CE30 – Discussion 4

Rigid Body Equilibrium

Textbook: 4.2 – 4.3

Çağlar Tamur

caglar.tamur@berkeley.edu

Spring 2024
Instructor: Shaofan Li

Berkeley
UNIVERSITY OF CALIFORNIA

Announcements

- No discussion next Monday 02/19 (Presidents Day)
  - Please attend Tue/Wed sections

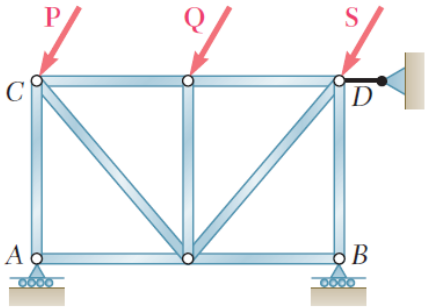
- HW4 Problems from the textbook:

  4.11, 4.12, 4.13, 4.43, 4.53, 4.61, and 4.66

Rigid Body Constraints

$$\sum F_x = 0 \quad \sum F_y = 0 \quad \sum M_A = 0$$

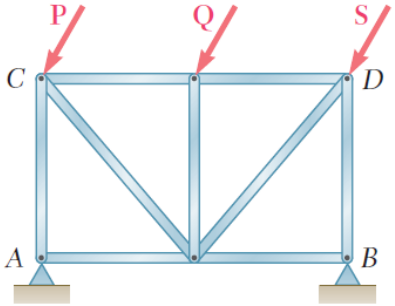
- Support reactions are usually unknown.
- We should have (# Equations) = (# Unknowns) to find the unique solution.
- Depending on the constraints (supports), we have 3 possible systems:



Statically Determinate

(#Unknowns) = (#Eqns.)

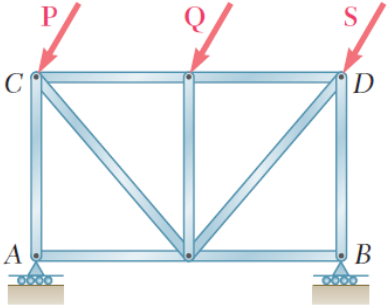
Can find unique solution



Statically Indeterminate

(#Unknowns) > (#Eqns.)

Need extra equations to solve



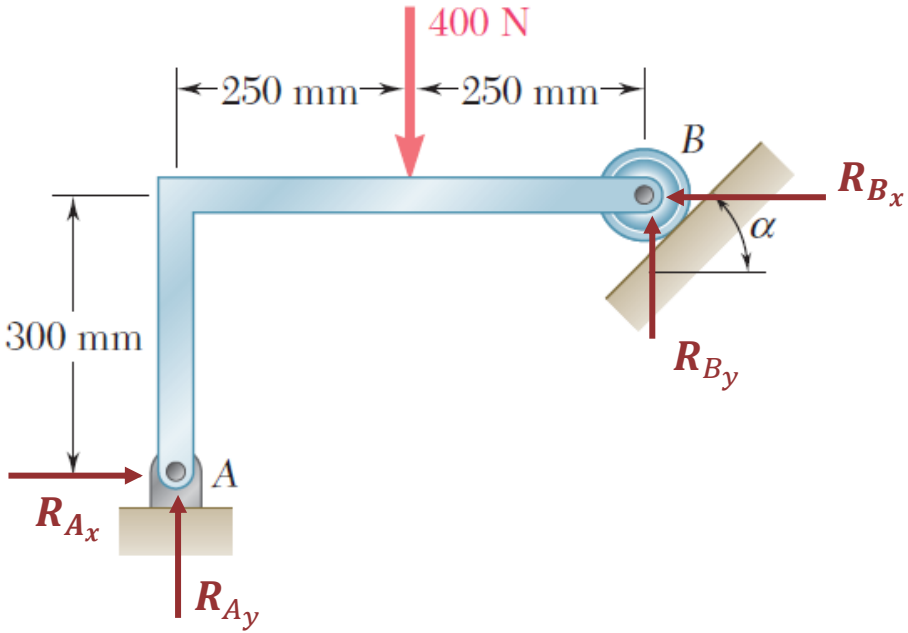
Partially Constrained

(#Unknowns) < (#Eqns.)

