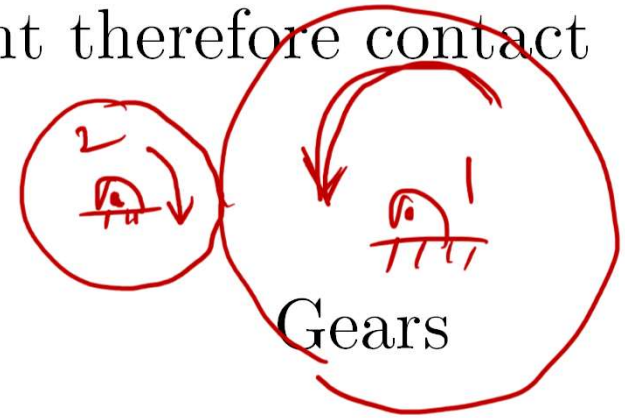
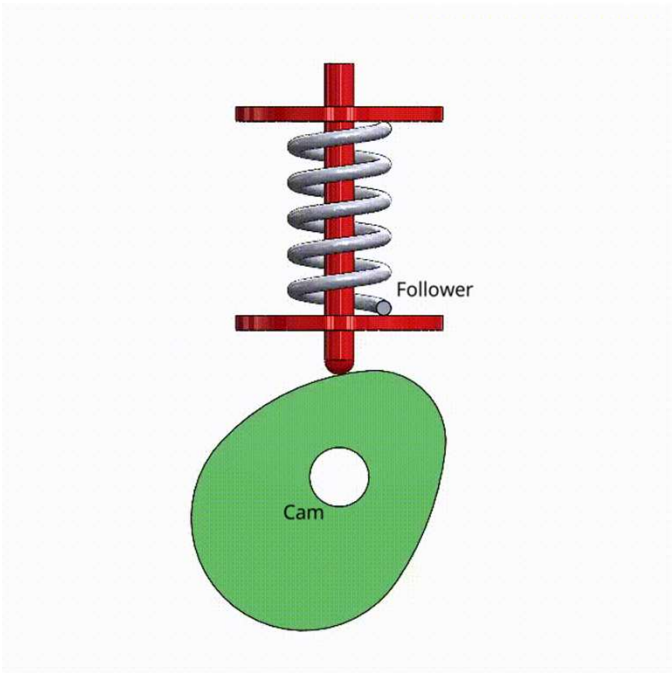
Joints – Higher pair

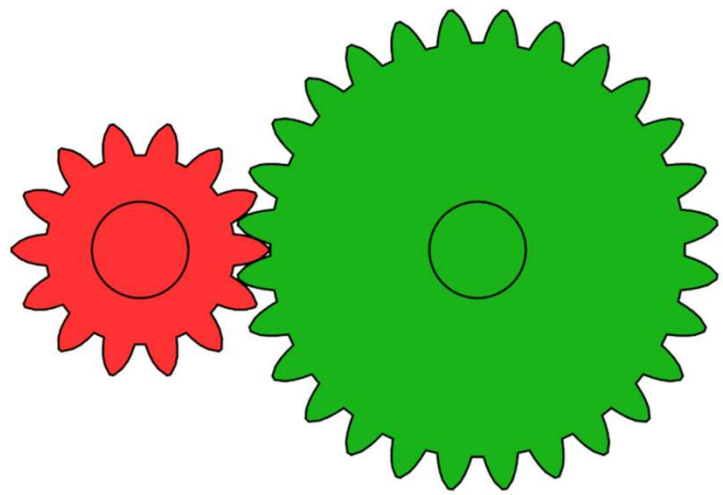
- Higher kinematic pair has contact with two kinematic elements along a line or at a point therefore contact stresses are higher



- Cam follower



Gears



https://www.wikiwand.com/en/articles/Gear

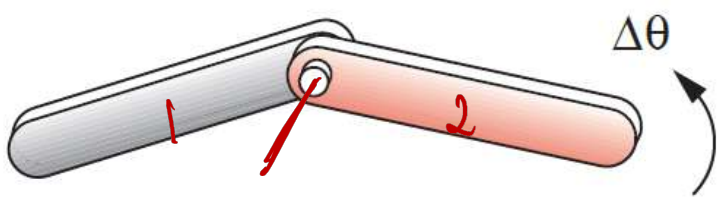
Joints

- A joint is a connection between two or more links (at their nodes), which allows some motion between the connected links.

