Four Bar Linkages

\[ M = 3(n - j - 1) + \sum_{i=1}^{n} f_i \]
Four Bar Linkages

- One of the most common
- Simplest is 1 DOF linkage

Types of four bar linkages
Let $s, l, p, q$ – lengths of links

Grashof Type I
- Crank rocker $s + l < p + q$
- Double-rocker
- Drag-link

Grashof of Type II (Non-Grashof)
- Triple rocker $s + l > p + q$

$s = \text{smallest link length}$
$l = \text{longest link length}$
$p, q = \text{other two lengths}$
Grashof of Type I Linkages

\[ s + l < p + q \]

- \( s \): smallest link length
- \( l \): longest link length
- \( p, q \): other two lengths

Drag Link  
Crank Rocker  
Double Rocker
Facts

- **Grashof Linkages**
  - There exists one link that completes a full 360 degree rotation relative to another link
  - This is the shortest link
  - The pair of joints connecting this link to other links are such that they rotate through 360 degrees
  - Three types of linkages
    - Crank rotates through 360 deg. (relative to frame)
    - Coupler rotates through 360 deg. (relative to frame)
    - Frame rotates through 360 deg. (relative to, let us say, crank)

- **Non-Grashof Linkages**
  - No link completes a full 360 degree rotation relative to another link
Geometric Significance of Grashof Inequality
E91: Dynamics
Crank Rocker

\[ s + l < p + q \]

Crank is the shortest link
Synthesis

- Two position synthesis of linkages
  - Find a four bar linkage whose coupler, when attached to a specified rigid body, guides the rigid body between two given positions (and orientations).
Circle points on coupler

Coupler link

Q

P
E91: Dynamics
Three-Position Synthesis of Linkages

Position 1

Position 2

Position 3