

ME 141

Engineering Mechanics

Lecture 5: Analysis of structures

Ahmad Shahedi Shakil

Lecturer, Dept. of Mechanical Engg, BUET

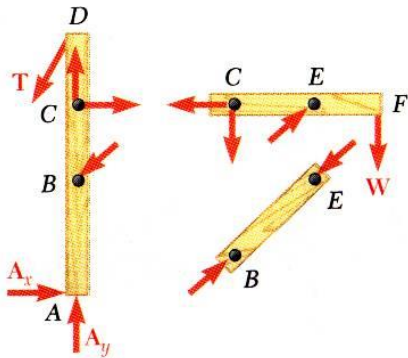
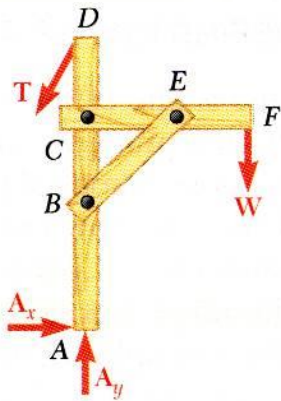
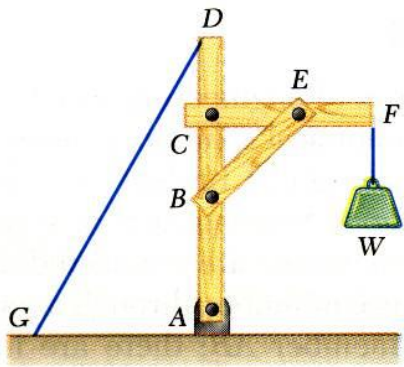
E-mail: sshakil@me.buet.ac.bd, shakil6791@gmail.com

Website: sshakil.buet.ac.bd



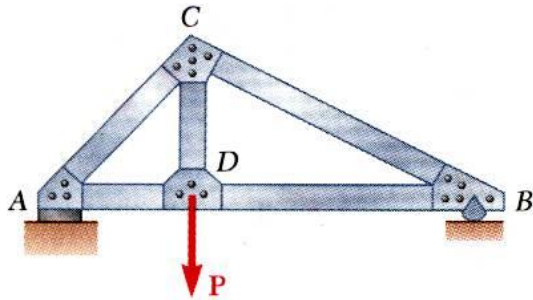
Courtesy: Vector Mechanics for Engineers, Beer and Johnston

Introduction

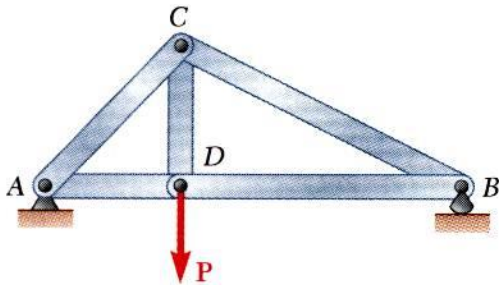


- For the equilibrium of structures made of several connected parts, the *internal forces* as well the *external forces* are considered.
- In the interaction between connected parts, Newton's 3rd Law states that the *forces of action and reaction* between bodies in contact have the same magnitude, same line of action, and opposite sense.
- Three categories of engineering structures are considered:
 - Frames:** contain at least one one multi-force member, i.e., member acted upon by 3 or more forces.
 - Trusses:** formed from *two-force members*, i.e., straight members with end point connections
 - Machines:** structures containing moving parts designed to transmit and modify forces.

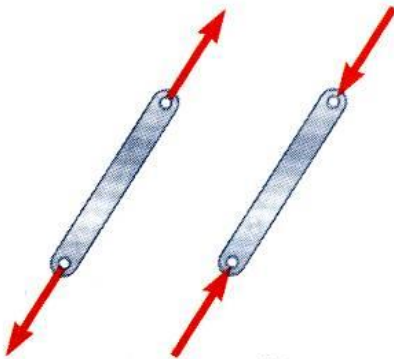
Definition of a Truss



- A truss consists of straight members connected at joints.