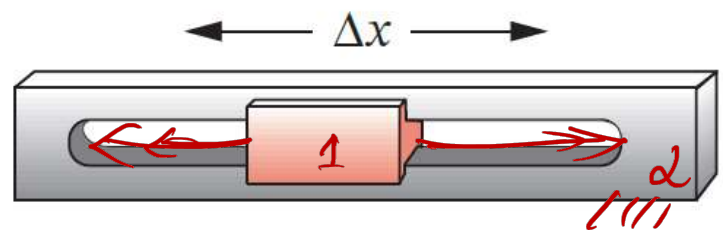
- Joints (also called kinematic pairs) can be classified in several ways
  - By the type of contact between the elements, line, point, or surface.
  - By the number of degrees of freedom allowed at the joint.
  - **By the type of physical closure of the joint: either force or form closed.**
  - By the number of links joined (order of the joint).

Full joints—1 DOF (lower pairs)

- **Form Closed**:
  - joint is kept together or closed by its geometry
  - One element envelops the other



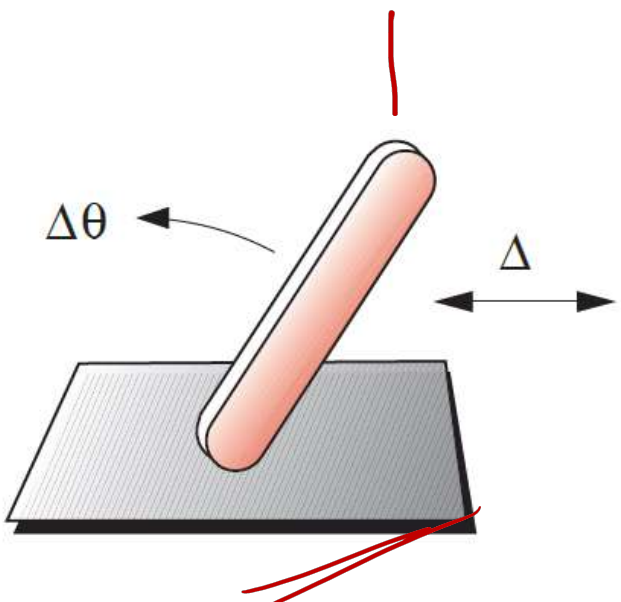
Rotating full pin (R) joint (form closed)



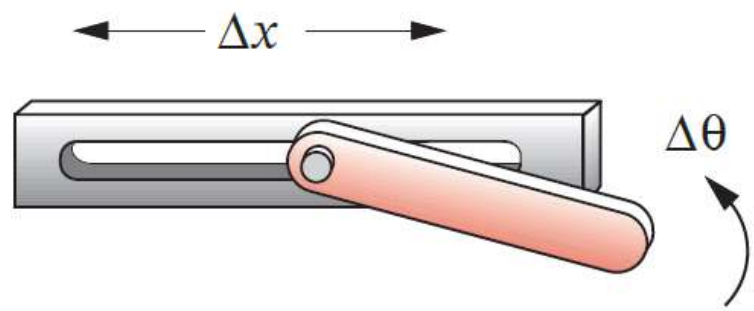
Translating full slider (P) joint (form closed)

Roll-slide (half or RP) joints—2 DOF (higher pairs)

- **Force Closed**: slider on a surface, requires some external force to maintain contact between two elements.



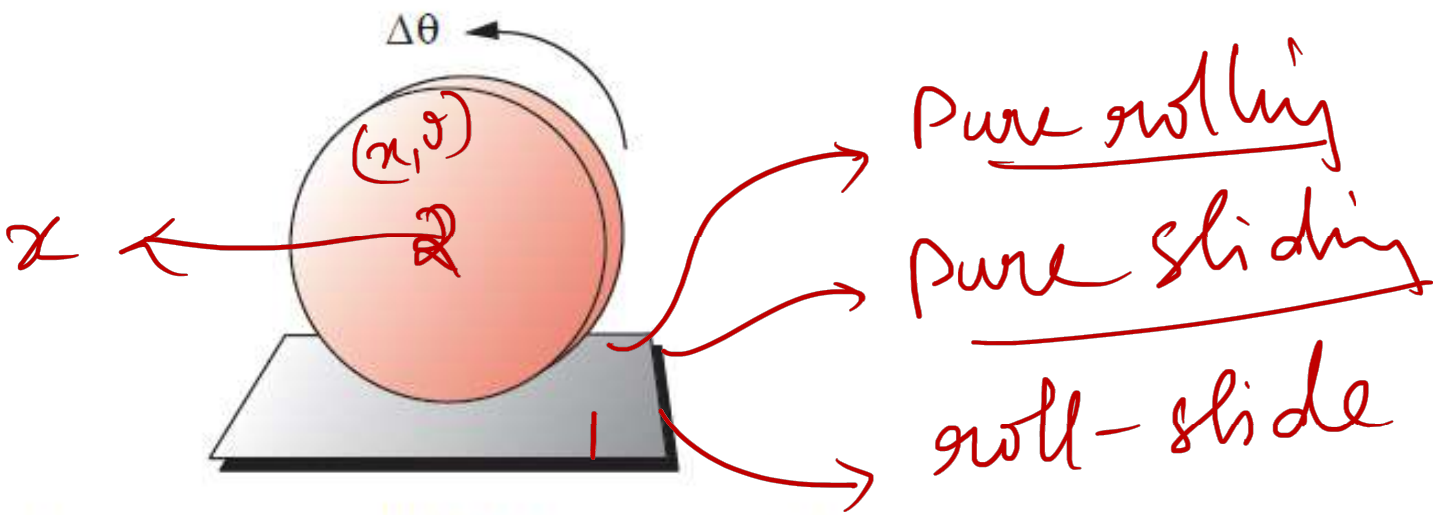
Link against plane (force closed)



