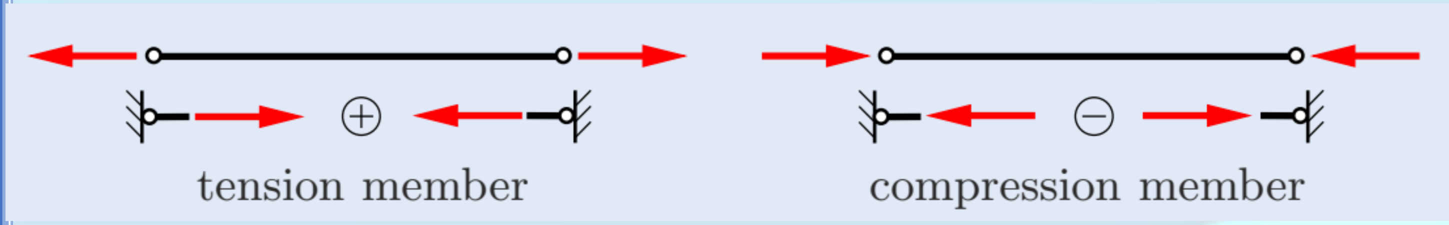
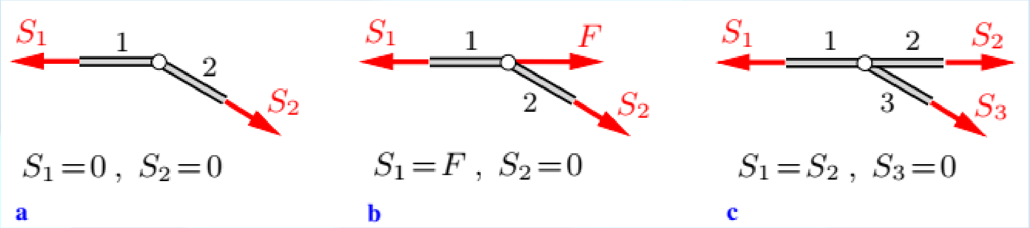
Trusses

الجيزان الشبكية

Definition: A truss is a structure composed of straight slender members that are connected at their ends by pin joints. The truss is one of the oldest and most important structures in engineering applications.

تعريف: يتكون الجائز الشبكي من عناصر مستقيمة نحيلة تتصل ببعضها عند نهاياتها بواسطة عقد مفصلية. يعد الجائز الشبكي واحدا من أقدم الجمل الإنشائية وأكثرها أهمية وفعالية.





2.2. Method of Sections

It is not always necessary to determine the forces in all of the members of a truss.

If several forces only are of interest, it may be advantageous to use the **method of sections** instead of the method of joints.

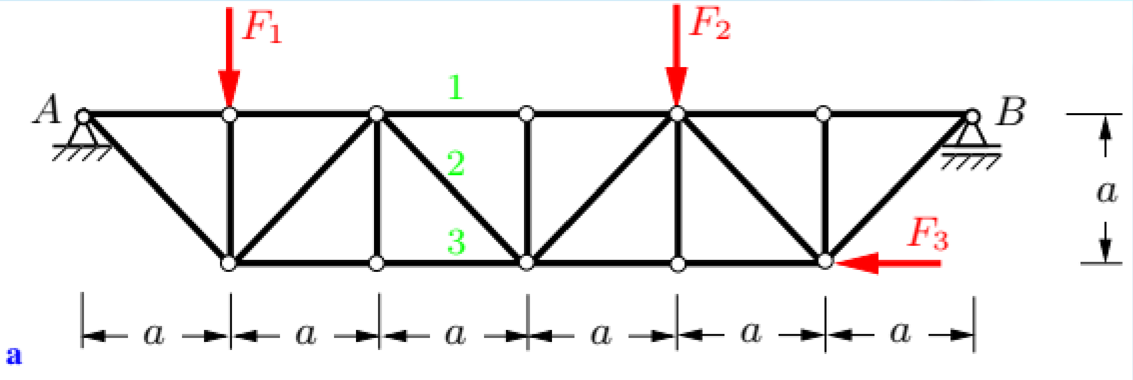
In this case, the truss is divided by a cut **(an imaginary)** into two parts.