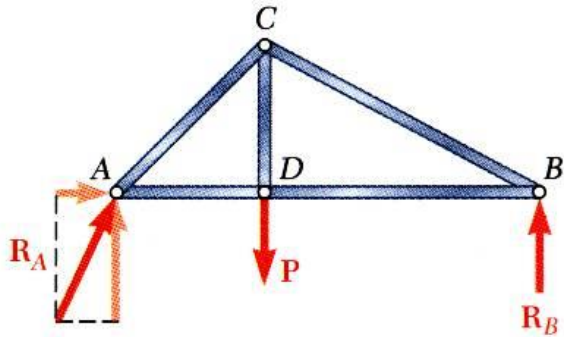


- Bolted or welded connections are assumed to be pinned together. Forces acting at the member ends reduce to a single force and no couple. Only *two-force members* are considered.

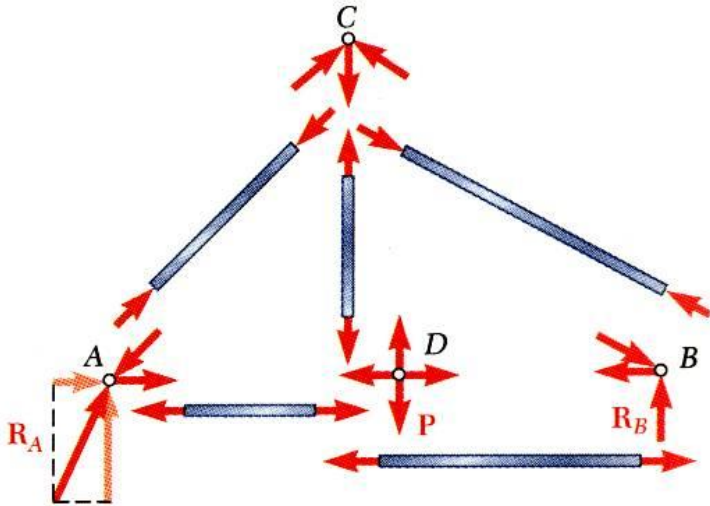


- When forces tend to pull the member apart, it is in *tension*. When the forces tend to compress the member, it is in *compression*.

