Truss Analysis – Method of Joints

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General Procedure for the Analysis of Simple Trusses using the Method of Joints

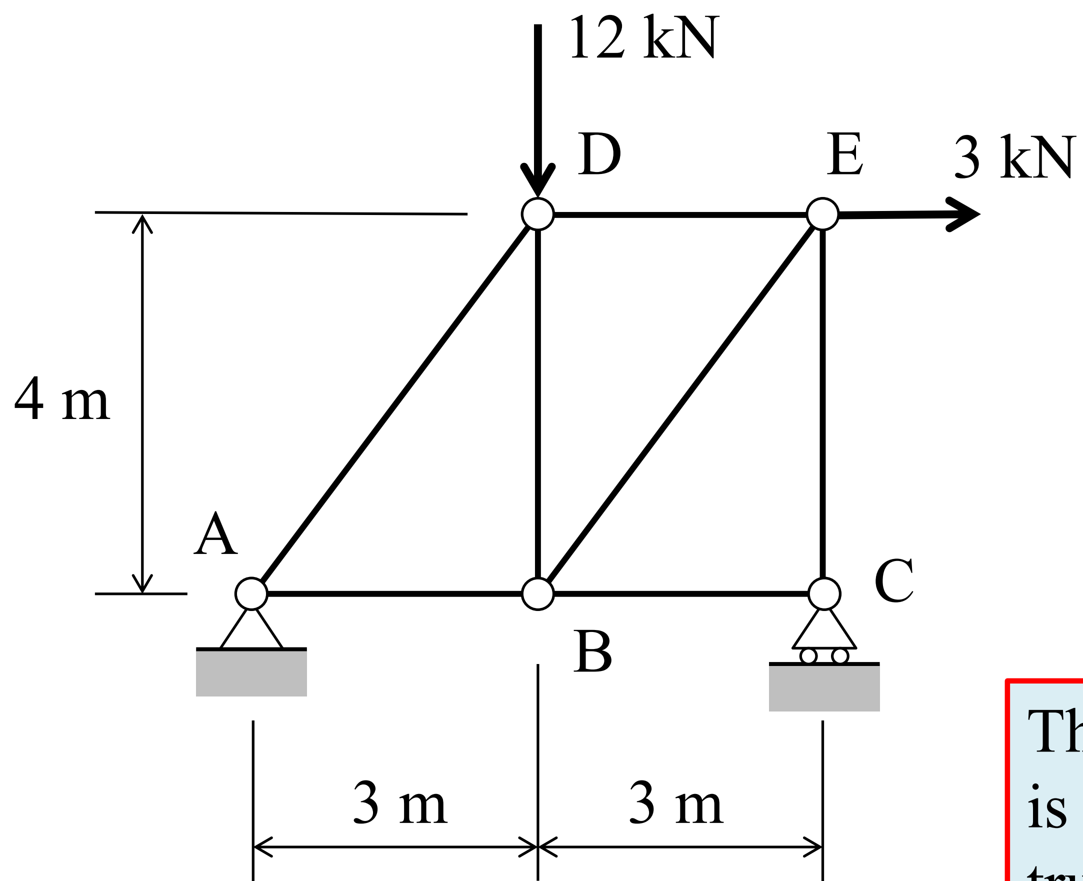
1. Draw a Free Body Diagram (FBD) of the **entire truss** cut loose from its supports and find the **support reactions** using the equations of equilibrium (we will see that for some truss structures this step is not always necessary);

2. Draw a FBD of a truss joint that has no more than **two unknowns** and use the **two equations of equilibrium** to find the two unknown truss member forces;

3. Draw a FBD of a truss joint adjacent to the joint analyzed in Step 2 that has no more than **two unknowns** (using the results from Step 2) use the **two equations of equilibrium** to find the two unknown truss member forces;

4. Repeat Step 3 until all truss member forces are found – a good check is if the last truss joint is in equilibrium then one has good confidence that the analysis is correct.

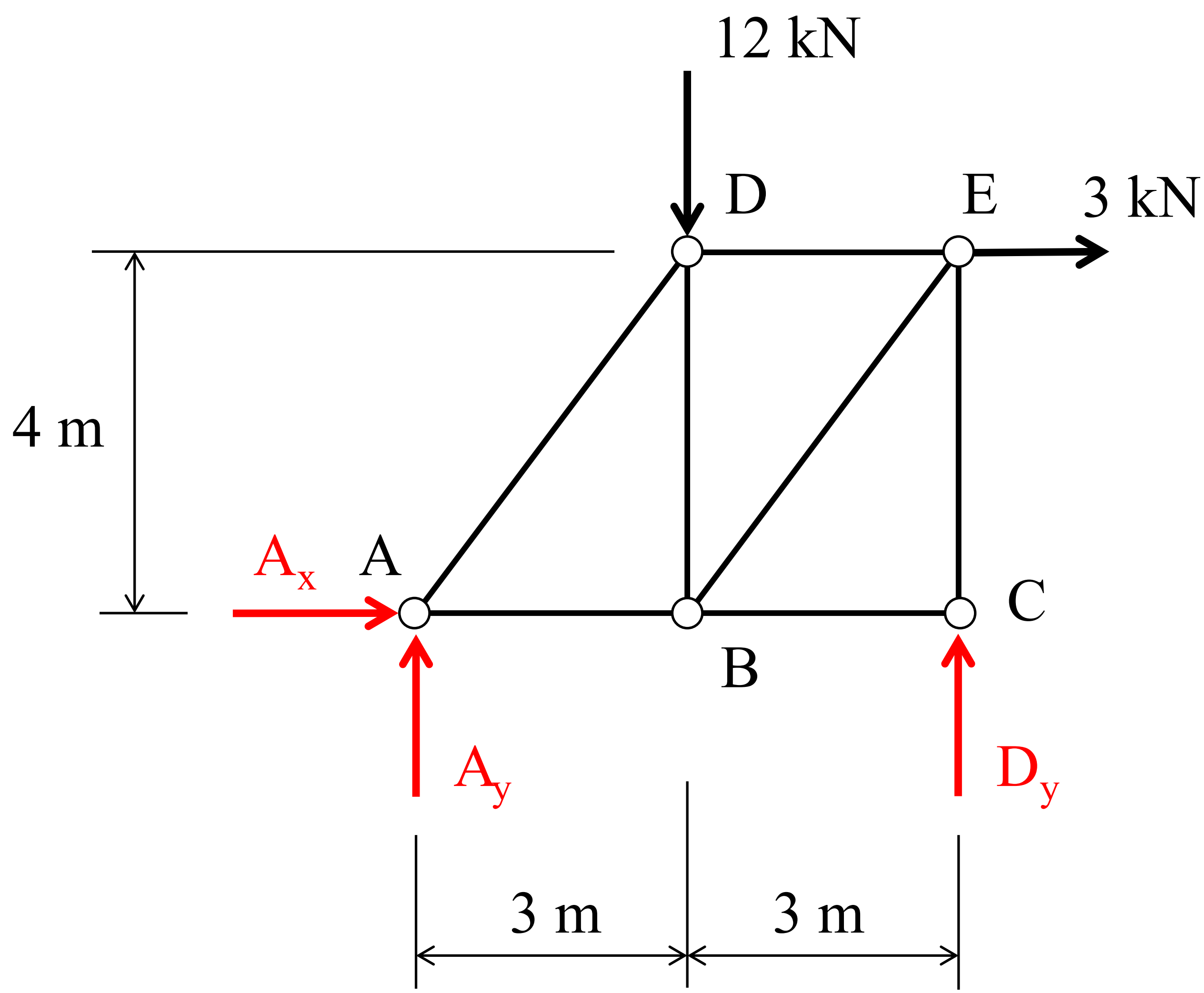
Analysis Example Using the Method of Joints



