ME101: Engineering Mechanics (3 1 0 8)

2019-20 (II Semester)

LECTURE: 6
(Continued)

Plane Truss :: Determinacy

When more number of members/supports are present than are needed to prevent collapse/stability

→ Statically Indeterminate Truss

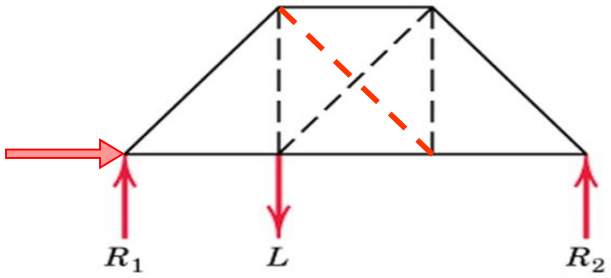
- cannot be analysed using equations of equilibrium alone!
- additional members or supports which are not necessary for maintaining the equilibrium configuration → Redundant

External and **Internal Redundancy**

Extra Supports than required → **External Redundancy**

– Degree of indeterminacy from available equilibrium equations

Extra Members than required → **Internal Redundancy**



Plane Truss :: Determinacy

Internal Redundancy or
Degree of Internal Static Indeterminacy

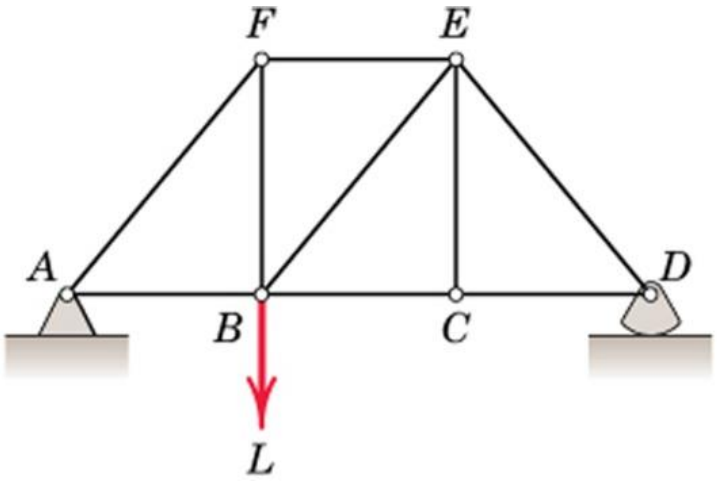
Extra Members than required → Internal Redundancy

Equilibrium of each joint can be specified by two scalar force equations → 2j equations for a truss with "j" number of joints
→ Known Quantities

For a truss with "m" number of two force members, and maximum 3 unknown support reactions → Total Unknowns = m + 3
("m" member forces and 3 reactions for externally determinate truss)

m + 3 = 2j → Statically Determinate Internally
m + 3 > 2j → Statically Indeterminate Internally
m + 3 < 2j → Unstable Truss

