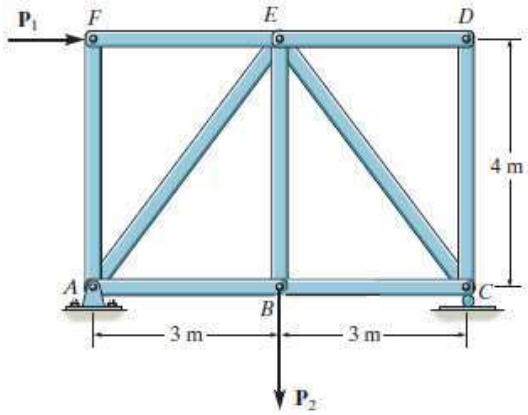
$-(452.13) - f_{db}\cos 53^\circ + 600 = 0 \quad \therefore f_{db} = 245.70\ (T)$

Problem Statement 3: Determine the force in each member of the truss and state if the members are in tension or compression. Set $P_1 = 30\ kN$, $P_2 = 15\ kN$.

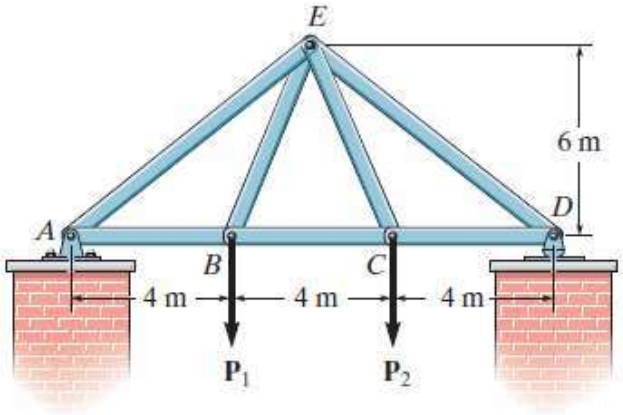


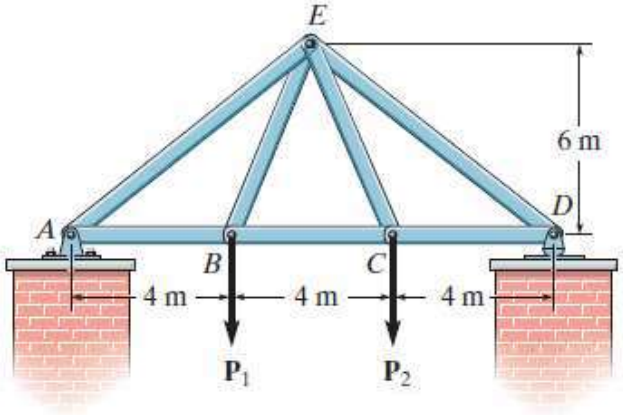


Problem Statement 3: Determine the force in each member of the truss and state if the members are in tension or compression. Set $P_1 = 30\ kN$, $P_2 = 15\ kN$.



Problem Statement 4: Determine the force in each member of the truss and state if the members are in tension or compression. Set $P_1 = 3\ kN$, $P_2 = 6\ kN$.



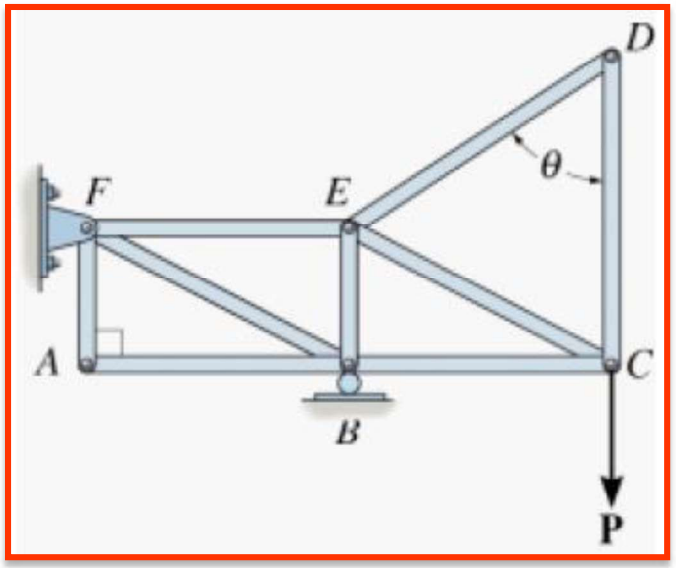


Zero Force Member : Truss members can take either *compression* or *tension* and if the member has *zero* force then it is called as "Zero Force Member"

Analysis of trusses (Zero-force members):

Why to find out Zero force Member : Analysis of trusses system is simplified if one can identify those members that support no loads. We call these zero-force members.