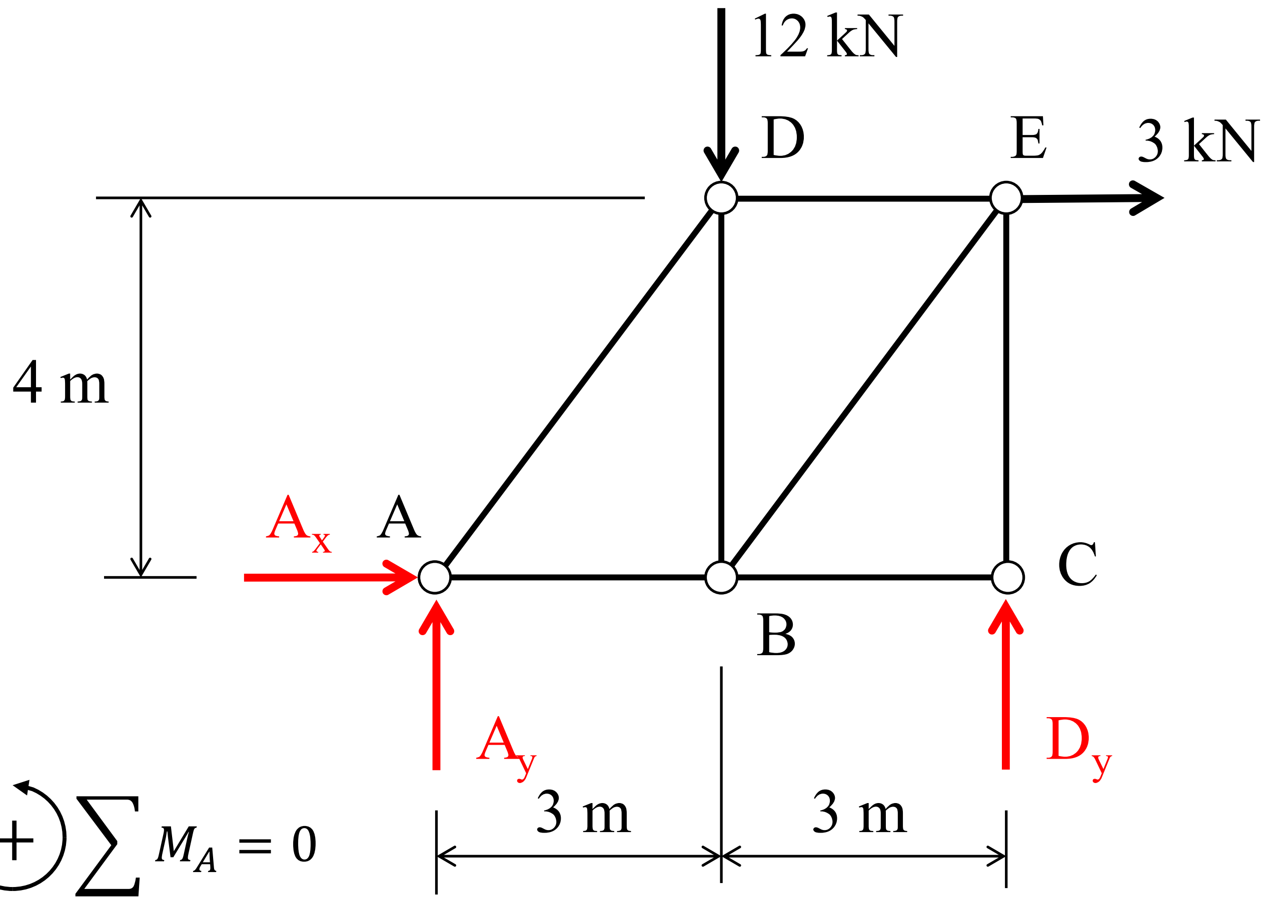
Consider the idealized truss structure with a pin support at A and a roller support at C. The truss is subjected to applied loads at D and E.

The objective of our analysis is to find all seven of the truss member internal forces

1. Draw a Free Body Diagram (FBD) of the **entire truss** cut loose from its supports and find the **support reactions** using the equations of equilibrium (we will see that for some truss structures this step is not always necessary)



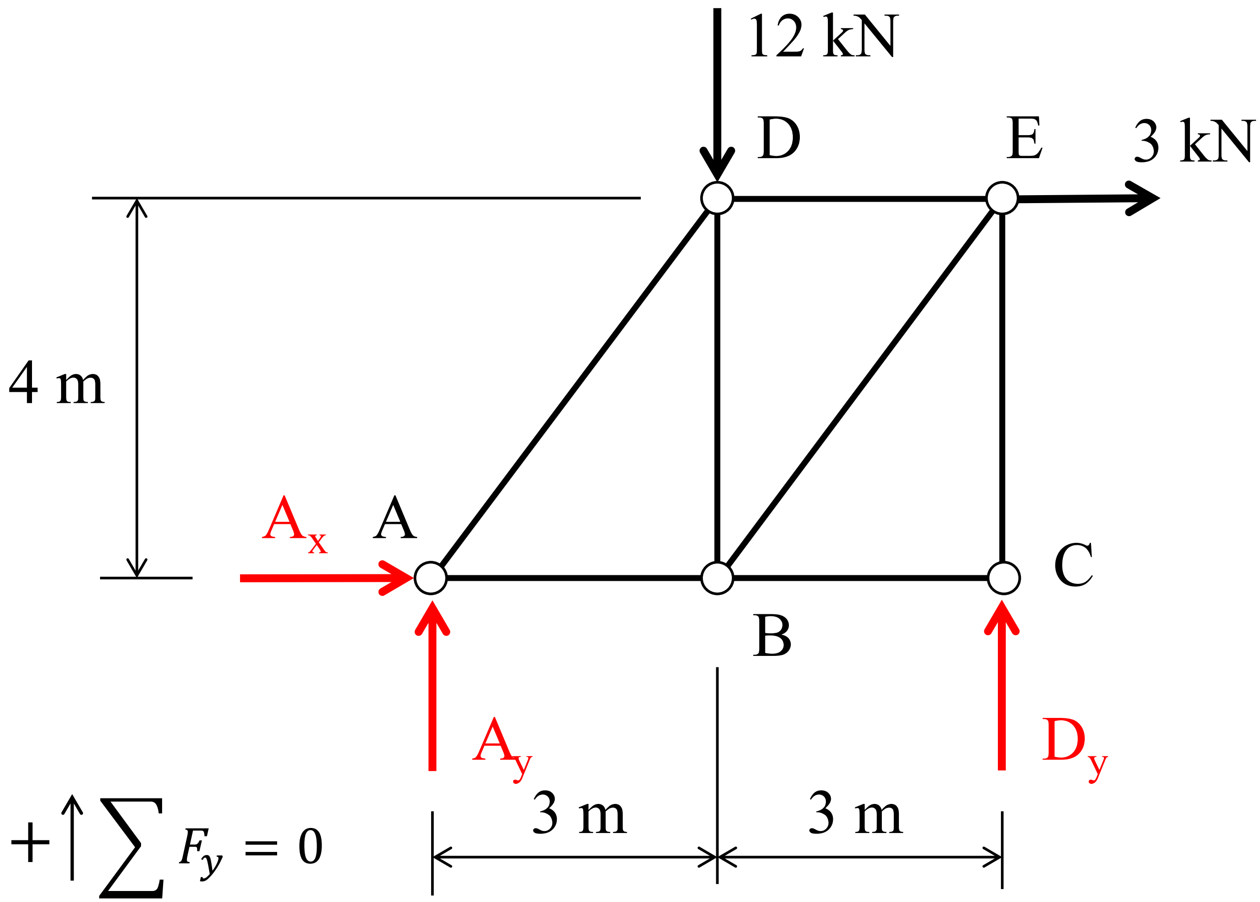
Use Equilibrium to Find Support Reactions



$$\circlearrowleft + \sum M_A = 0$$

$D_y = 8$ kN

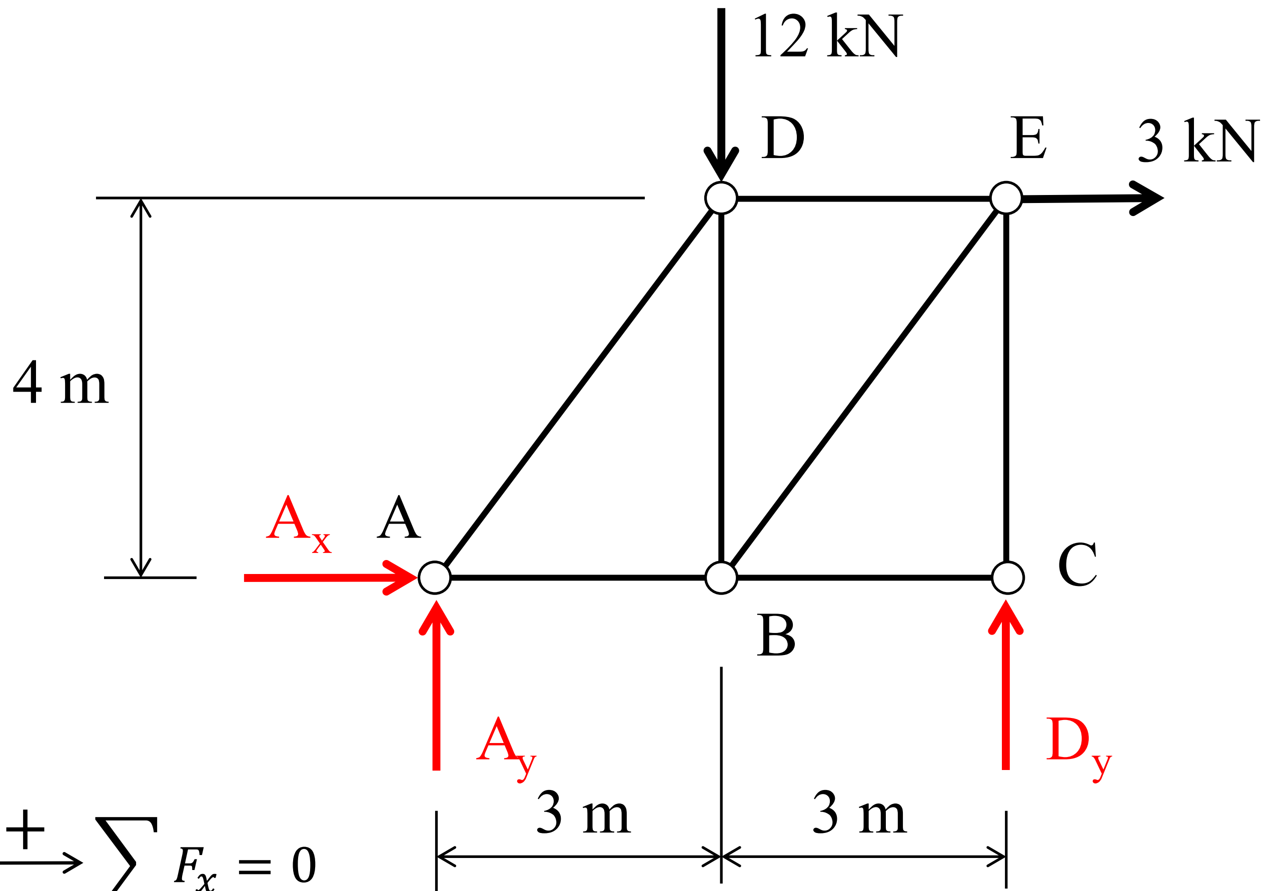
Use Equilibrium to Find Support Reactions