Pin in slot (form closed)

May roll, slide, or roll-slide, depending on friction

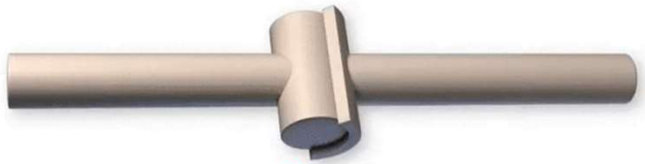
- **Half joint** is also called a **roll-slide joint** because it allows both rolling and sliding.



May roll, slide, or roll-slide, depending on friction

- **Friction** determines the actual number of freedoms at this kind of joint. It can be pure roll, pure slide, or roll-slide

Joints



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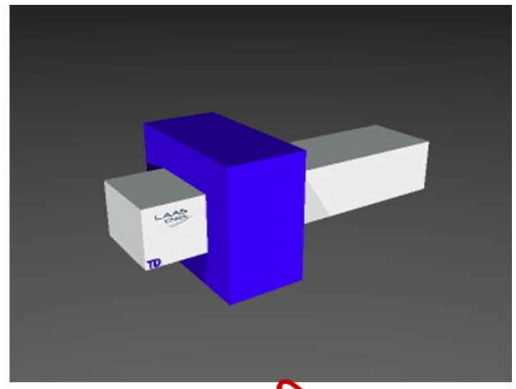

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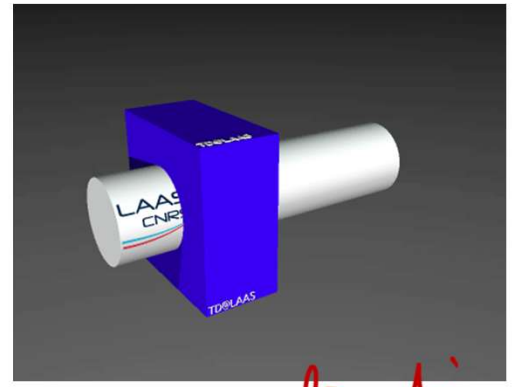
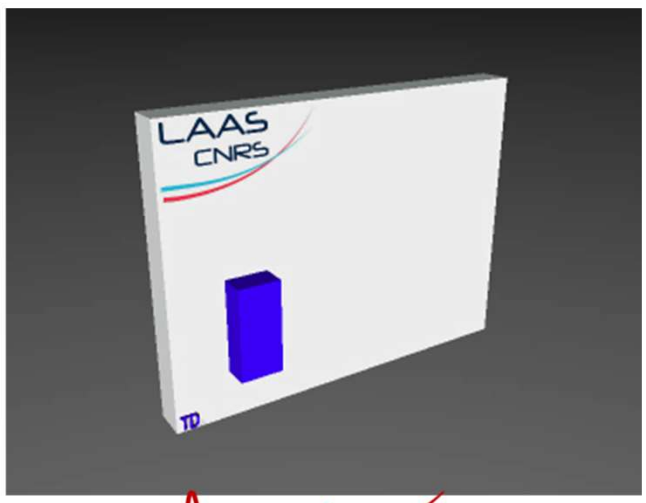
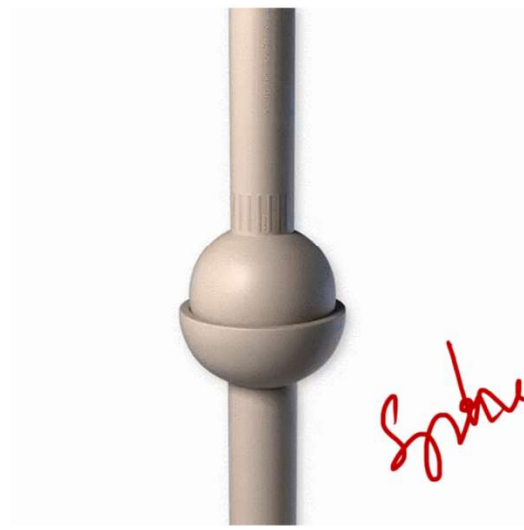