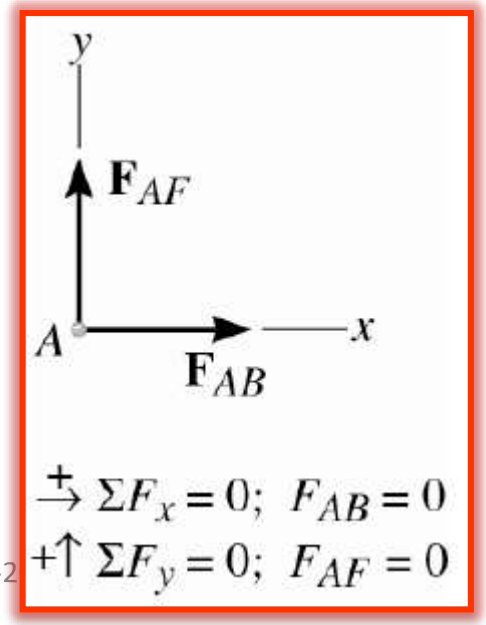
Examples to follow:

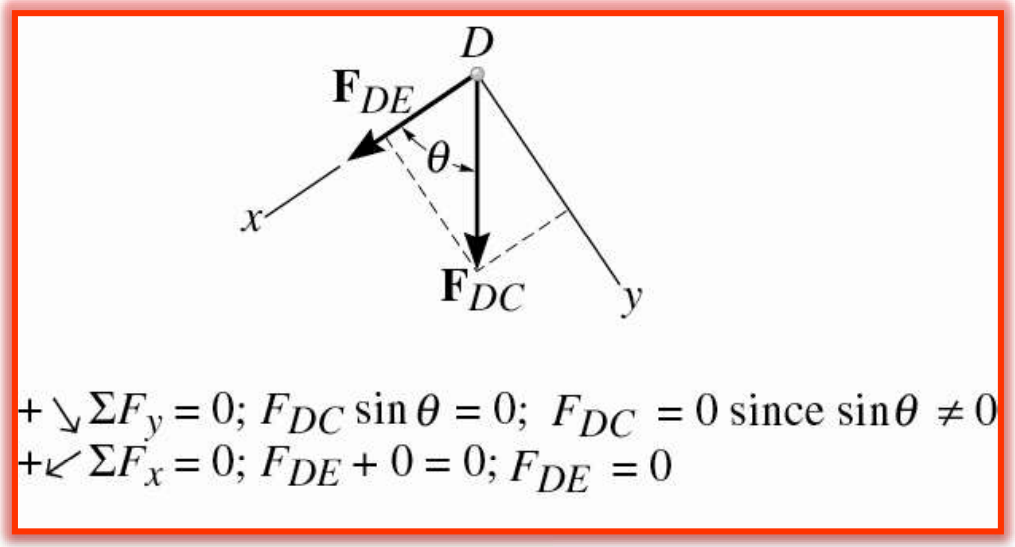


Rule 1: If ***two members*** form a *truss joint* and there is *no external load* or *support reaction* at that joint then *those members* are ***zero-force members***.

Joints D and A in the following figure are the joints with no external load or support reaction, so:

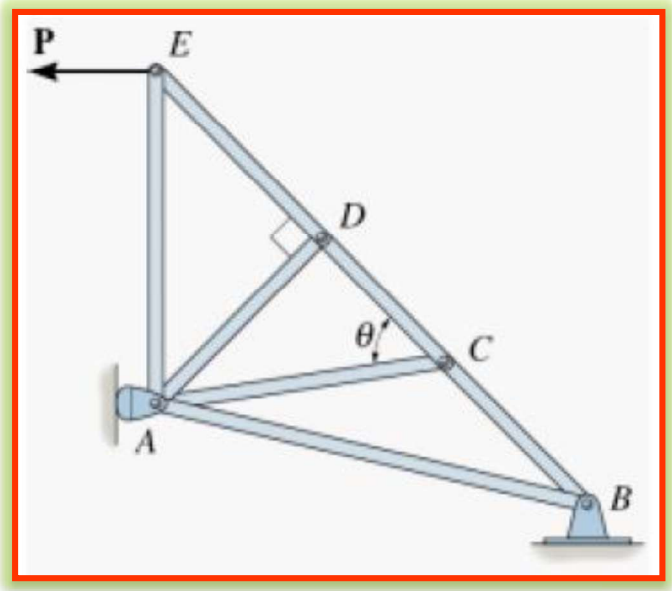
$$\mathbf{F_{AF} = F_{AB} = F_{DE} = F_{DC} = 0.}$$





Analysis of trusses (Zero-force members)

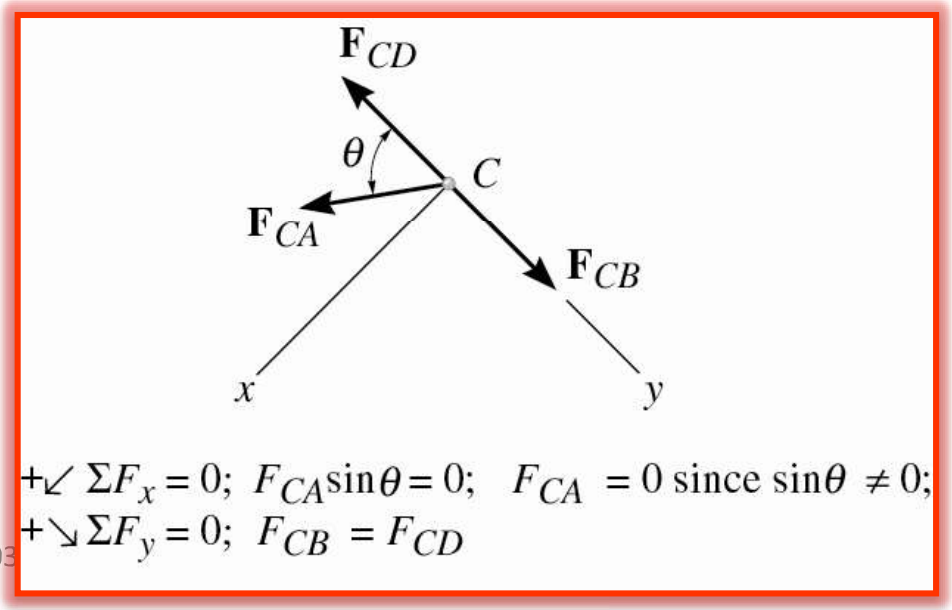
Examples to follow:

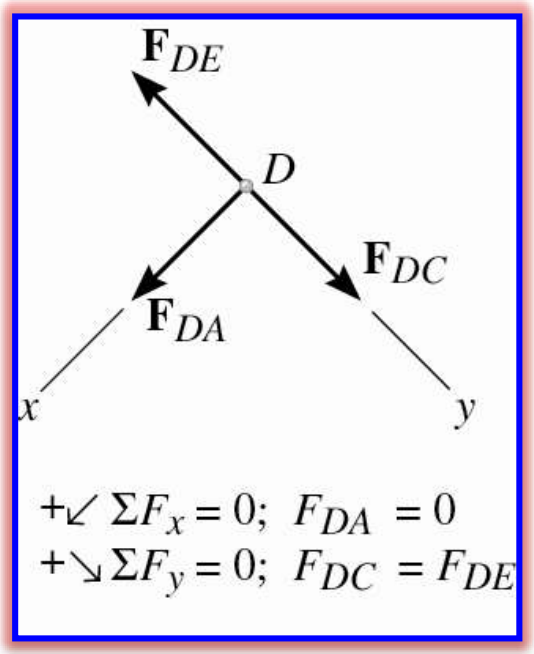


Rule 2: If ***three members*** form a truss **joint** and there is *no external load* or *support reaction* at that *joint* and *two of those members* are ***collinear*** then the *third member* is a ***zero-force member***.