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

$A_y = 4$ kN

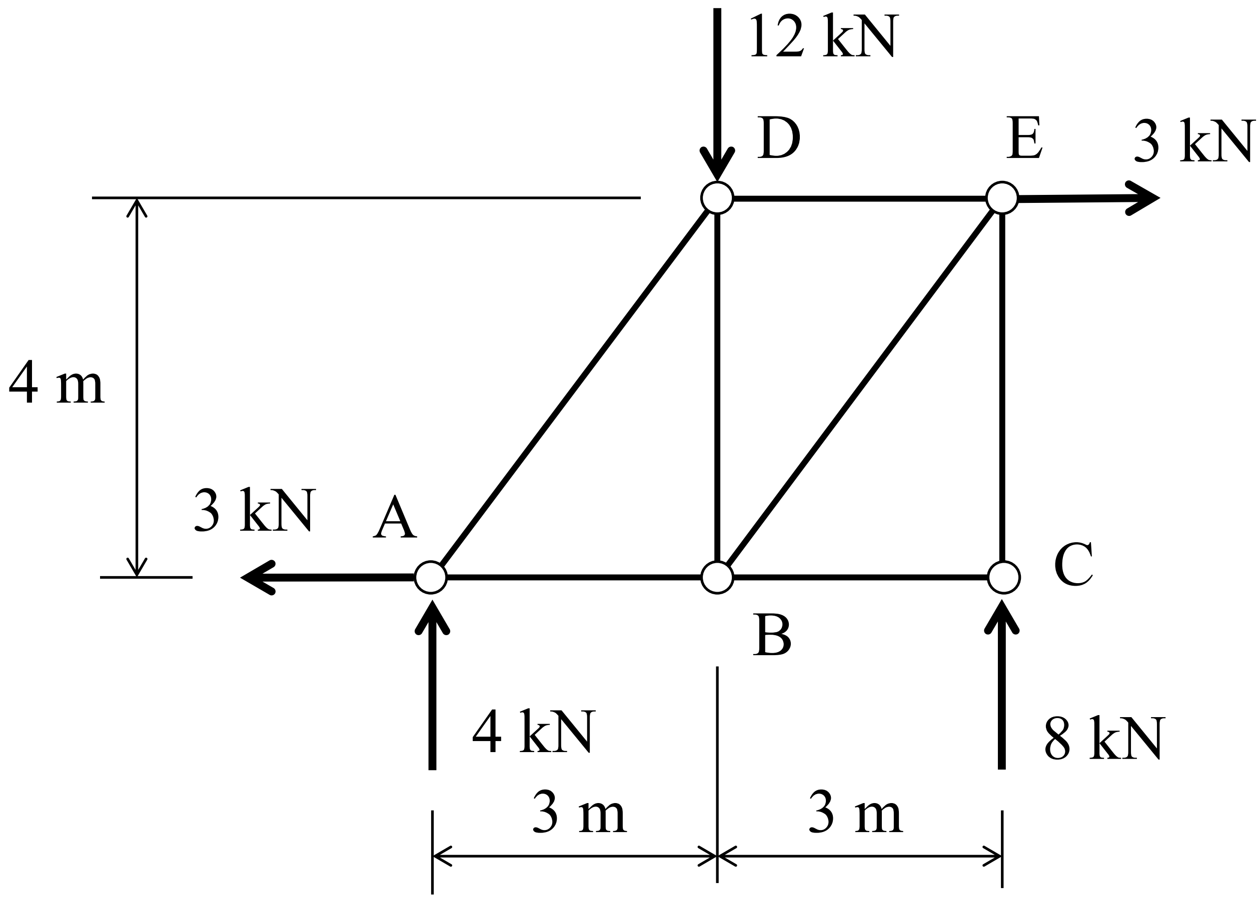
Use Equilibrium to Find Support Reactions



$$\xrightarrow{+} \sum F_x = 0$$

$A_x = -3$ kN

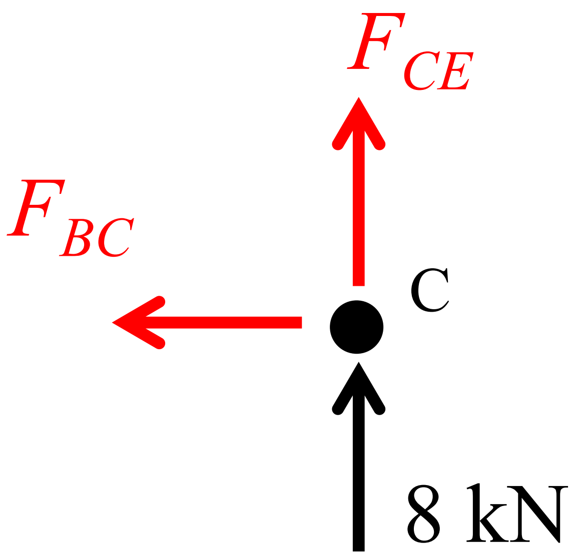
FBD Showing Known Support Reactions



Joints A and C are the only joints with two unknowns

2. Draw a FBD of a truss joint that has no more than **two unknowns** and use the **two equations of equilibrium** to find the two unknown truss member forces;

FBD of the Connecting Pin at Joint C

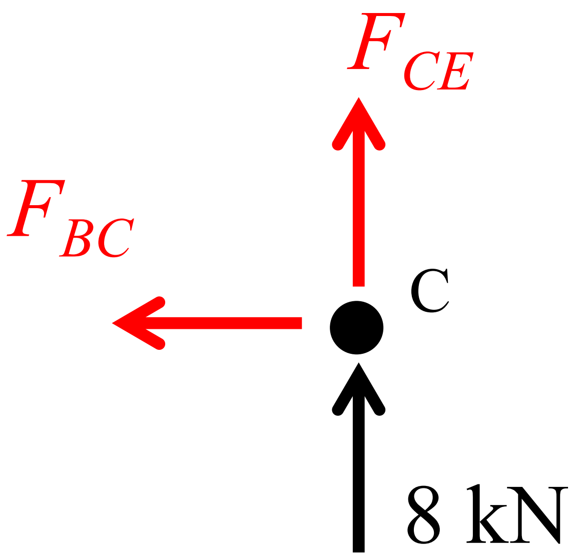


> Note
>
> Unknown truss member forces are assumed to act in tension (pulling away form the joint).