cylindri



planar



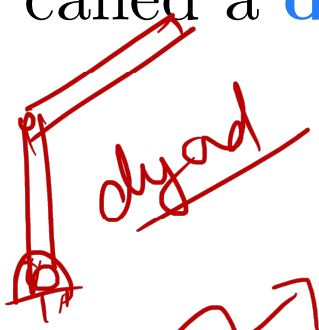
spherical joint

Kinematic chains

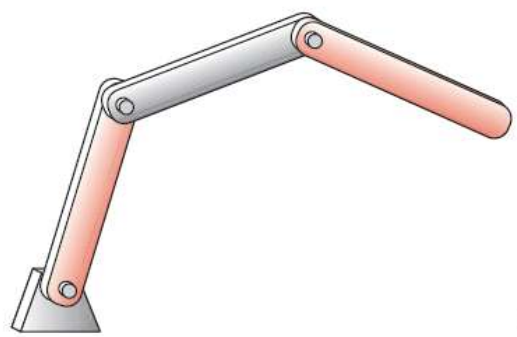
- Kinematic chain: an assemblage of rigid bodies/links, $l_0, l_1, l_2 \dots l_{n-1}$ connected via joints $j_1, j_2 \dots j_{n-1}$. Where each link l_i is attached to link l_{i+1} at joint j_{i+1}

- **Open Chain:** Serial chain.

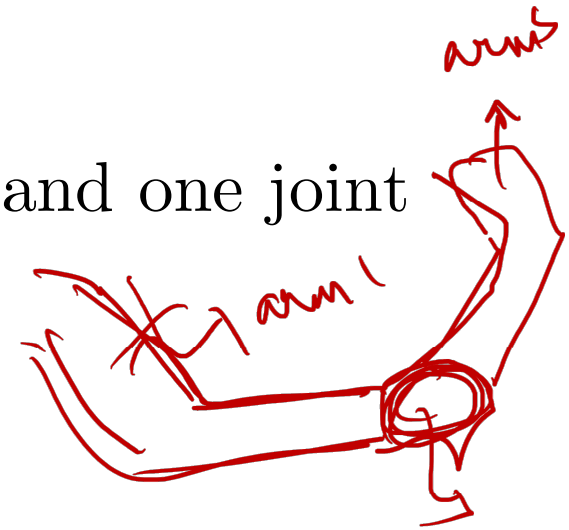
An open kinematic chain of two binary links and one joint is called a **dyad**



parallel chain



(a) Open mechanism chain

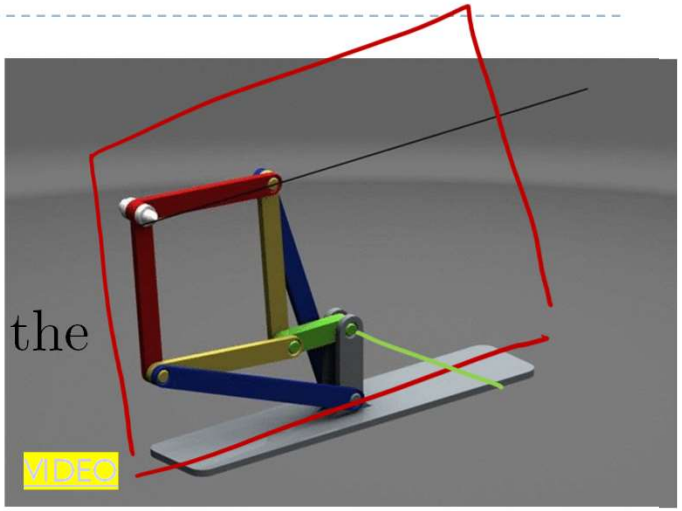


- **Closed Chain:**

A closed mechanism will have no open attachment points or nodes and may have one or more degrees of freedom

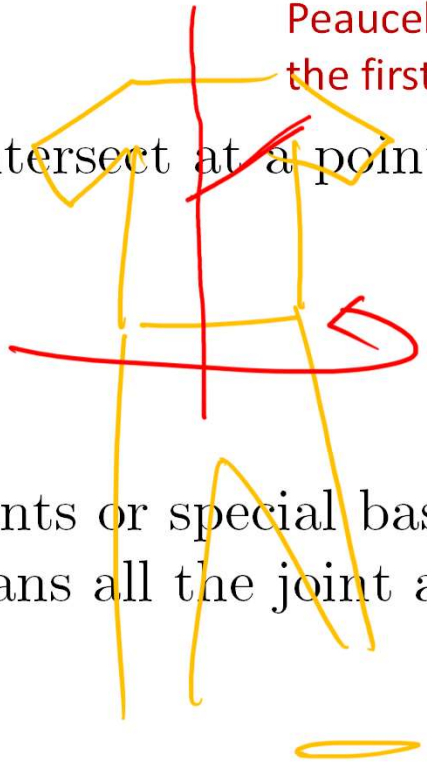
Mechanism Types:

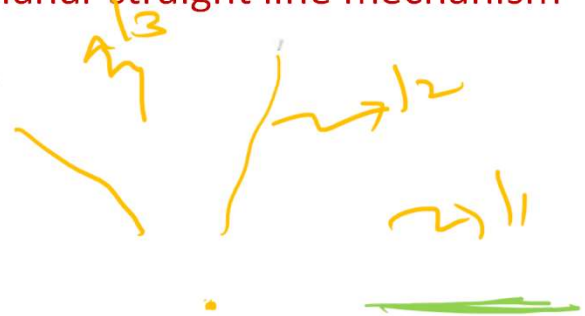
- Planar mechanism:
  - If all the points of a mechanism move in planes *parallel* to certain plane.
  - If the axes of hinges are *perpendicular* to the base plane



Peaucellier–Lipkin linkage, invented in 1864, was the first true planar straight line mechanism

- Spherical mechanism:
  - The axes of all joints intersect at a point.
  - Example – Gyro.



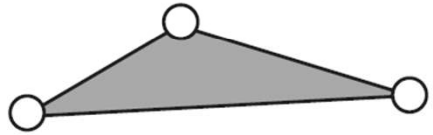


- Spatial mechanism:
  - Do not have special points or special base plane, in general, it means all the joint axes are skew to each other.