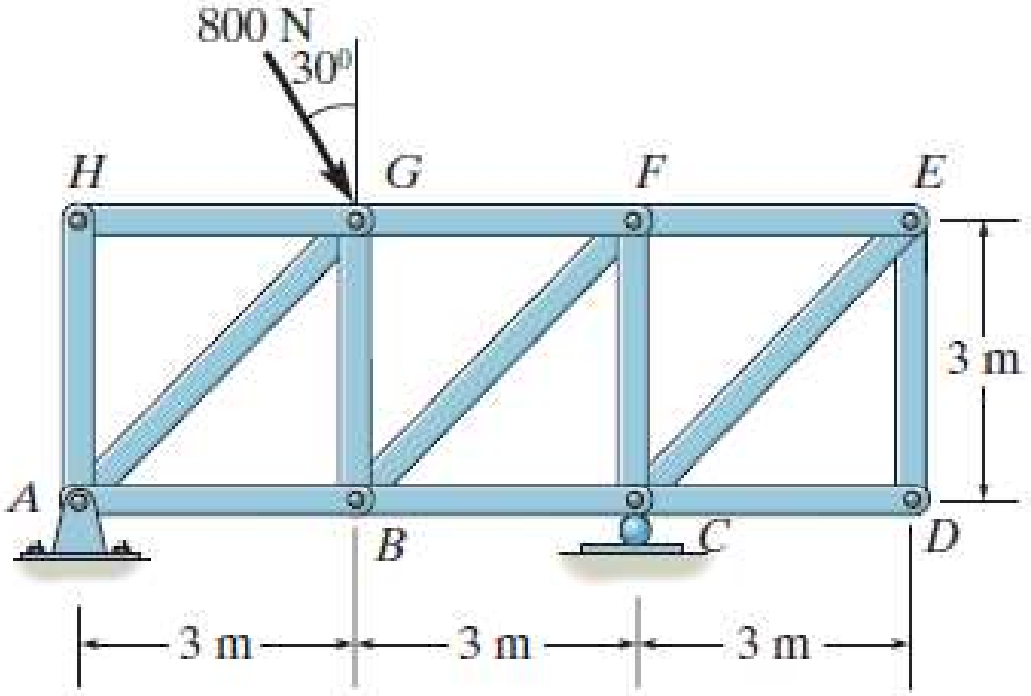
In the following figure, AC and AD are zero-force members, because Joints D and A in the following figure are the joints with three members, there is no external load or support reaction, so:

$$\mathbf{F_{CA} = F_{DA} = 0}$$





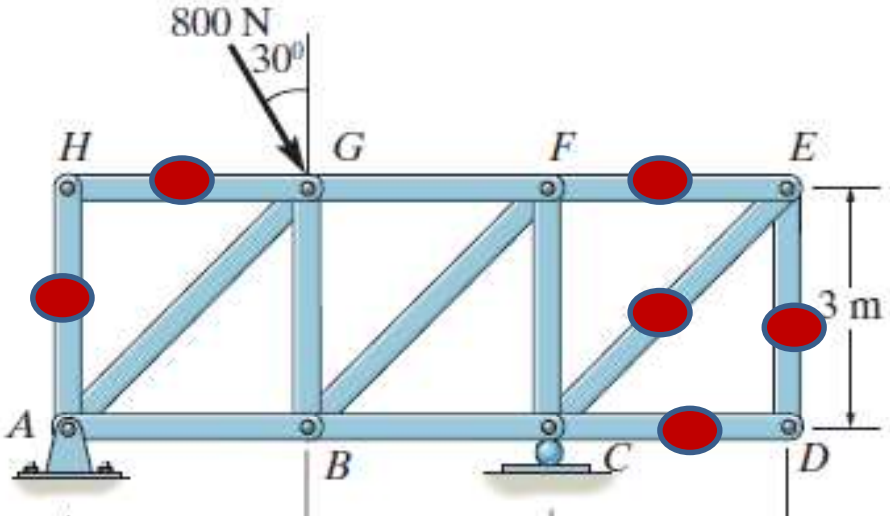
Example 1

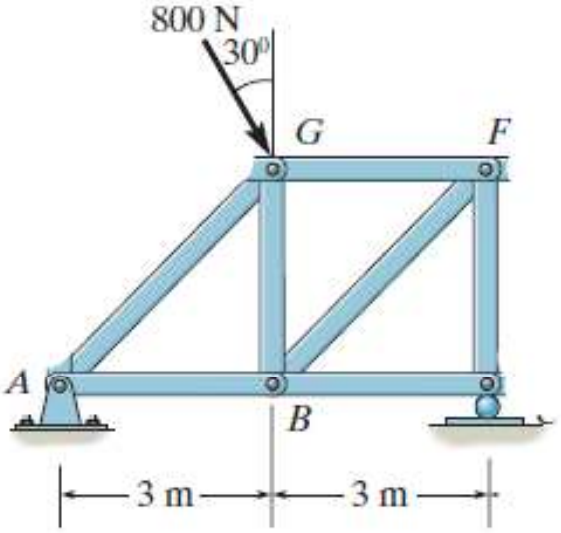


Rule 1: If ***two members*** form a *truss joint* and there is *no external load* or *support reaction* at that joint then *those members* are ***zero-force members***.

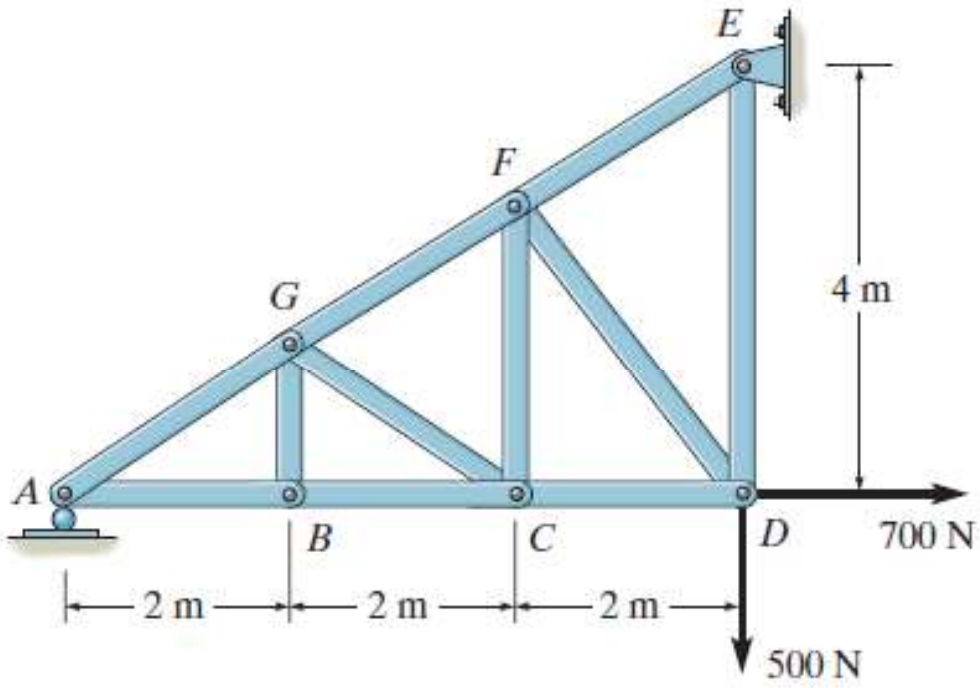
Rule 2: If ***three members*** form a truss **joint** and there is *no external load* or *support reaction* at that *joint* and *two of those members* are ***collinear*** then the *third member* is a ***zero-force member***.

Example 1 (*cont..*)