$$\xrightarrow{+} \sum F_x = 0$$

$F_{BC} = 0$

FBD of the Connecting Pin at Joint C



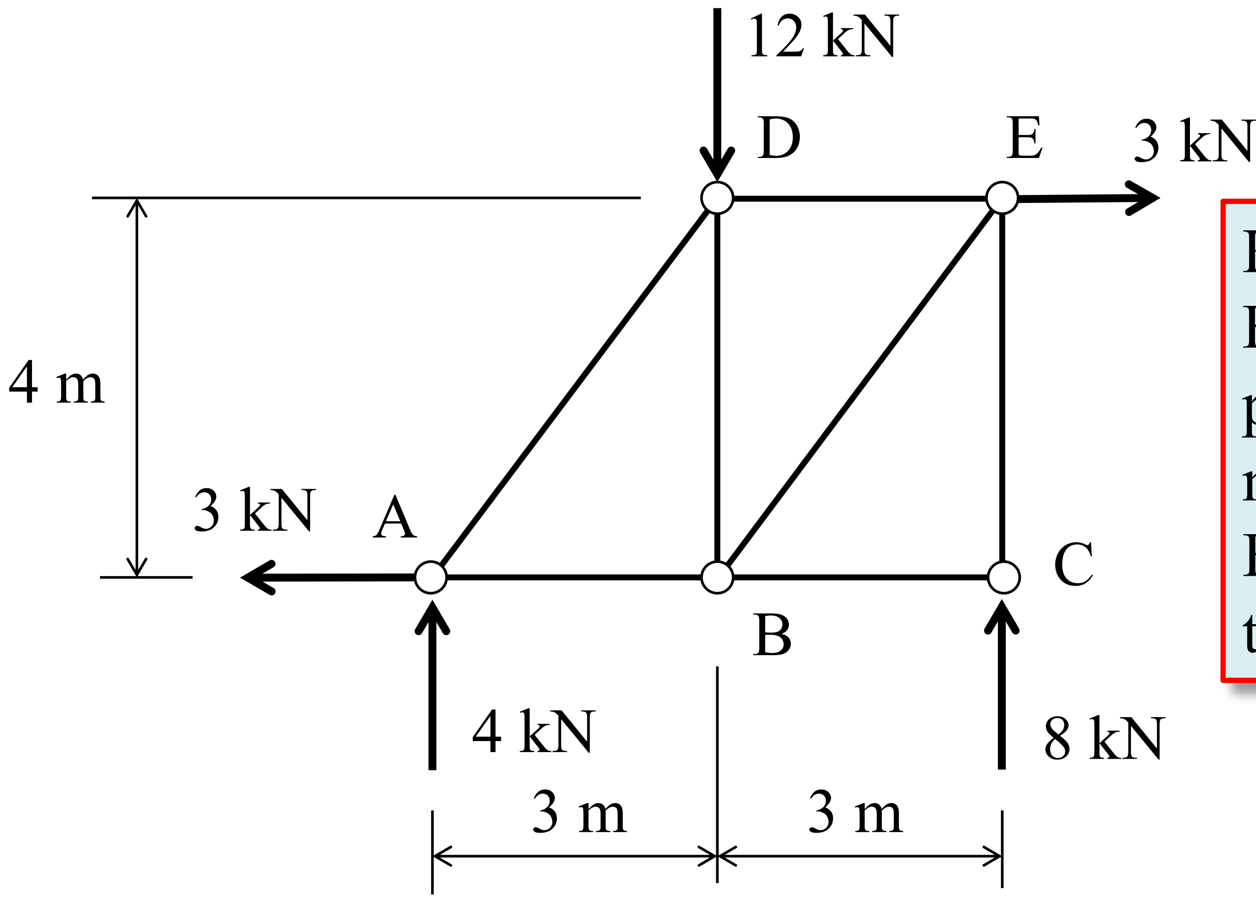
Note

Unknown truss member forces are assumed to act in tension (pulling away form the joint).

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

$F_{CE} = -8\text{kN}$

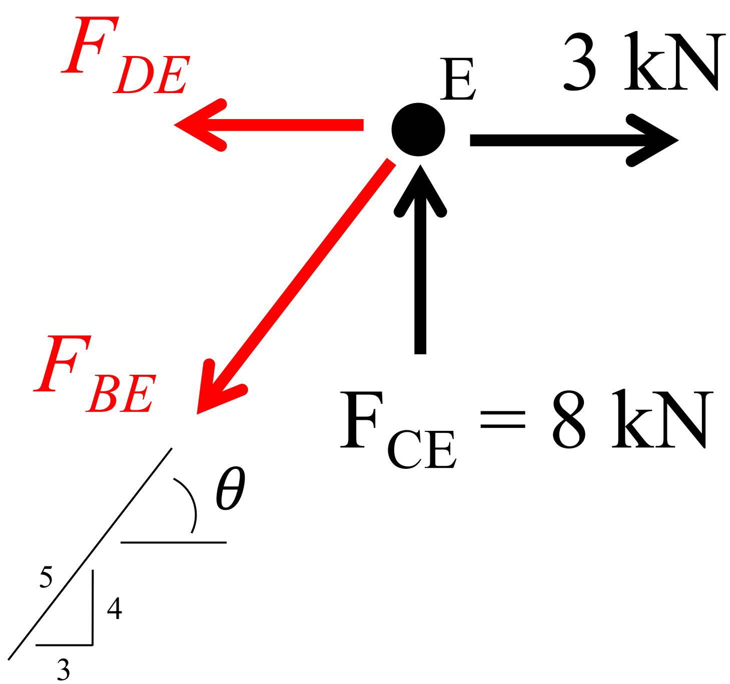
Return to FBD Showing Support Reactions



Knowing F_{CE} and F_{BC} from the previous analysis, now joints A and E are joints with two unknowns

3. Draw a FBD of a truss joint adjacent to the joint analyzed in Step 2 that has no more than **two unknowns** (using the results from Step 2) use the **two equations of equilibrium** to find the two unknown truss member forces;

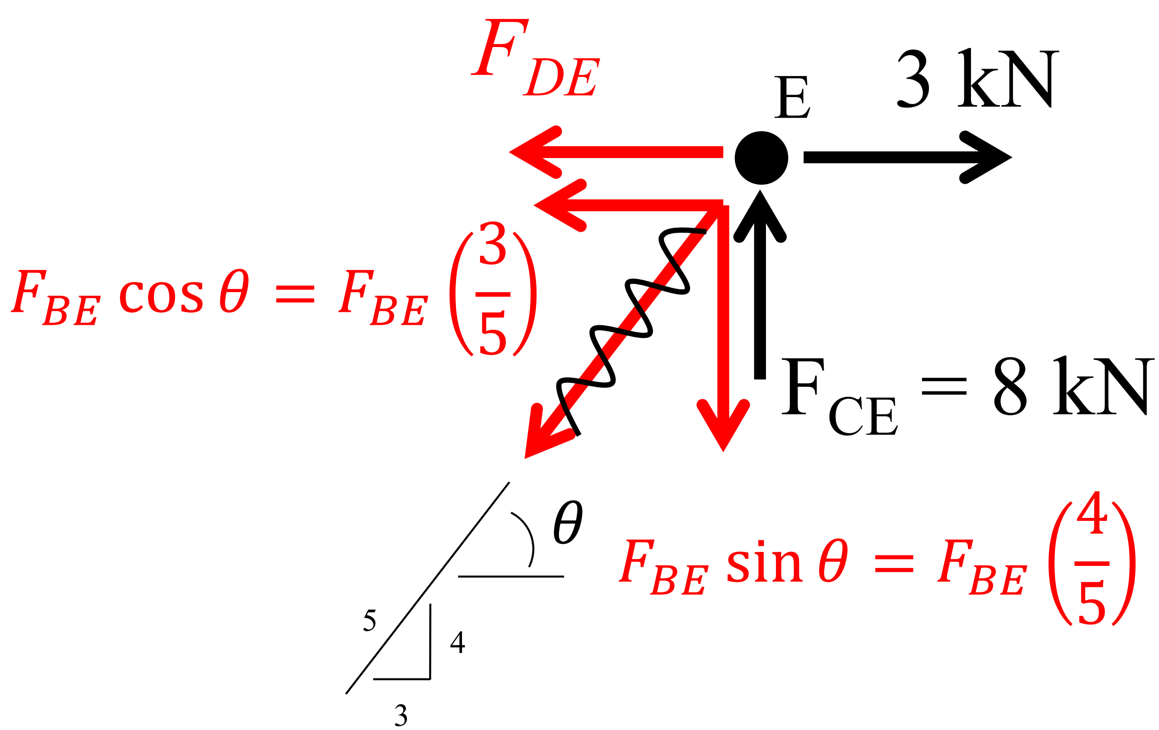
FBD of the Connecting Pin at Joint E



Notes

- Unknown truss member forces are assumed to act in tension (pulling away form the joint);
- Known force F_{CE} is shown acting in compression as was found in the previous step (no need for minus sign!)