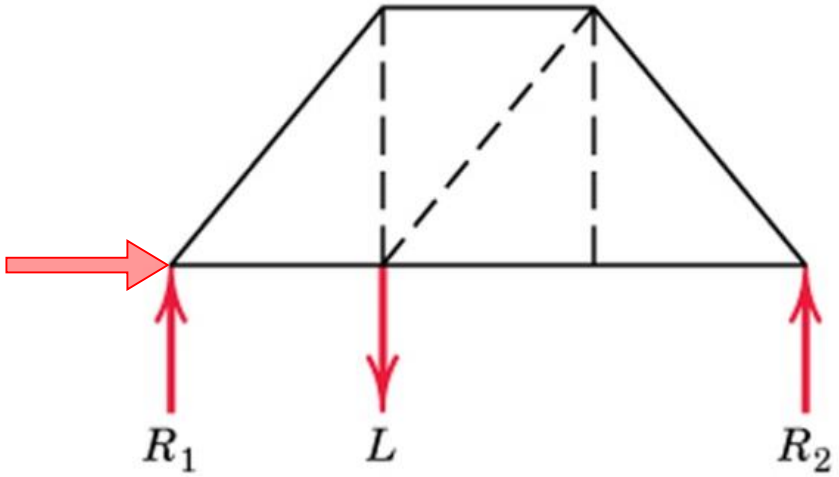
Plane Truss :: Determinacy



No. of unknown reactions = **3**

No. of equilibrium equations = **3**

: **Statically Determinate *(External)***



No. of members (m) = 9

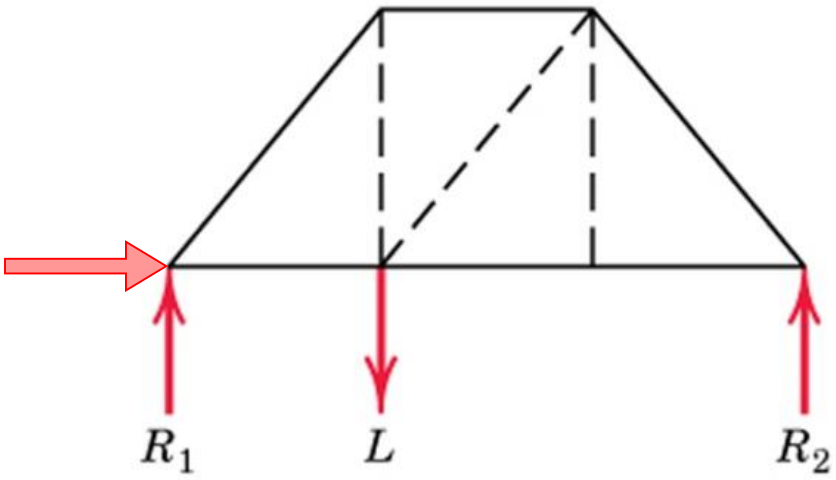
No. of joints (j) = 6

No. of unknown reactions (R) = 3

$\therefore$ m + R = 2j

: **Statically Determinate *(Internal)***

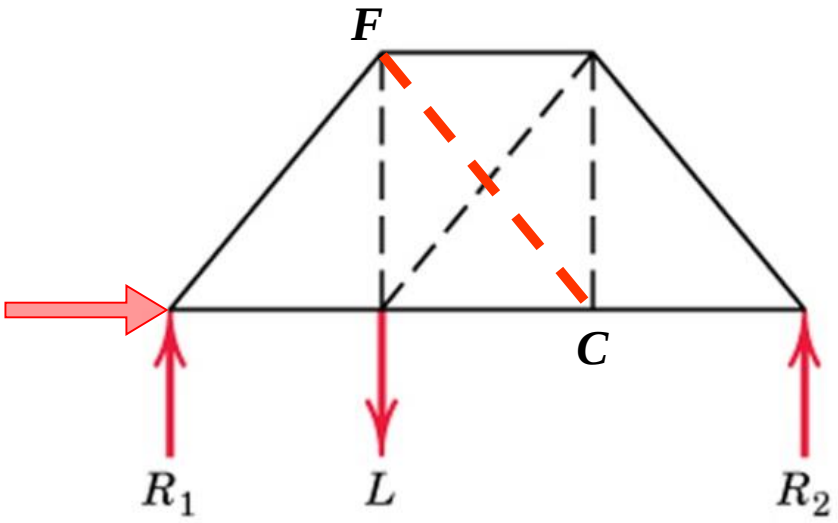
Plane Truss :: Determinacy



Presence of internal members

: **Additional sharing for forces**

: **Additional Stability**



Further addition of internal members

: **Strengthening** of Joints C and F

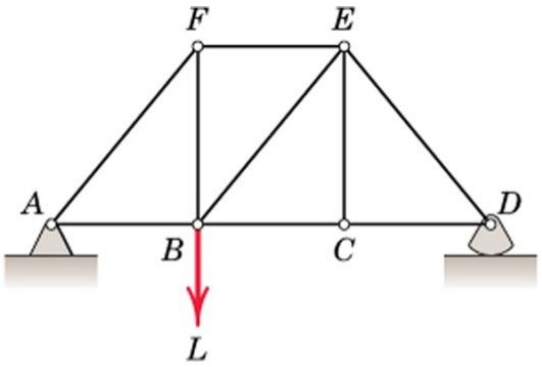
: **Additional Stability and force sharing**