Analysis of Trusses by the Method of Joints

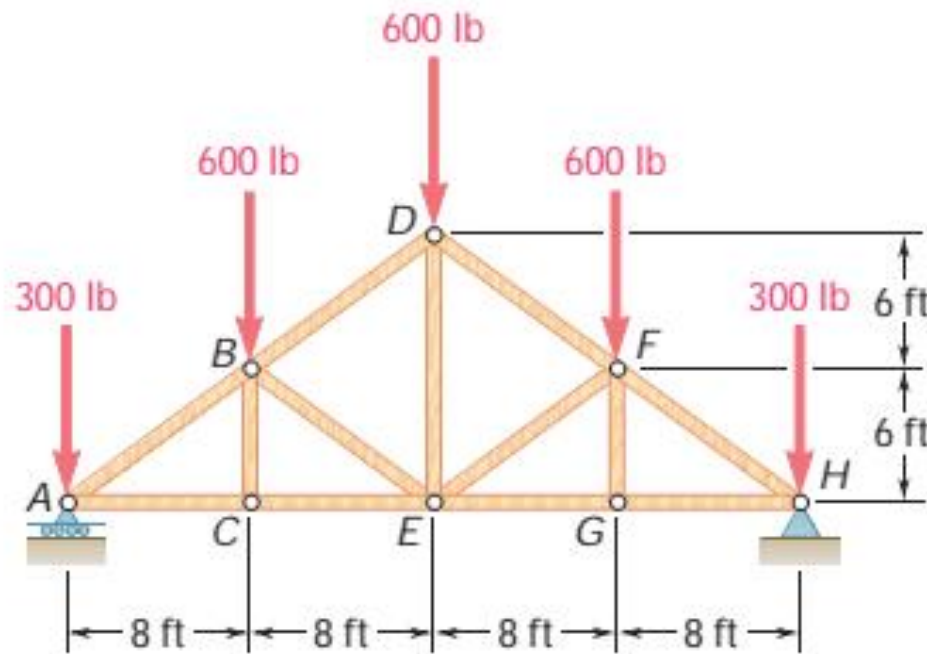


- Dismember the truss and create a freebody diagram for each member and pin.
- The two forces exerted on each member are equal, have the same line of action, and opposite sense.
- Forces exerted by a member on the pins or joints at its ends are directed along the member and equal and opposite.

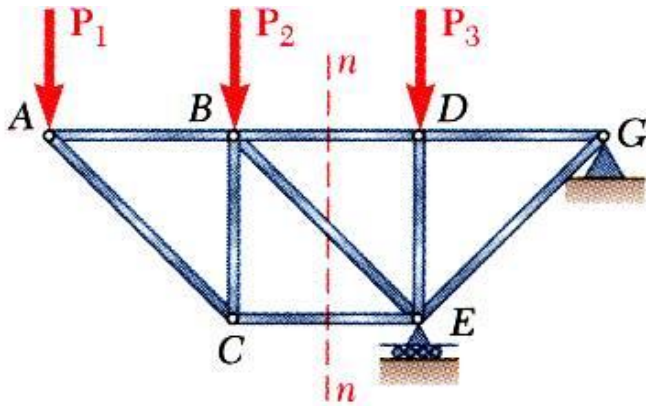


Prob # 6.10

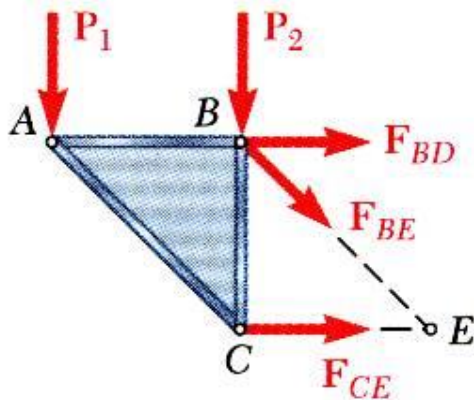
- Using the method of joints, determine the force in each member of the truss shown. State whether each member is in tension or compression.



Analysis of Trusses by the Method of Sections



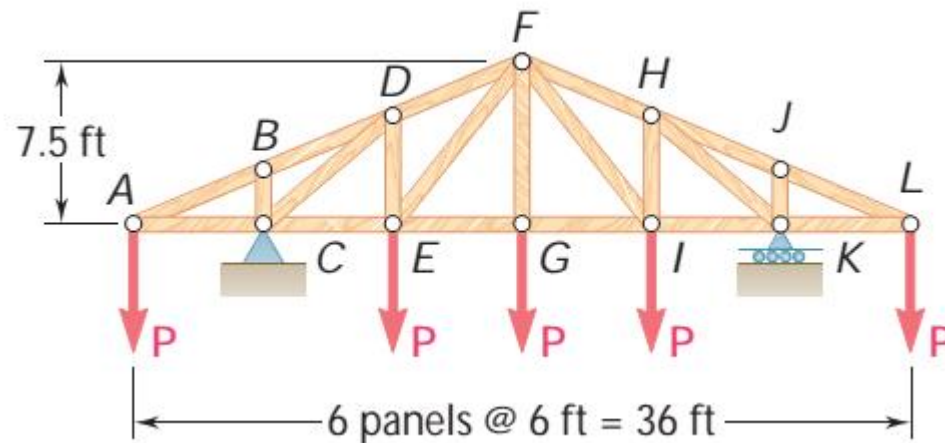
- When the force in only one member or the forces in a very few members are desired, the *method of sections* works well.
- To determine the force in member BD , pass a section through the truss as shown and create a free body diagram for the left side.