FBD of the Connecting Pin at Joint E



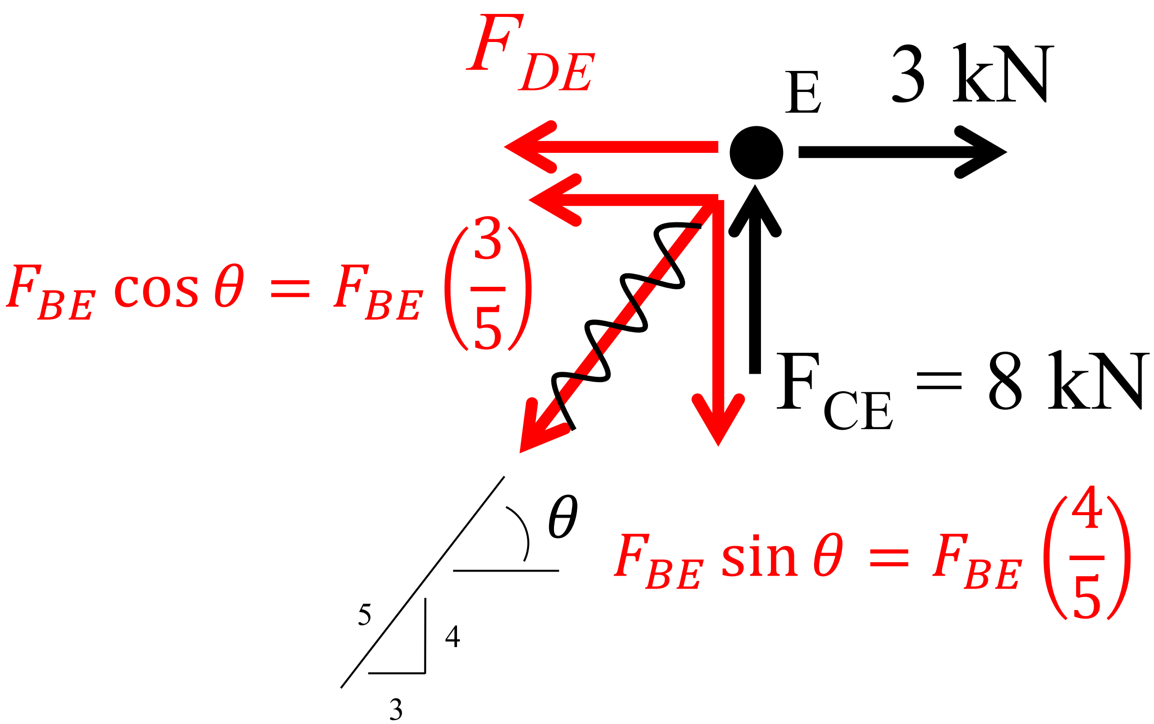
$$+\uparrow \sum F_y = 0$$

Notes

- Unknown truss member forces are assumed to act in tension (pulling away form the joint);
- Known force F_{CE} is shown acting in compression as was found in the previous step (no need for minus sign!)
- Best to start with equilibrium in the vertical direction.

$F_{BE} = 10$ kN

FBD of the Connecting Pin at Joint E



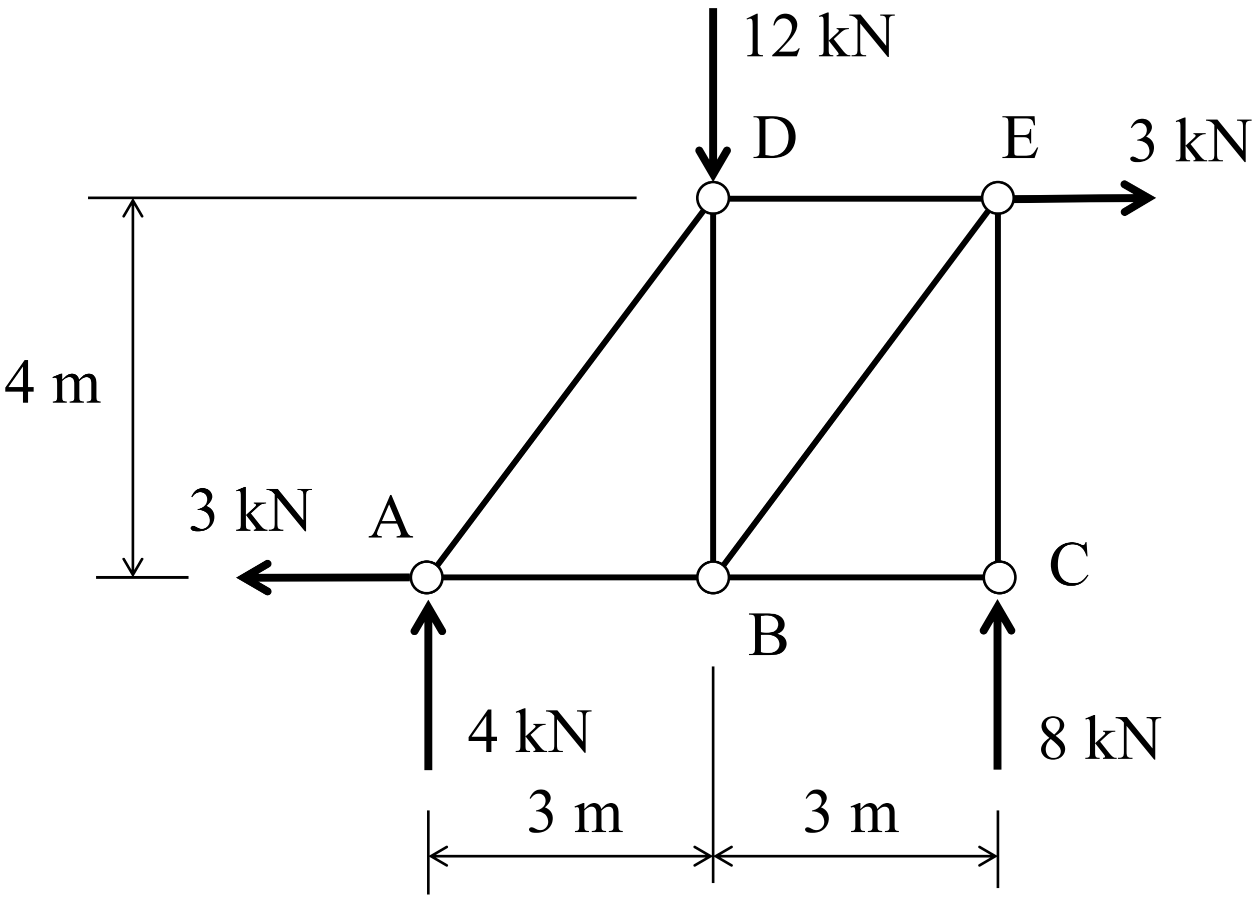
$$\xrightarrow{+} \sum F_x = 0$$

Notes

- Unknown truss member forces are assumed to act in tension (pulling away form the joint);
- Known force F_{CE} is shown acting in compression as was found in the previous step (no need for minus sign!)

$F_{DE} = -3$ kN

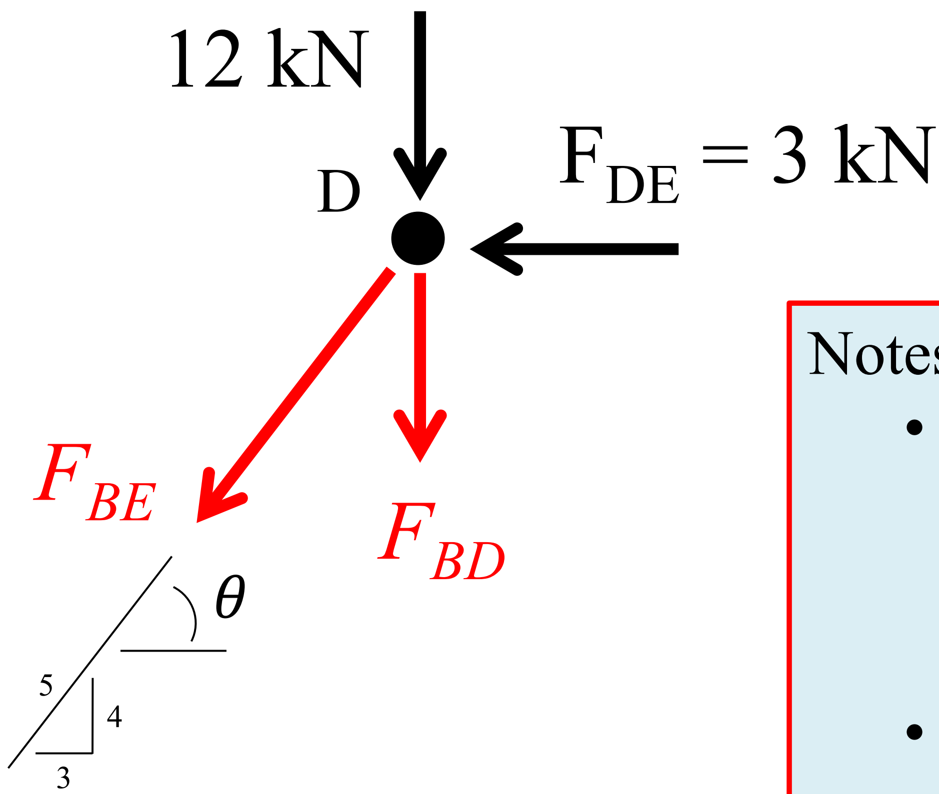
Return to FBD Showing Support Reactions



Knowing F_{CE}, F_{BC}, F_{DE}, and $F_{BE,}$ from the previous analyses, now joints A, B, and D are joints with two unknowns

4. Repeat Step 3 until all truss member forces are found – a good check is if the last truss joint is in equilibrium then one has good confidence that the analysis is correct.