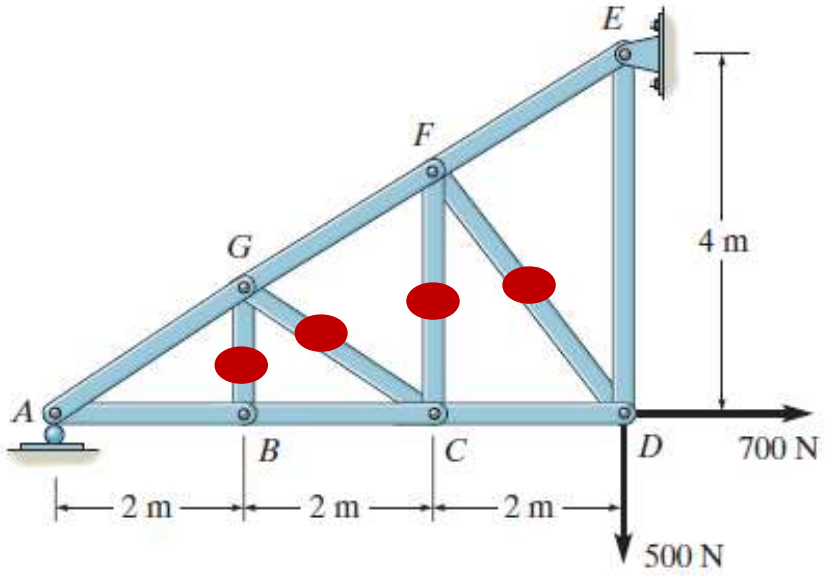
Example 2

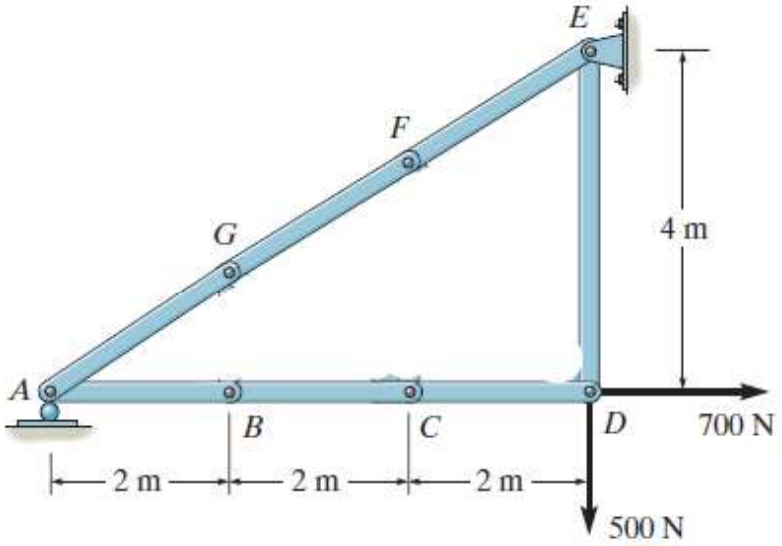


Rule 1: If ***two members*** form a *truss joint* and there is *no external load* or *support reaction* at that joint then *those members* are ***zero-force members***.

Rule 2: If ***three members*** form a truss **joint** and there is *no external load* or *support reaction* at that *joint* and *two of those members* are ***collinear*** then the *third member* is a ***zero-force member***.

Example 2 (*cont..*)





Determinate and Indeterminate Structures (Truss)

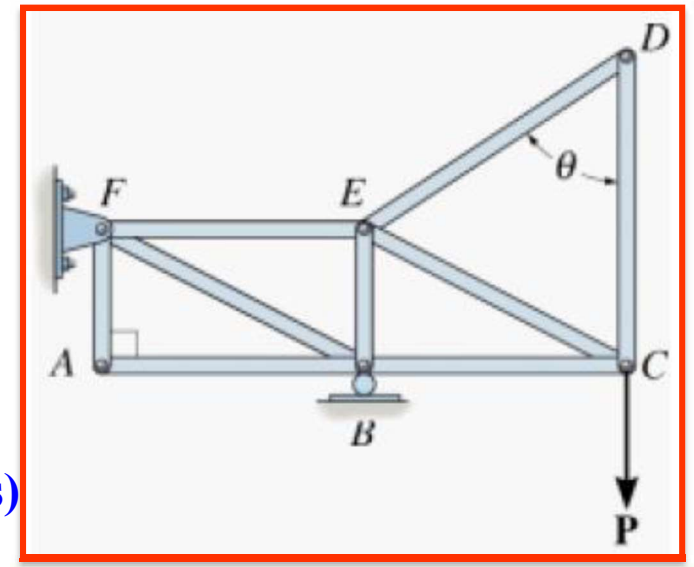
Determinate (Present Course): When **all the unknowns** (external reactions and internal forces) can be found using "Statics" i.e. Drawing FBDs and writing equilibrium equations

Indeterminate (Higher Course): When, **not all the unknowns** can be found using Statics.