The cut has to be made in such a way that it either goes through three members that do not all belong to the same joint.

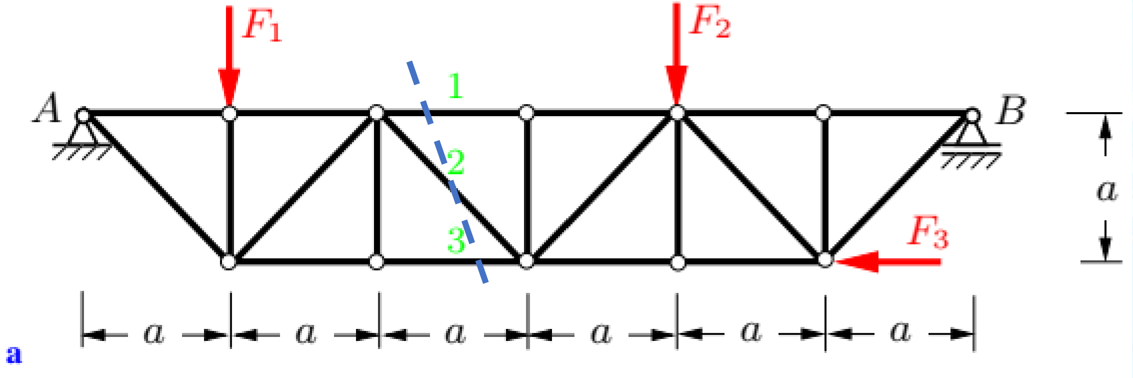
If the support reactions are computed in advance, the F. B. D. for each part of the truss contains only 3 unknown forces that can be determined by the 3 conditions of equilibrium.

Example 1

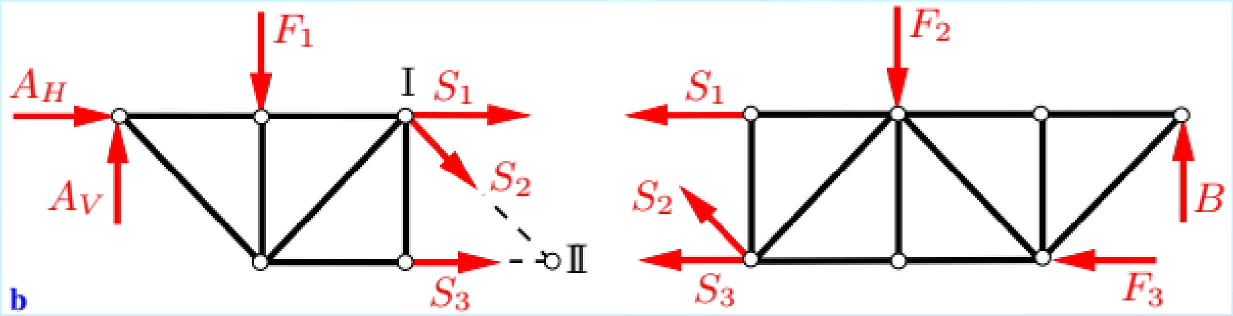
To illustrate the method, we consider the truss shown in Fig.a with the aim of determining the forces in members 1,2 &3.



As a first step, the reactions at supports *A* & *B* are computed by applying the Eq. Eqs. to the free-body diagram of the whole truss



In the second step, we pass an imaginary section through the members 1,2 & 3, cutting the truss into two parts. Fig.b shows the free-body diagrams of the two parts of the truss. The internal forces in members 1,2 & 3 act as external forces in the free-body diagrams; they are assumed to be tensile forces.



$$\overset{\curvearrowleft}{\mathrm{I}}:\ aF_1 - 2aA_V + aS_3 = 0 \ \Rightarrow S_3 = 2aA_V - F_1$$

$$\overset{\curvearrowleft}{\mathrm{II}}: -aA_H - 3aA_V + 2aF_1 - aS_1 = 0 \Rightarrow S_1 = 2F_1 - 3\,A_V - A_H$$