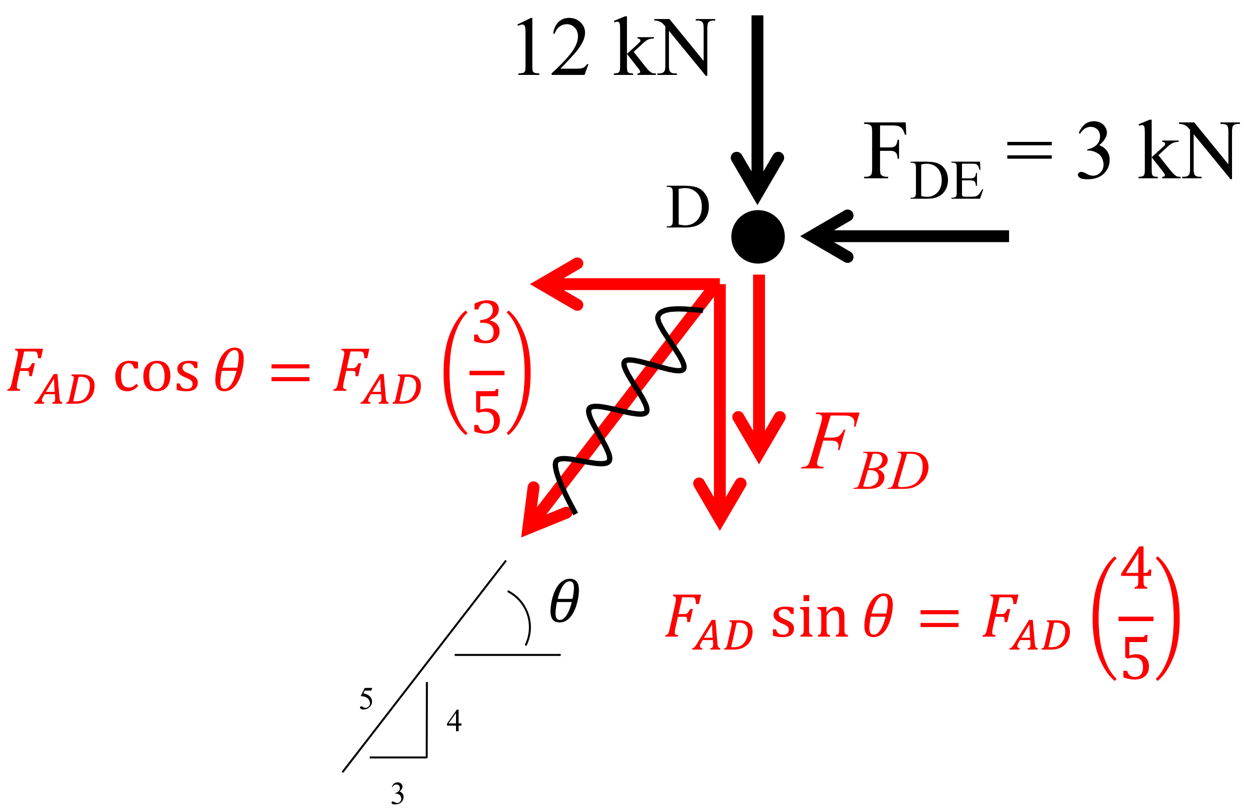
FBD of the Connecting Pin at Joint D



Notes

- Unknown truss member forces are assumed to act in tension (pulling away form the joint);
- Known force F_{DE} is shown acting in compression as was found in the previous step (no need for minus sign!)

FBD of the Connecting Pin at Joint D



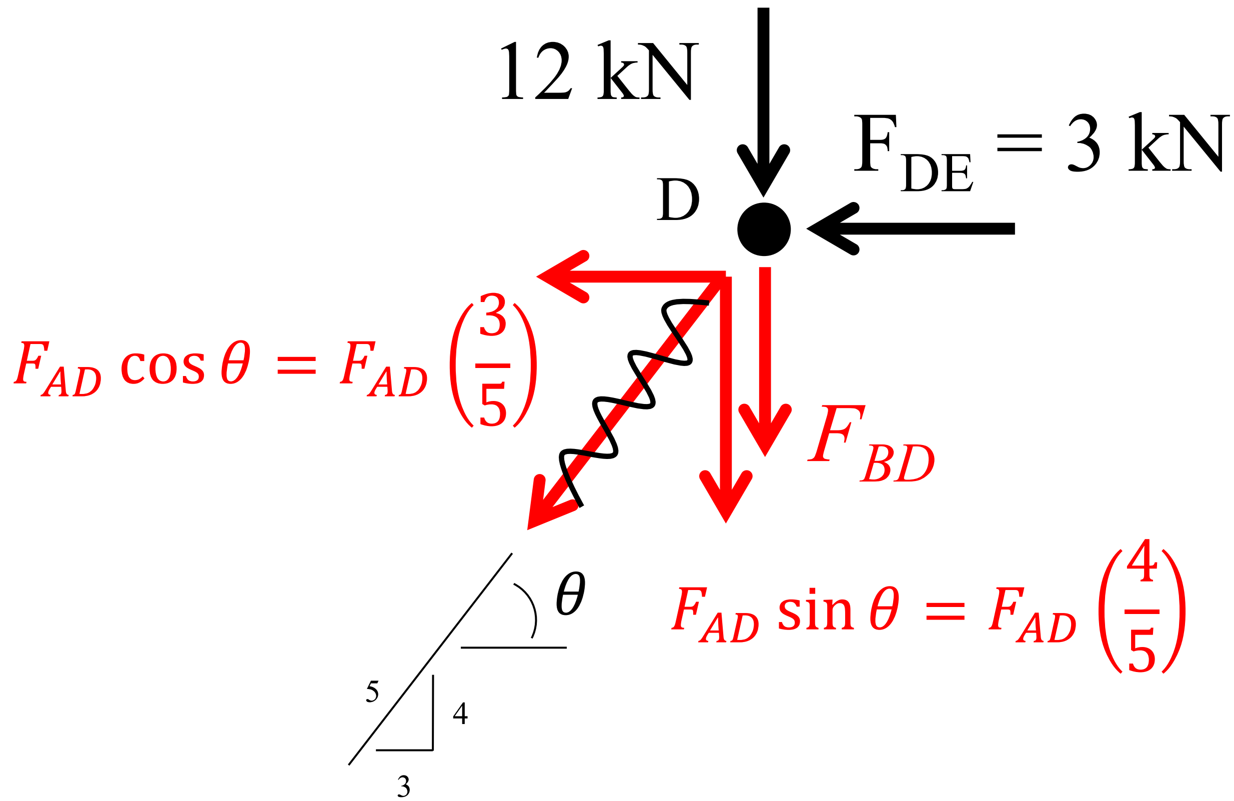
$$\xrightarrow{+} \sum F_x = 0$$

Notes

- Unknown truss member forces are assumed to act in tension (pulling away form the joint);
- Known force F_{DE} is shown acting in compression as was found in the previous step (no need for minus sign!);
- Best to start with equilibrium in the horizontal direction.