Unstable structure

Practice – Similar to HW P4.13

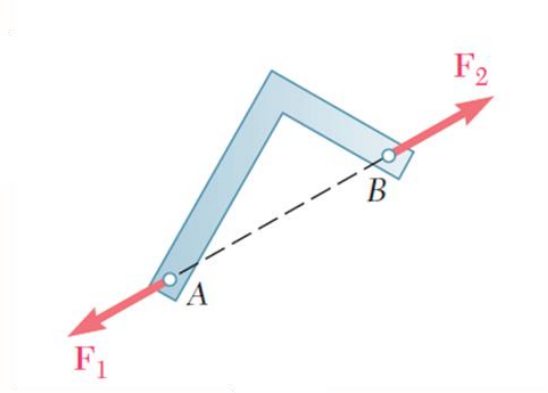
Determine the reactions at A and B when $\alpha = 60°$.



Two force members

Rigid body subjected to two forces:

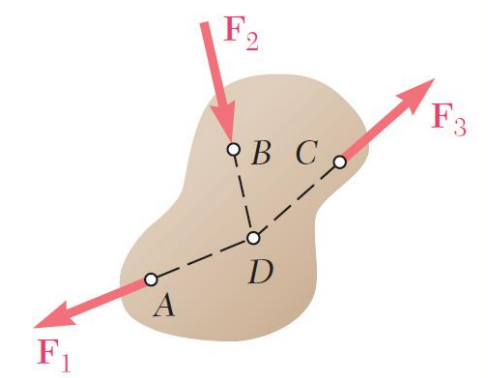
- Forces should be **same magnitude, opposite direction** (force equilibrium)
- Forces should have **same line of action** (moment equilibrium)



Three force members

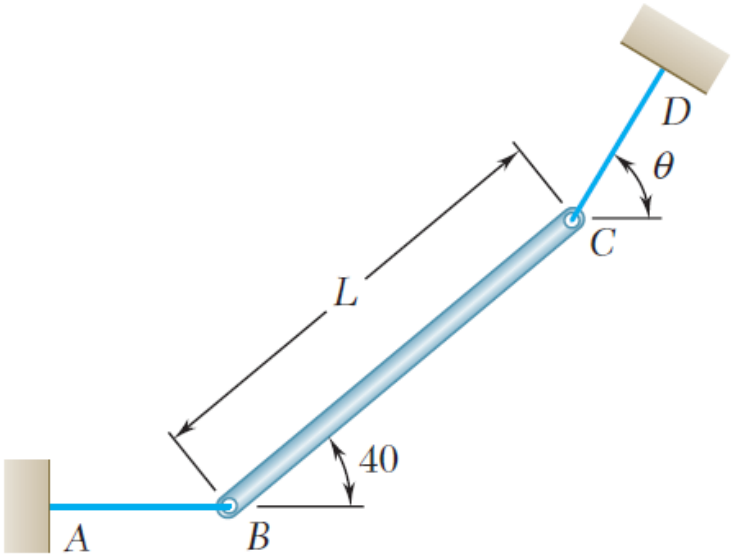
Rigid body subjected to three forces:

- Forces should be **concurrent** (all intersect at a single point) (moment equilibrium)
- Except if none of them intersect (parallel line of action)



Practice – Similar to HW P4.43

A slender rod BC of length L and weight W is held by two cables as shown. Knowing that cable AB is horizontal and that the rod forms an angle of $40°$ with the horizontal, determine (a) the angle θ that cable CD forms with the horizontal, (b) the tension in each cable.