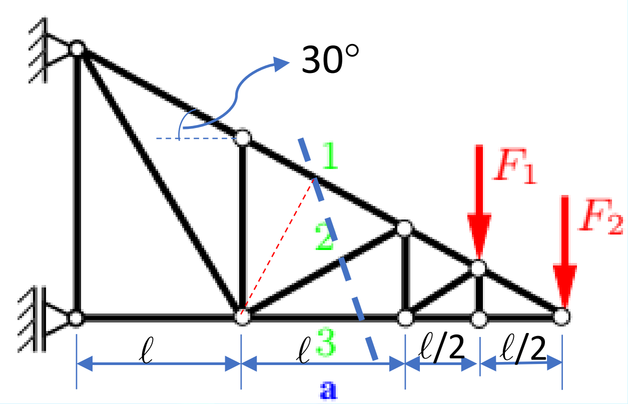
$$\uparrow:\ A_V - F_1 - S_2 \sin 45^\circ = 0 \Rightarrow S_2 = \sqrt{2}(A_V - F_1)$$

Both parts of the truss in Fig.b are rigid bodies in equilibrium. Therefore, either part may be used for the analysis.

We shall apply the Eq. Eqs. to the free-body diagram on the left-hand side of Fig.b.

Example 2

In many cases, the method of sections can be applied without having to determine the forces at the supports.
Consider, for example, the truss in Fig.a. The forces in members 1,2 & 3 can be obtained immediately from the Eq. Eqs. for the part of the truss on the right as shown in Fig.b.

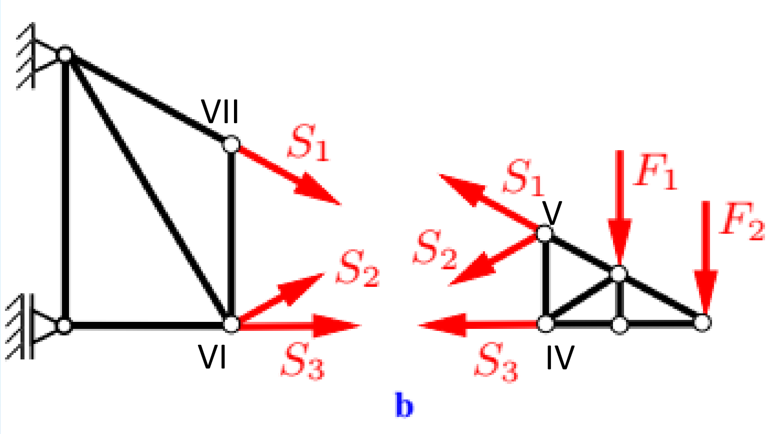


Solution

$\overset{\curvearrowleft}{\text{V}}$: $$-lF_2 - (l/2)F_1 - (l\tan 30^\circ)S_3 = 0 \Rightarrow S_3 = -(2F_2 + F_1)/2\tan 30^\circ$$

$\overset{\curvearrowleft}{\text{VI}}$: $$-2lF_2 - (3l/2)F_1 + l\,S_1 = 0 \Rightarrow S_1 = (4F_2 + 3F_1)/2$$

$\uparrow$: $$-F_2 - F_1 + S_1\sin 30° - S_2\sin 30° = 0 \Rightarrow S_2 = -F_1/2$$



Example 3 A truss is loaded by two forces, $F_1 = 2\ F$ and $F_2 = F$, as shown in Fig.a. Determine the force S_4.