$F_{AD} = -5$ kN

FBD of the Connecting Pin at Joint D



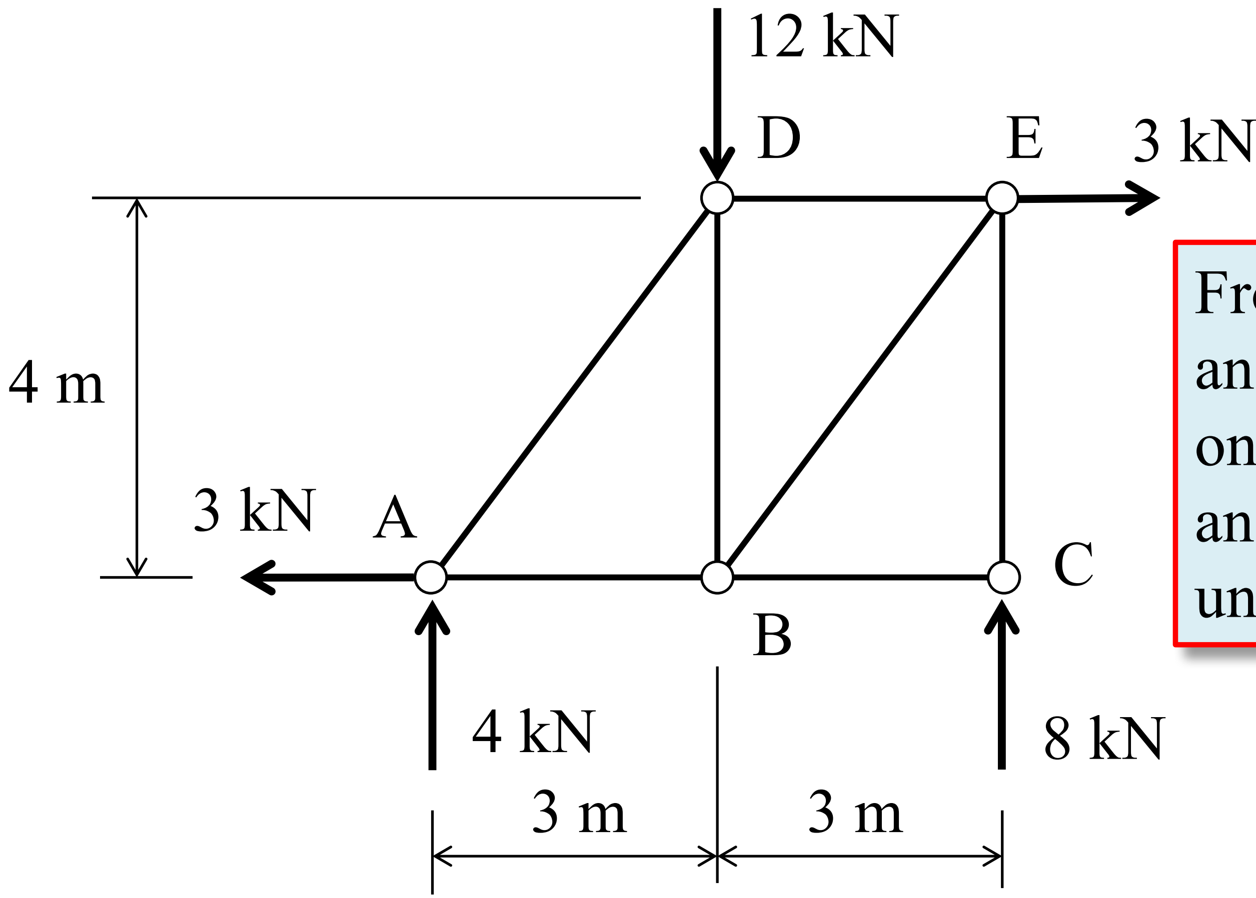
Notes

- Unknown truss member forces are assumed to act in tension (pulling away form the joint);
- Known force F_{DE} is shown acting in compression as was found in the previous step (no need for minus sign!)

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

$F_{BD} = -8$ kN

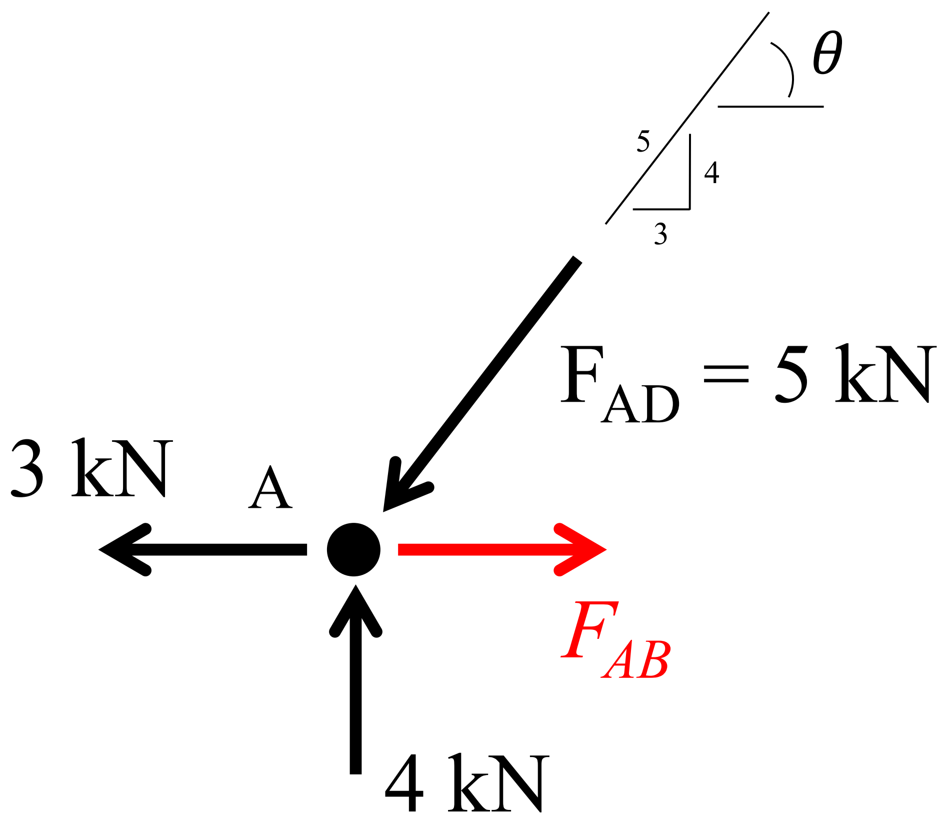
Return to FBD Showing Support Reactions



From the previous analysis, joint A has one unknown (F_{AB}) and joint B has one unknown (F_{AB}).

4. Repeat Step 3 until all truss member forces are found – a good check is if the last truss joint is in equilibrium then one has good confidence that the analysis is correct.

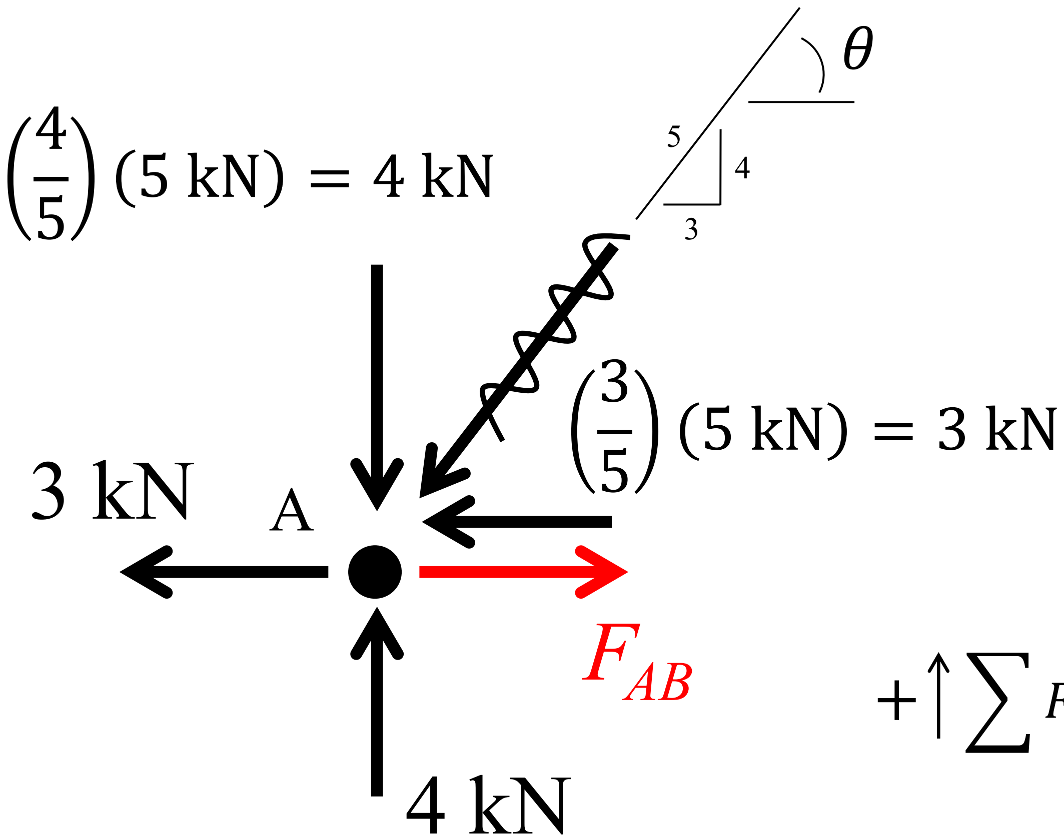
FBD of the Connecting Pin at Joint A



Notes

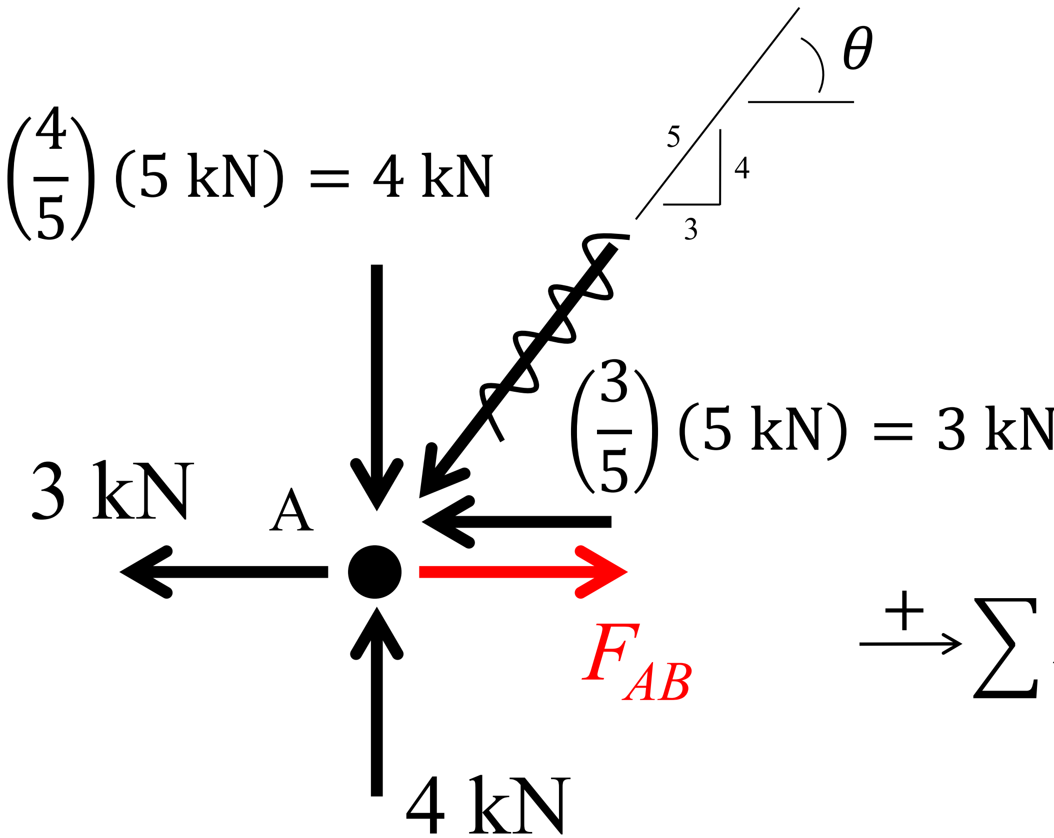
- Unknown truss member force is assumed to act in tension (pulling away from the joint);
- Known force F_{AD} is shown acting in compression as was found in the previous step (no need for minus sign!)
- Two equations of equilibrium and one unknown – one equation is used as a check.