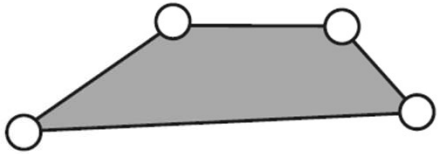
gimbals

Drawing Kinematic Diagrams

Binary link



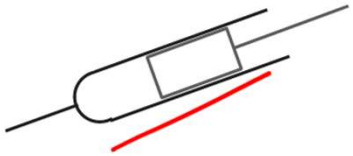
Ternary link



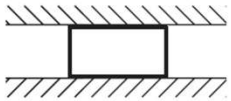
Quartenary link

Moving rotating joint

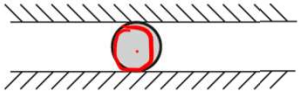
Grounded rotating joint



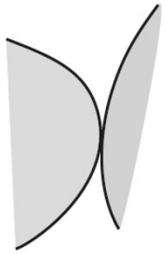
Moving translating joint



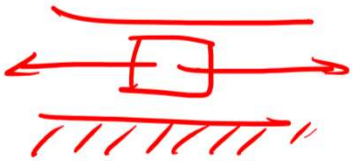
Grounded translating joint



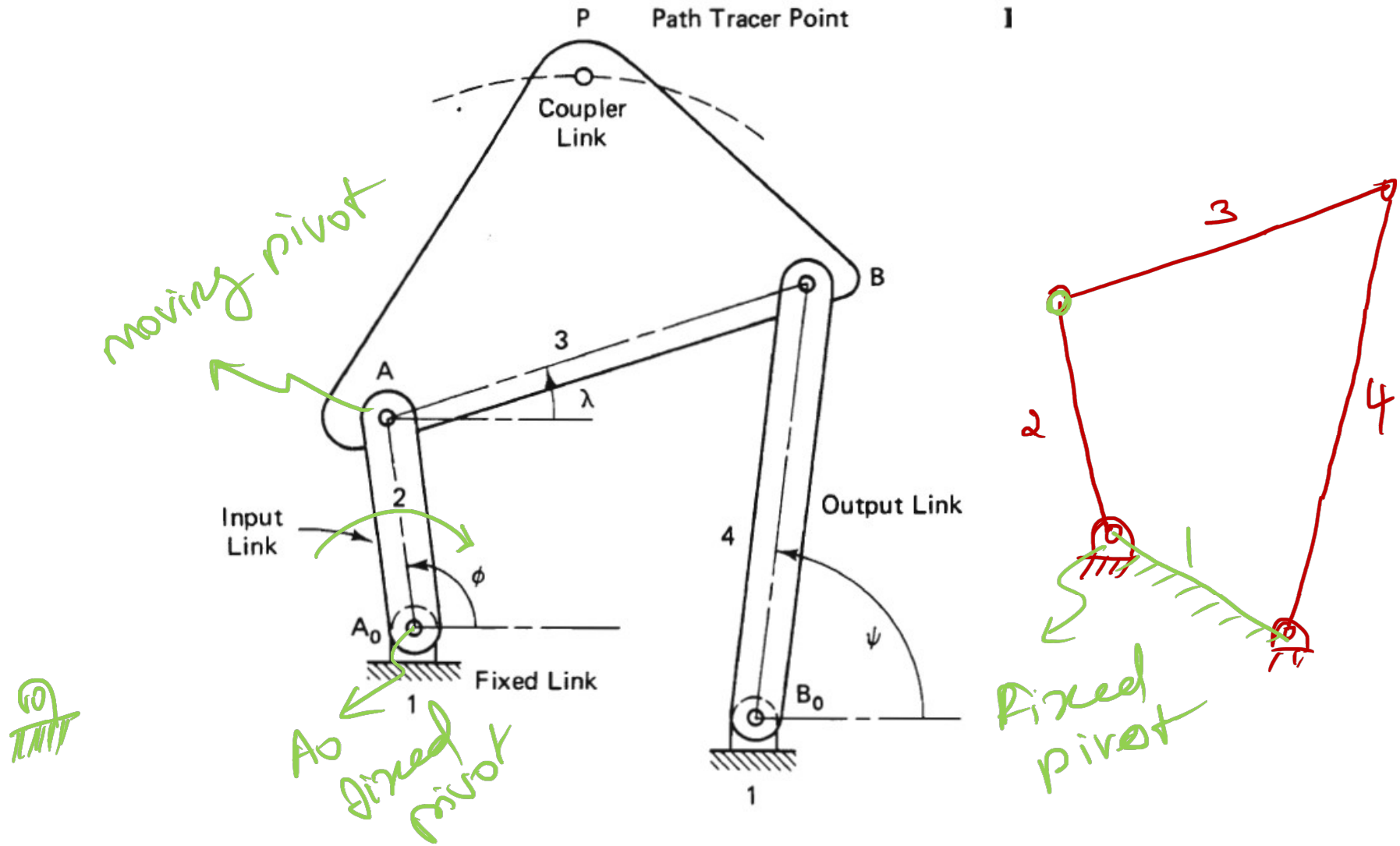
Grounded half joint



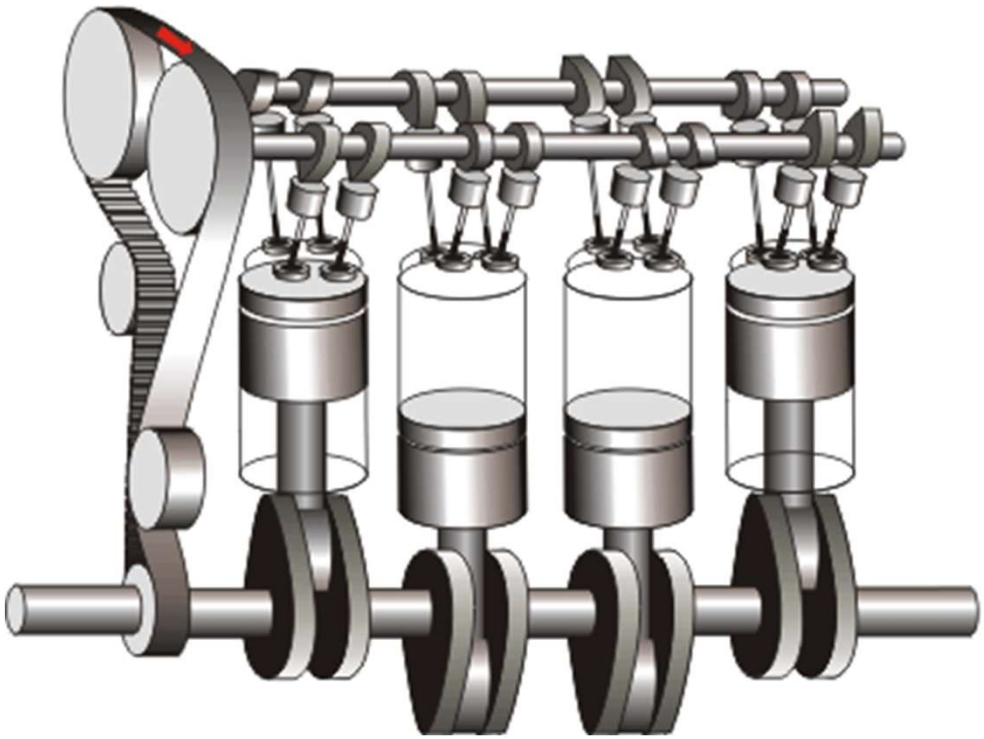
Moving half joint

