Today:

Trusses continued

- Method of sections
- Rigid trusses
- Frames

Book: Chapter 6.4 & 6.6

Two Methods to Analyze Trusses

1) Method of joints

2) Method of sections



Method of joints

Determine the force in the members by calculating the equilibrium of the joints

- 1. Draw Free Body Diagram
- 2. Determine the reaction forces at the supports of the whole structure
- 3. Calculate the forces in a joint with max. 2 unknowns
- 4. Proceed to the next joint with max. 2 unknowns until all joints are analyzed

Method of sections

Determine the force in a members by dividing the structure in two sections by cutting the members and calculating the equilibrium of one of the sections.

- 1) Determine the section by cutting just three members (in general)
- 2) Use the moment equilibrium equation in a clever way.



Determine the force in member DE.

Source: R.C. Hibbeler,

"Engineering Mechanics – Statics"



1) Determine the force in member DE.

2) Determine the force in member DL.







3 members, 3 joints

Flexible truss (mechanism)



4 members, 4 joints





3 members, 3 joints

5 members, 4 joints

7 members, 5 joints

Rigid truss consisting of triangular elements

$$s = 2k - 3$$

Where

s = number of members

k = number of joints

Non-rigid truss

s < 2k - 3

Rigid truss

$$s \ge 2k - 3$$

This is a *necessary* condition, but not *sufficient*!!

















Constraints





Constraints





Constraint truss structure

$$n = r + s - 2k$$

Where

- n = difference between number of unknowns and equations
- r = number of constraints
- s = number of members
- k = number of joints

Constraint truss structure

$$n = r + s - 2k$$

- n < 0 kinematically indeterminate (mechanism)
- n >= 0 kinematically determinate (necessary, not sufficient)
- n = 0 statically determinate
- n > 0 statically indeterminate

Statically determinate?



Frames







Calculate the reaction forces in hinge A when the normal reaction force on the nose wheel is 24 kN.

Source: R.C. Hibbeler,

"Engineering Mechanics – Statics"





Frame

A **frame** is a structure where at least one of its individual members is a *multi-force* member.



Calculate the angle θ of the ramp in B for which the reaction force in A is completely horizontal.



Determine the orientation of the reaction force in A graphically .



Compound-lever snips are designed to replace regular tinners' snips when large cutting forces are required. For the gripping force of 150 N, what is the cutting force P at a distance of 30 mm along the blade from the pin at A



Calculate the force in member FG