FBD of the Connecting Pin at Joint A



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

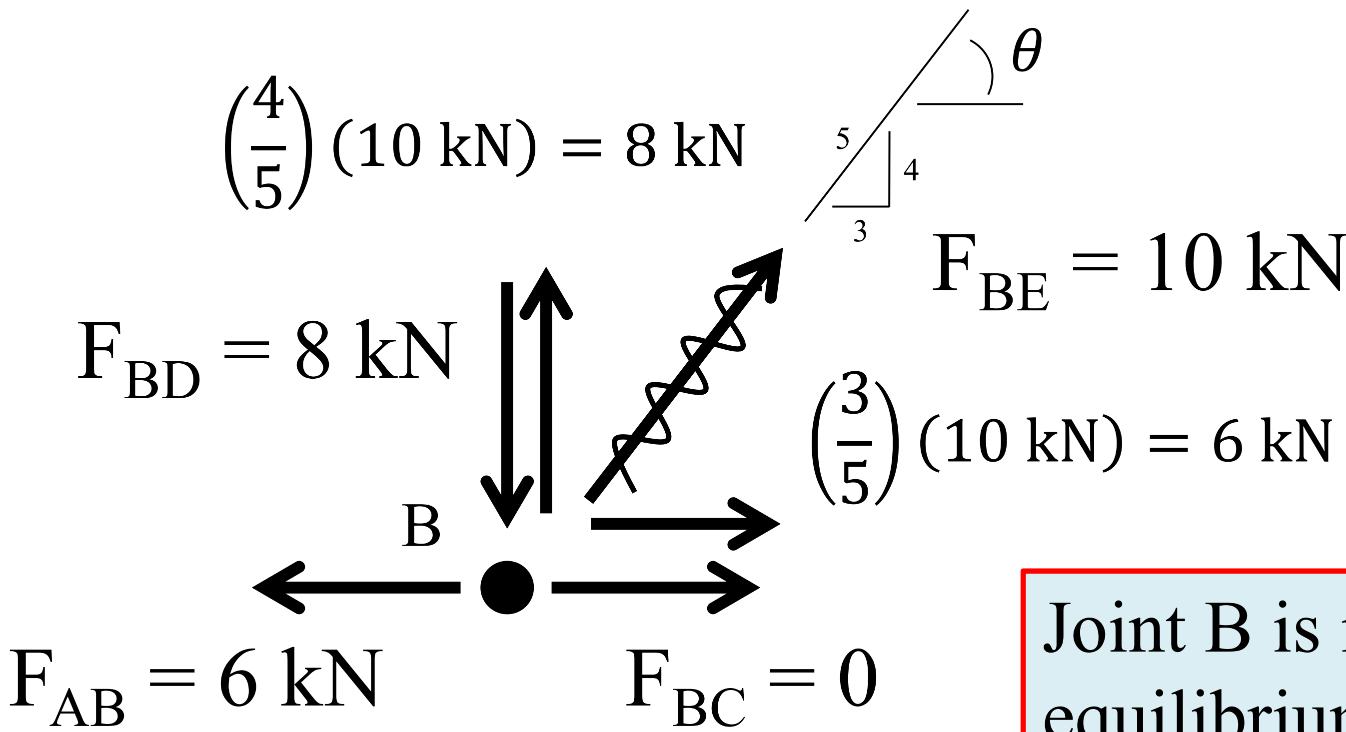
FBD of the Connecting Pin at Joint A



$$\xrightarrow{+} \sum F_x = 0$$

$F_{AB} = 6$ kN

Check Equilibrium of Connecting Pin at Joint B

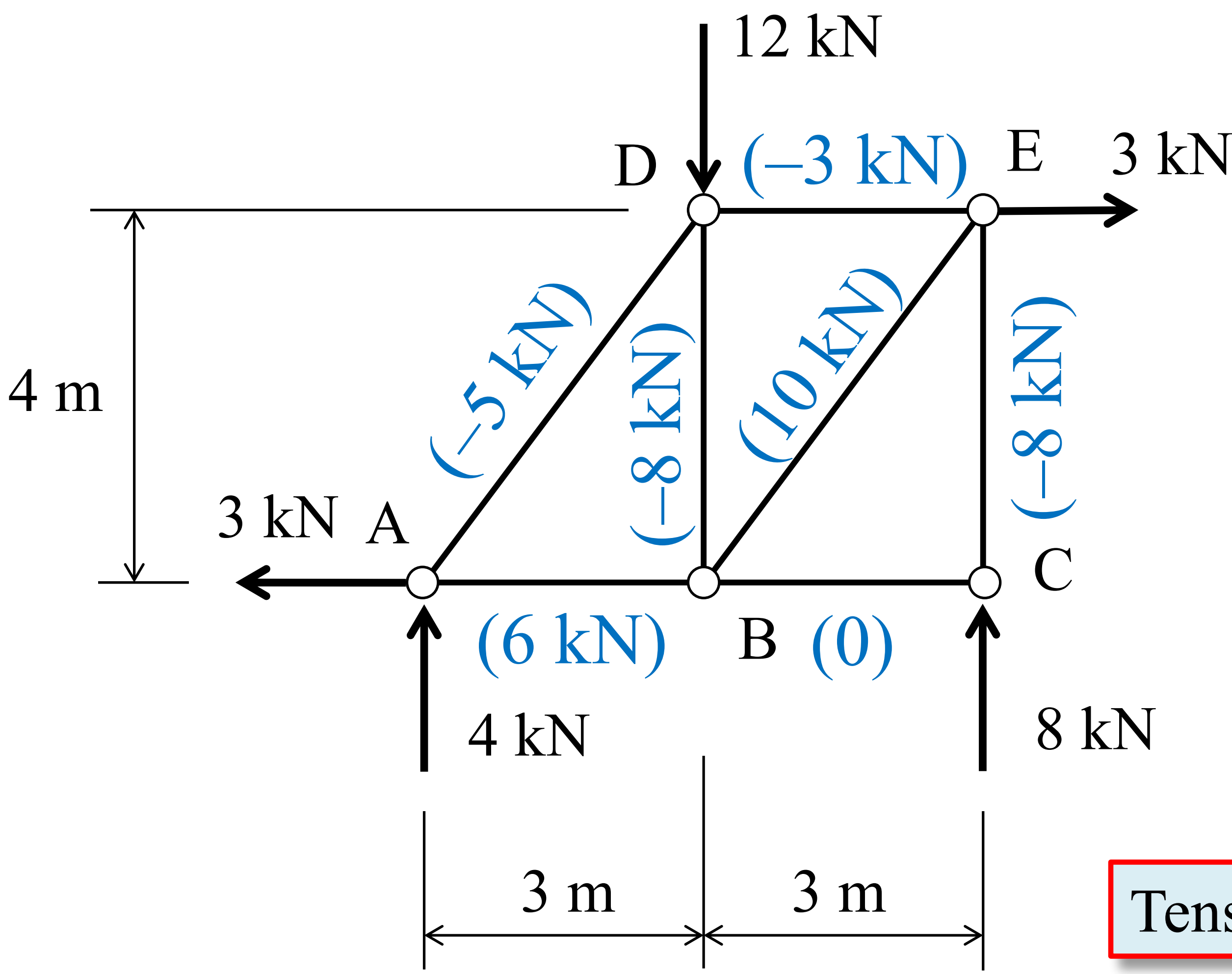


Joint B is in equilibrium!

$\xrightarrow{+} \sum F_x = 0$

$+\uparrow \sum F_y = 0$

Show Results on FBD of Entire Truss



Tension is Positive