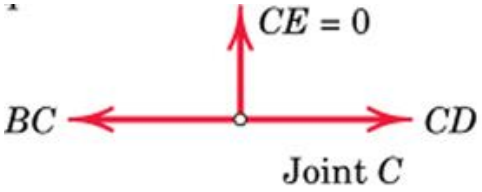
: **m + R > 2j**

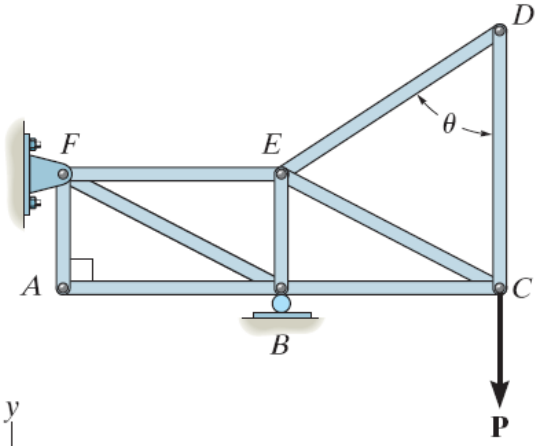
: **Statically Indeterminate *(Internal)***

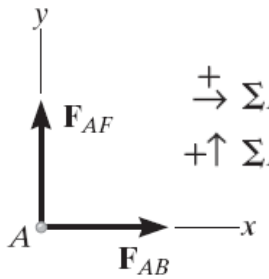
Plane Truss :: Analysis Methods

Zero Force Members



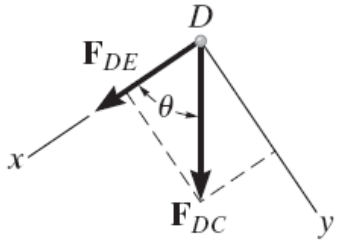






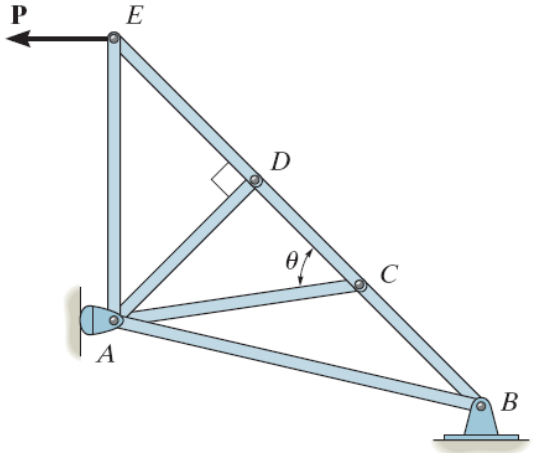
$\overset{+}{\rightarrow} \Sigma F_x = 0;\ \boxed{F_{AB} = 0}$

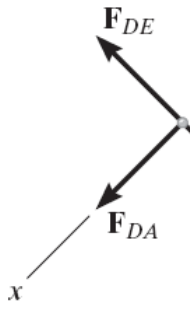
$+\uparrow \Sigma F_y = 0;\ \boxed{F_{AF} = 0}$



$+\searrow \Sigma F_y = 0;\ F_{DC} \sin\theta = 0;\ \boxed{F_{DC} = 0}$ since $\sin\theta \neq 0$

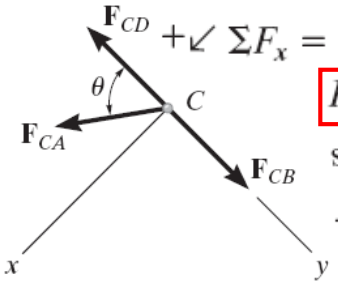
$+\swarrow \Sigma F_x = 0;\ F_{DE} + 0 = 0;\ \boxed{F_{DE} = 0}$