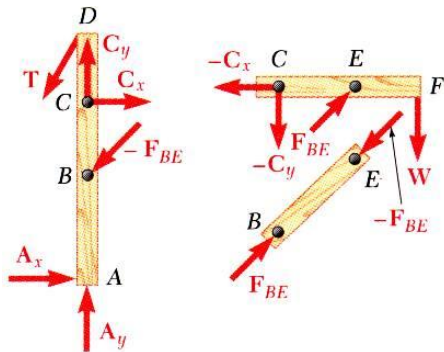
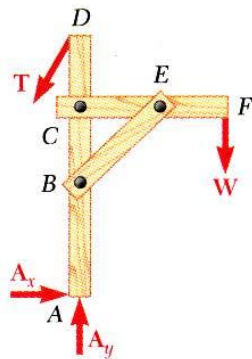
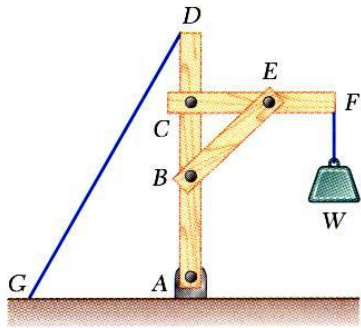
- With only three members cut by the section, the equations for static equilibrium may be applied to determine the unknown member forces, including F_{BD} .

Prob# 6.59

Determine the force in members DE and DF of the truss shown when $P = 20$ kips.



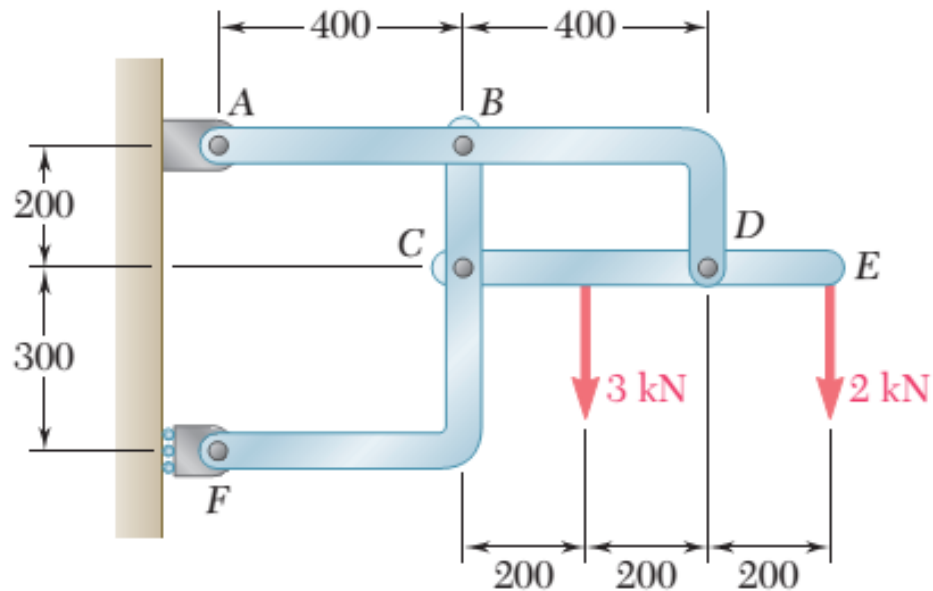
Analysis of Frames



- *Frames* and *machines* are structures with at least one *multiforce* member. Frames are designed to support loads and are usually stationary. Machines contain moving parts and are designed to transmit and modify forces.
- A free body diagram of the complete frame is used to determine the external forces acting on the frame.
- Internal forces are determined by dismembering the frame and creating free-body diagrams for each component.

Prob #6.105

For the frame and loading shown, determine the components of all forces acting on member ABD



Dimensions in mm

Assignments

- Solve problems,
6.17, 6.27, 6.61, 6.53, 6.87, 6.101