# Lecture_2



## 1. Kinematic Chain

is an assembly of links connected by means of pairs

- Locked Chain
- A Constrained Chain
- An Unconstrained Chain

## 2. Mobility

the mobility is the numbers of freedom

### Gruebler's Equation

$$M = 3(L - 1) - 2J_1 - J_2$$

Where:

- $M$: mobility
- $L$: number of links (**including ground**)
- $J_1$: number of 1 degree of freedom joints
- $J_2$: number of 2 degrees of freedom joints

**where k links connect at a single joint, it must be counted as k-1 joints**

### Summary: Mobility

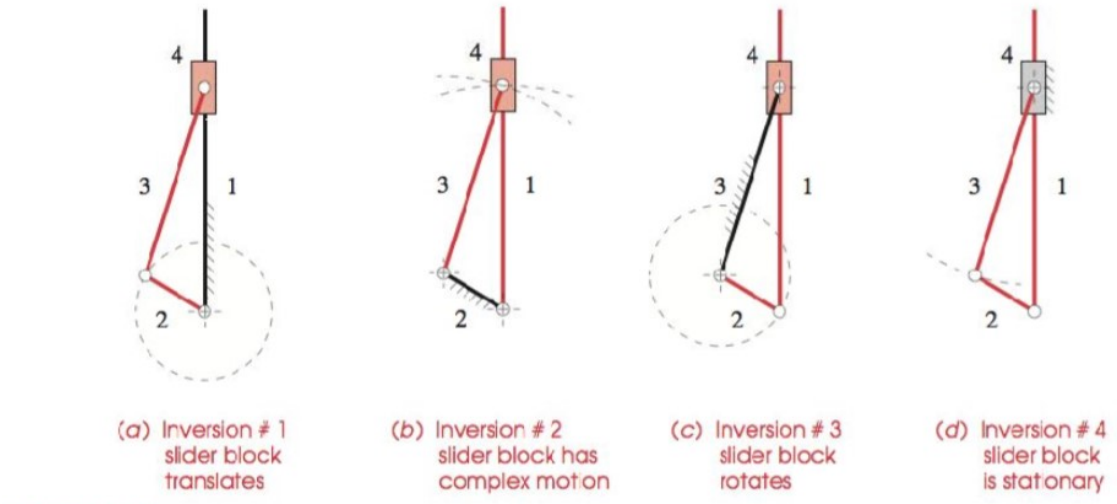
- $M > 1$: maybe an unconstrained mechanism
- $M = 1$: a constrained mechanism
- $M = 0$: a statically determinate structure
- $M < 0$: a statically indeterminate structure

## 3. Paradoxes

Because the Gruebler criterion pays no attention to link sizes or shapes, it can give misleading results in the face of unique geometric configurations.

## 4. Inversion

an inversion is created by grounding a different link in the kinematic chain.




# 5. Grashof Conditions

Let:

$$S = length\ of\ shortest\ link$$

$$L = length\ of\ longest\ link$$

$$P = length\ of\ one\ remaining\ link$$

$$Q = length\ of\ other\ remaining\ link$$

If $S + L \leq P + Q$, then the linkage is Grashof

- **Class I case,** $S + L < P + Q$

  *At least one link will be capable of making a full revolution with respect to the ground plane*

  Ground either link adjacent to the shortest: **Crank Rocker**

  Ground the shortest link adjacent to the shortest: **Double Crank**

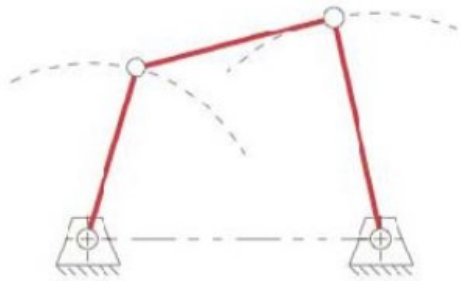
  Ground the opposite link to the shortest: **Grashof Double Rocker**

- **Class II case,** $S + L > P + Q$

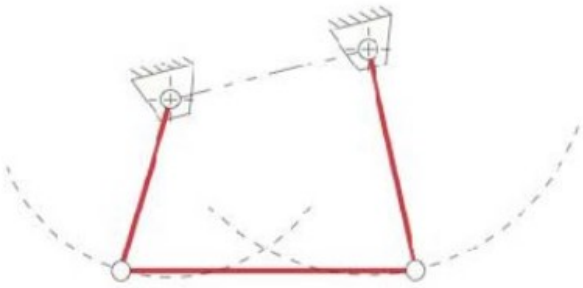
  All inversions will be **Triple Rockers**

- **Class III case,** $S + L = P + Q$

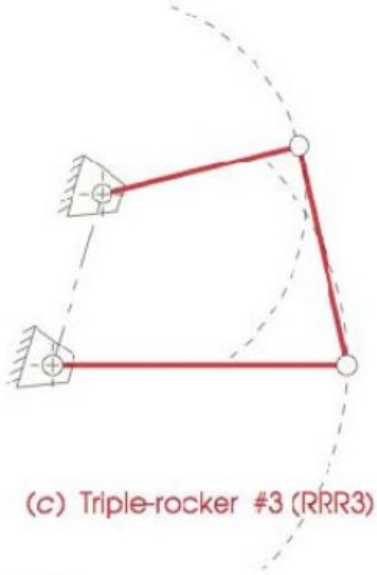
  All inversions will be either **Double Ranks** or **Crank Rockers**



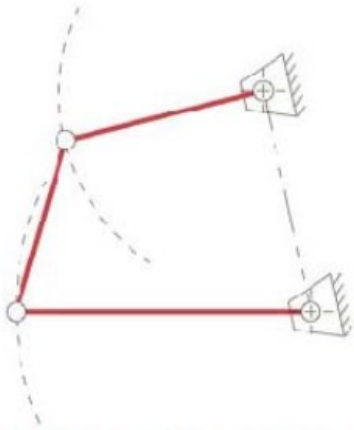
(a) Triple-rocker #1 (RRR1)



(b) Triple-rocker #2 (RRR2)



(c) Triple-rocker #3 (RRR3)



(d) Triple-rocker #4 (RRR4)