Note: Some/most unknowns can still be found

How to determinate whether the structure is Determinate/Indeterminate

m = Number of members in truss
r = Number of support reaction
j = Number of joints in truss structure

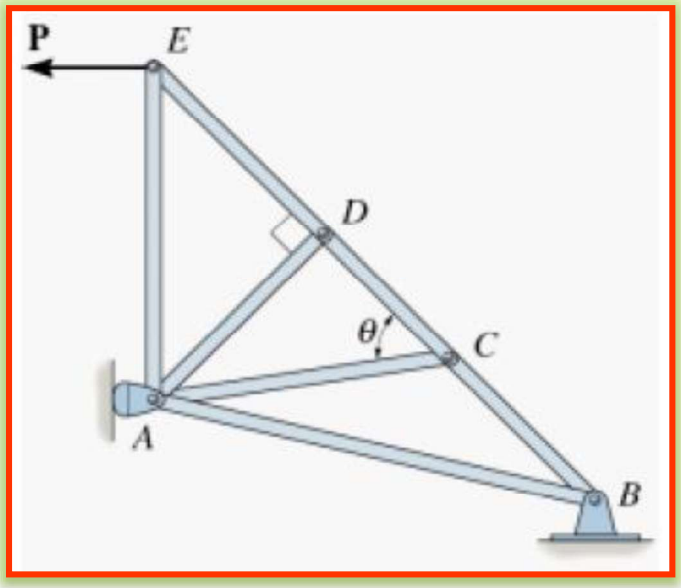


For 2D Truss

Case 1: $m + r - 2j = 0$ (Statically determinate Truss)

Case 2: $m + r - 2j > 0$ (Statically indeterminate Truss)

Case 3: $m + r - 2j < 0$ (Unstable Truss)



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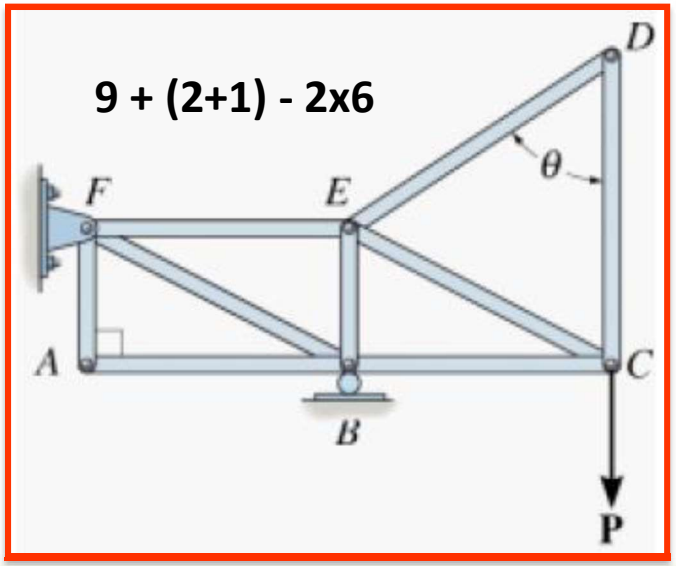

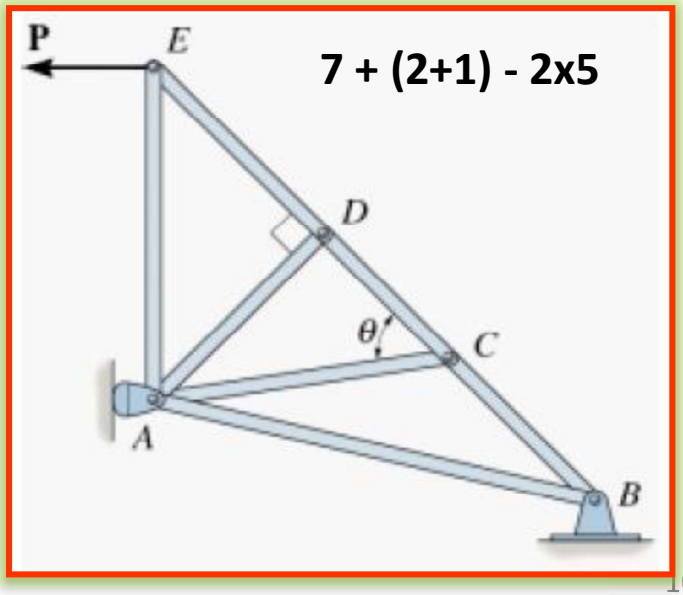

Thank you