Solution First, we determine the forces at the supports. Applying the equilibrium conditions to the free-body diagram of the whole truss (Fig.b) yields

$$\overset{\curvearrowleft}{A}: \quad -3aF_1 + aF_2 + 6aB = 0 \Rightarrow B = \frac{3F_1 - F_2}{6} = 5F/6$$

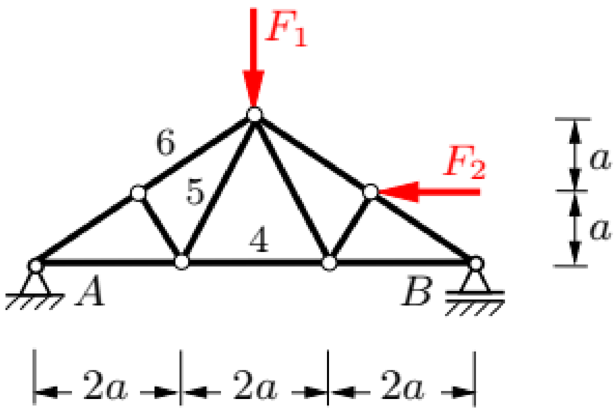
$$\overset{\curvearrowleft}{B}: \quad 3aF_1 + aF_2 - 6A_V = 0 \Rightarrow A_V = (3aF_1 + aF_2)/6 = 7F/6$$

$$\longrightarrow: \quad A_H - F_3 = 0 \Rightarrow A_H = F_2 = F$$

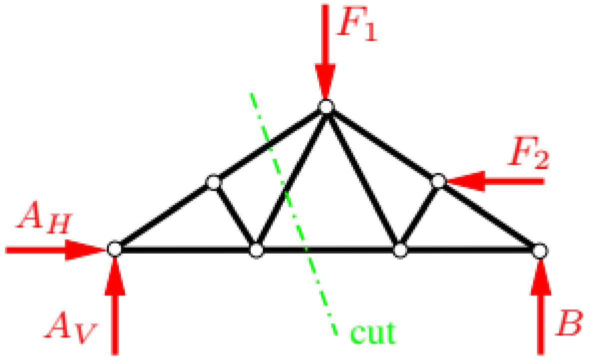
Then we pass an imaginary section through the members 4, 5 & 6 (Fig.c).

The unknown force S_4 follows from the moment equation about point I

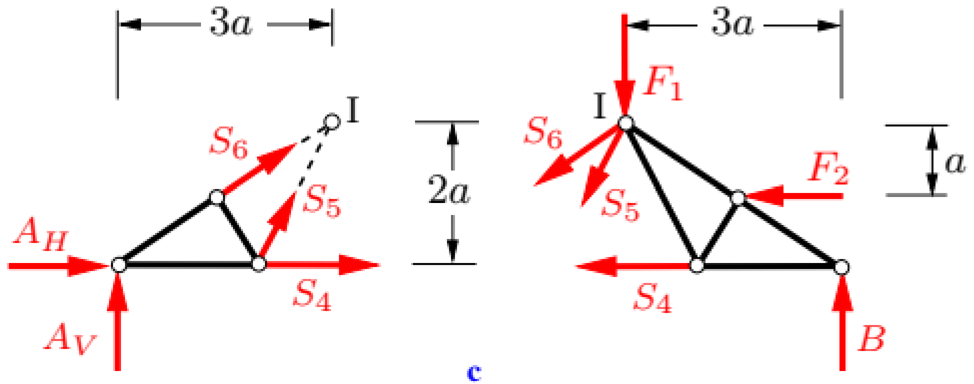
$$\overset{\curvearrowleft}{I}: \quad 2S_4 + 2A_H - 3A_V = 0 \Rightarrow S_4 = \frac{3}{4}F$$