Rigid Body Equilibrium in 3D

Six scalar equations to be satisfied

$$\sum F_x = 0 \qquad \sum F_y = 0 \qquad \sum F_z = 0$$

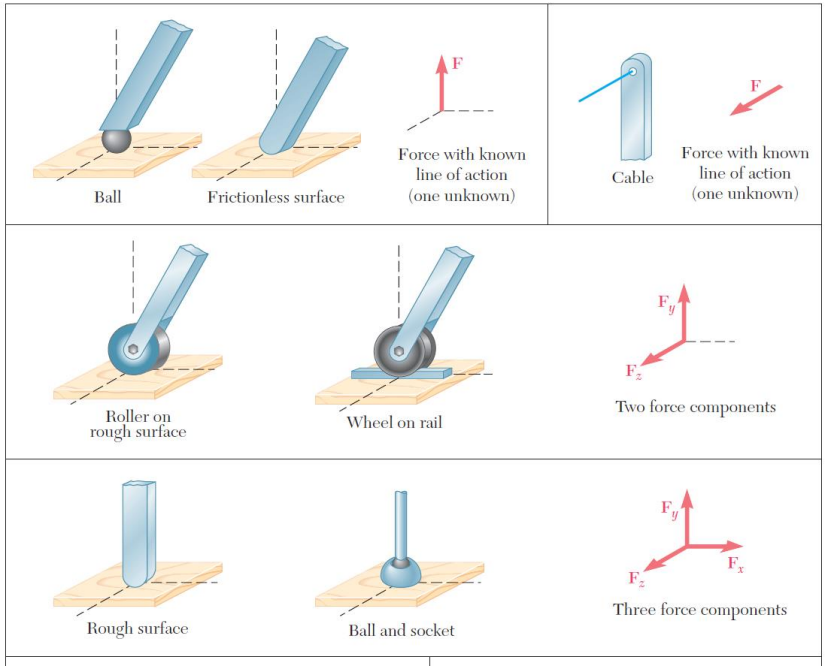
$$\sum M_x = 0 \qquad \sum M_y = 0 \qquad \sum M_z = 0$$

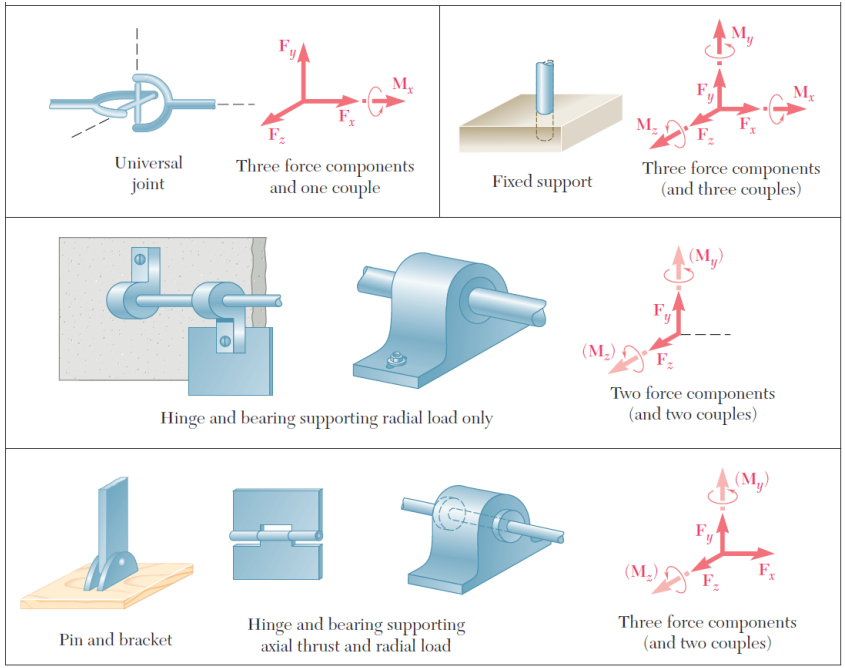
In vector notation

$$\sum \mathbf{F} = 0 \qquad \sum \mathbf{M}_O = \sum (\mathbf{r} \times \mathbf{F}) = 0$$

Supports in 3D

Depending on the type, there will be a combination of force and moment reactions at the support





Practice - Similar to HW P4.61

A 7-ft boom is held by a ball and socket at A and by two cables EBF and DC; cable EBF passes around a frictionless pulley at B. Determine the tension in each cable.