$+\swarrow \Sigma F_x = 0;\ \boxed{F_{DA} = 0}$

$+\searrow \Sigma F_y = 0;\ F_{DC} = F_{DE}$



$+\swarrow \Sigma F_x = 0;\ F_{CA} \sin\theta = 0$

$\boxed{F_{CA} = 0}$

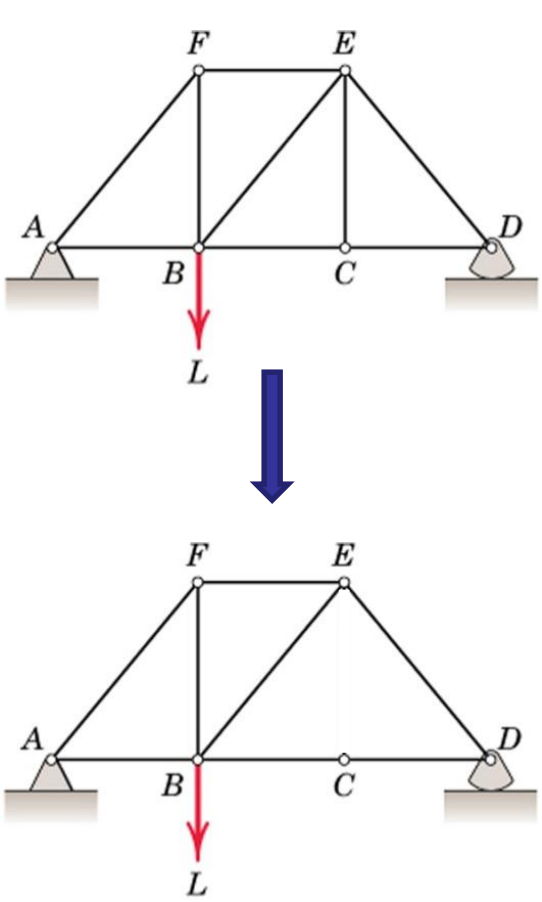
since $\sin\theta \neq 0$

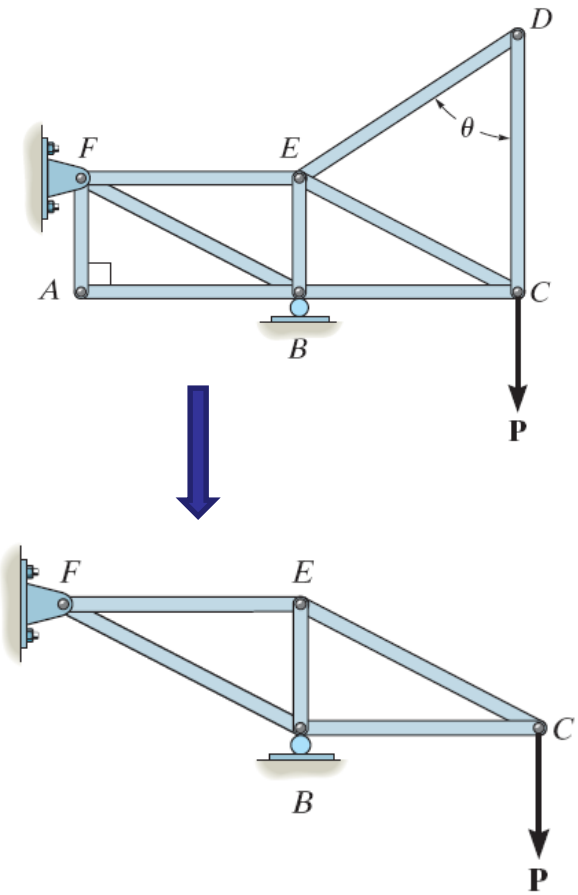
$+\searrow \Sigma F_y = 0;$

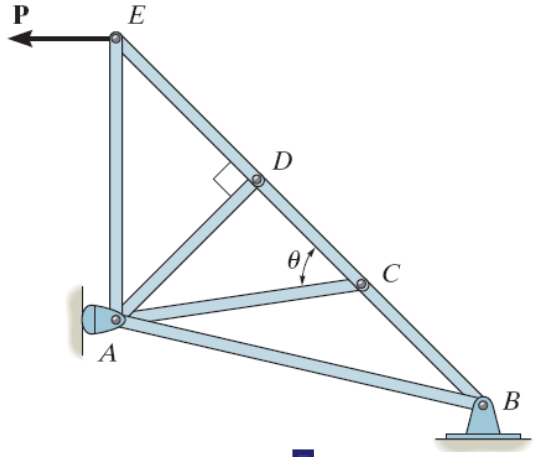
$F_{CB} = F_{CD}$

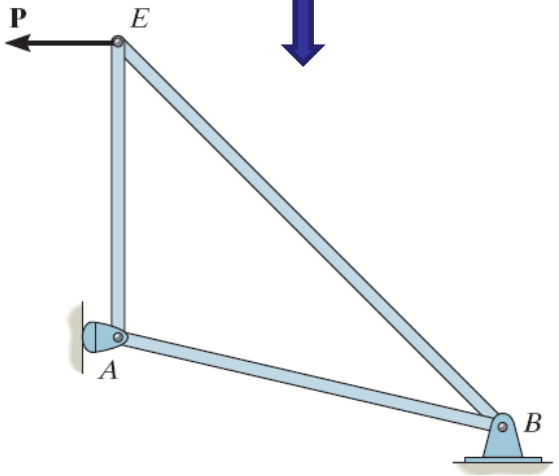
Plane Truss :: Analysis Methods

Zero Force Members: Simplified Structures







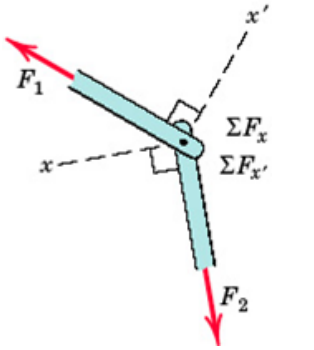


Plane Truss :: Analysis Methods

Zero Force Members: Conditions

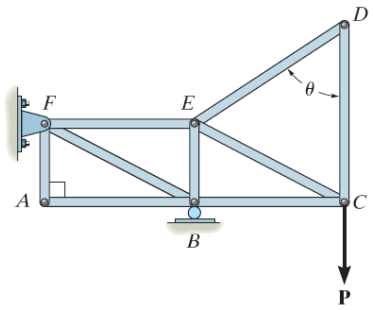
• if only two noncollinear members form a truss joint and no external load or support reaction is applied to the joint, the two members must be zero force members