a

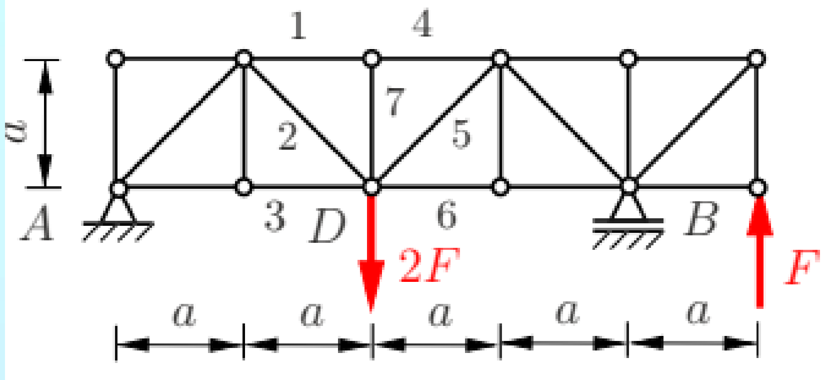


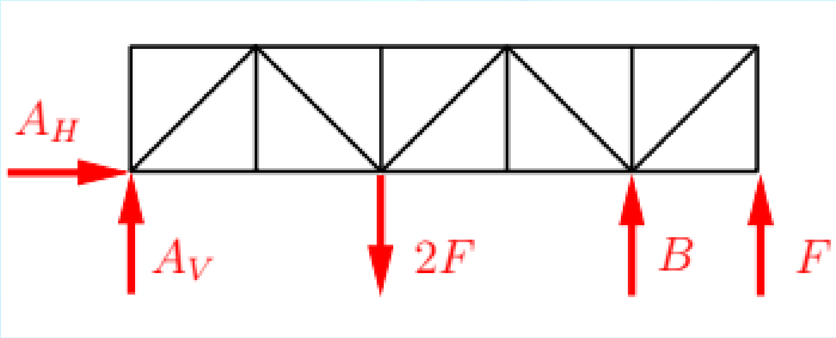
b

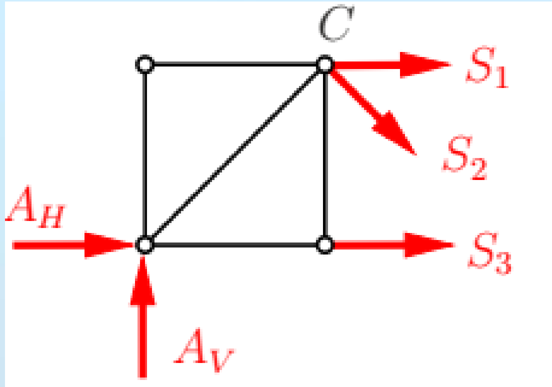


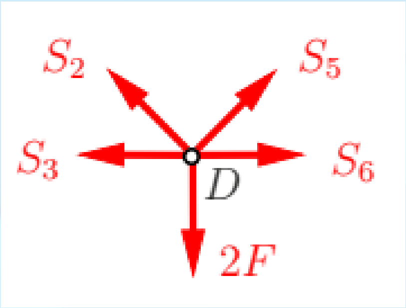
c

Example 4 For the given truss, the forces in the bars 1 through 7 shall be determined

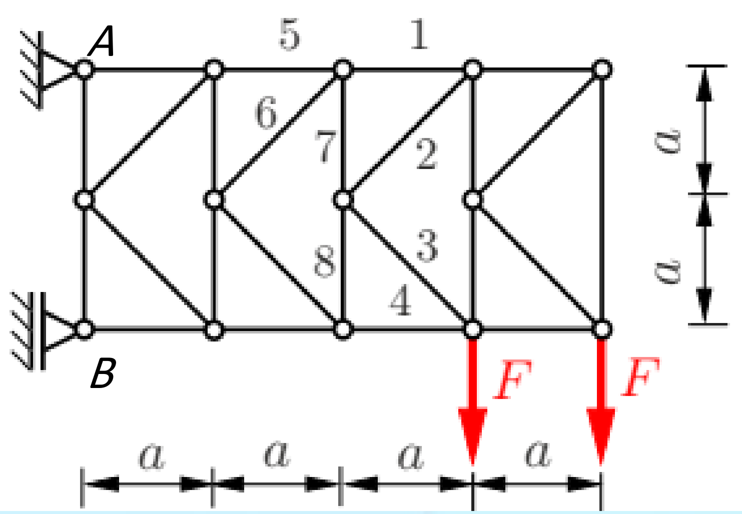








Example 5 Determine the bar forces for the given truss.



Example 6 Determine the bar forces for the given truss.