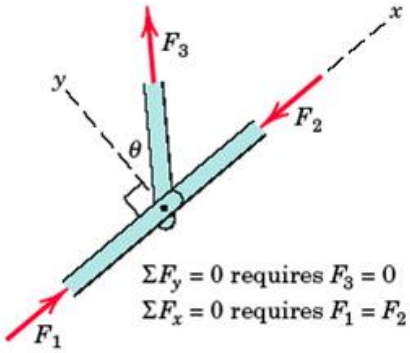
•if three members form a truss joint for which two of the members are collinear, the third member is a zero-force member provided no external force or support reaction is applied to the joint



$\Sigma F_x = 0$ requires $F_1 = 0$

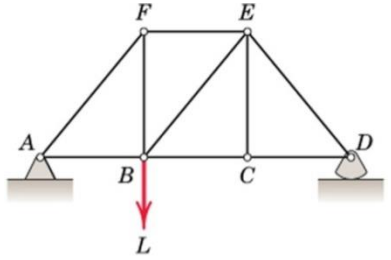
$\Sigma F_{x'} = 0$ requires $F_2 = 0$

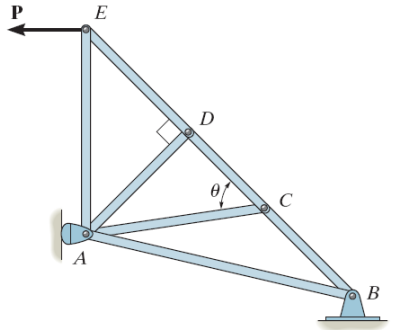




$\Sigma F_y = 0$ requires $F_3 = 0$

$\Sigma F_x = 0$ requires $F_1 = F_2$





Structural Analysis: Plane Truss

Special Condition

- When two pairs of collinear members are joined as shown in figure, the forces in each pair must be equal and opposite.