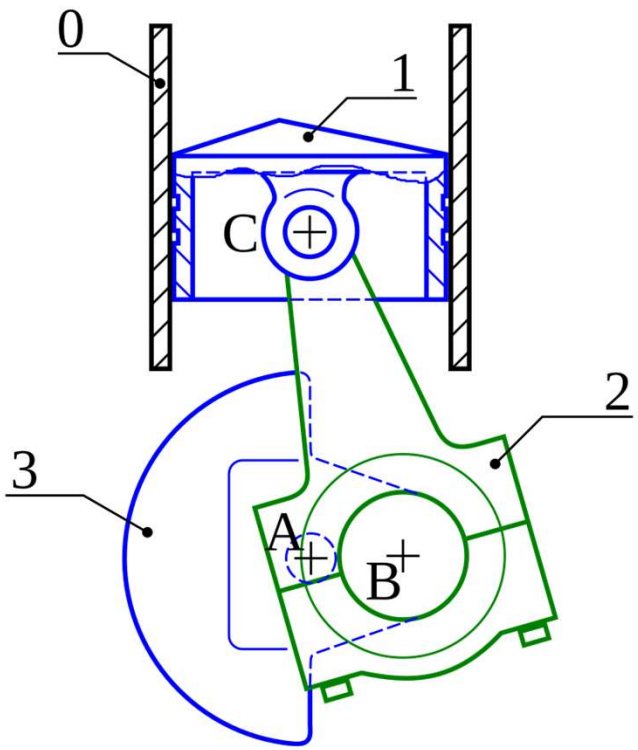


Fourbar Linkage

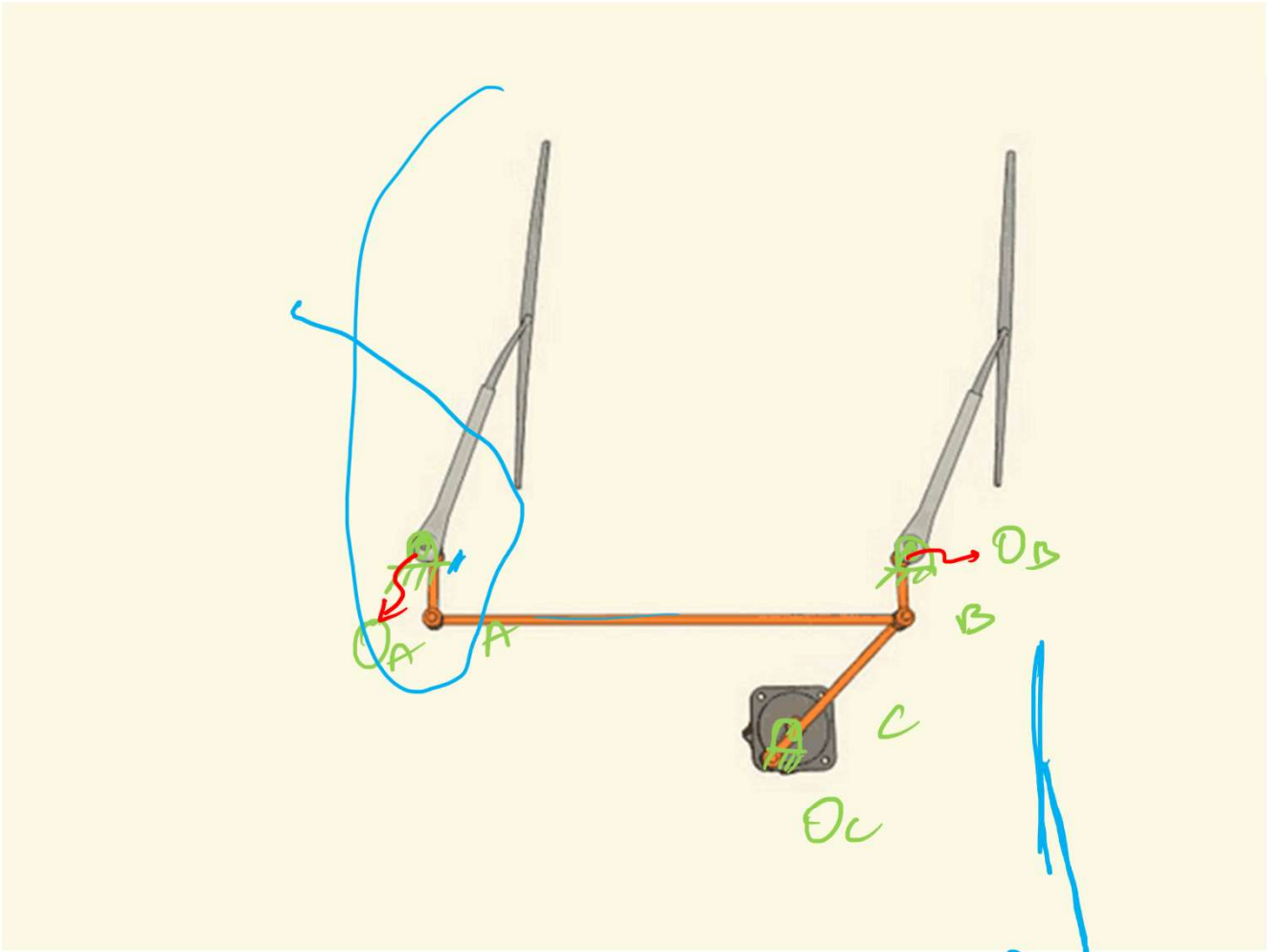


Kinematic Diagrams

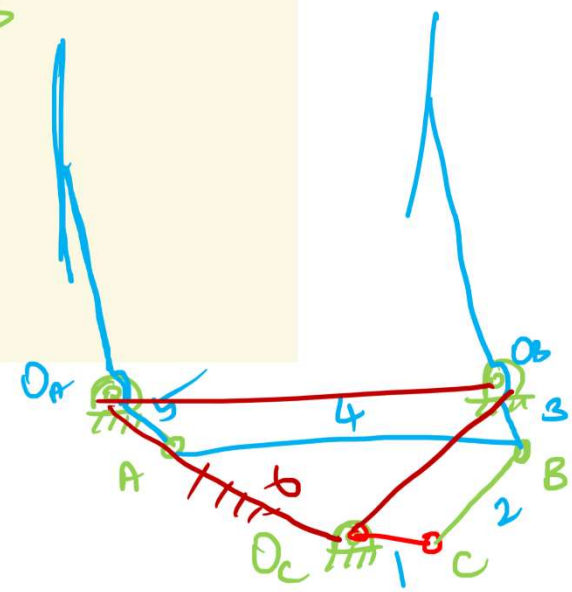




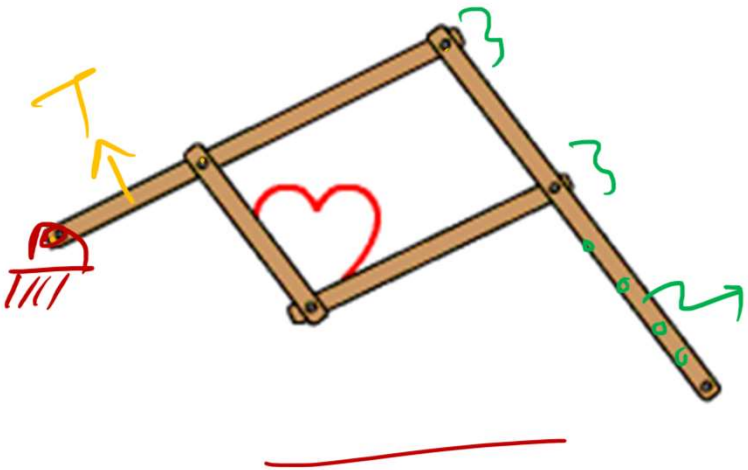
Kinematic Diagrams

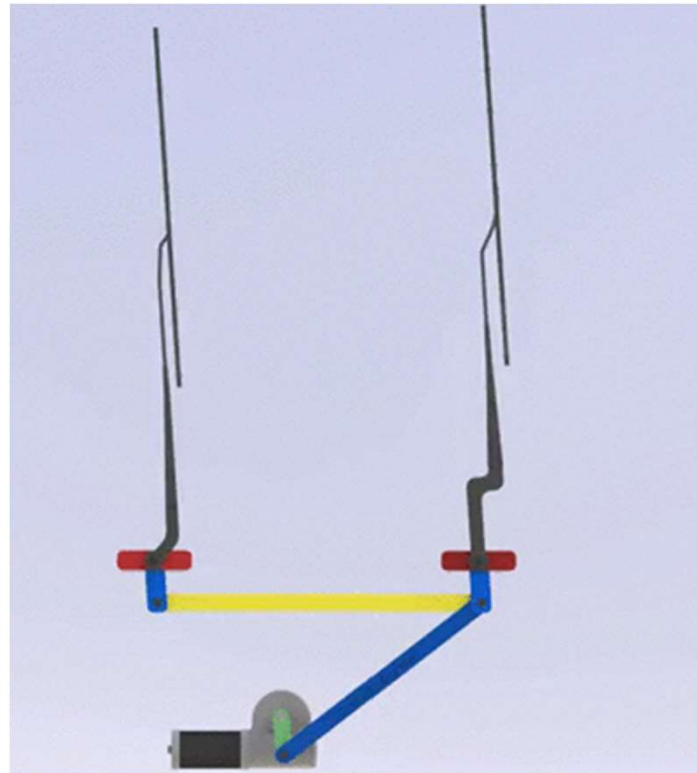


$N = 6$

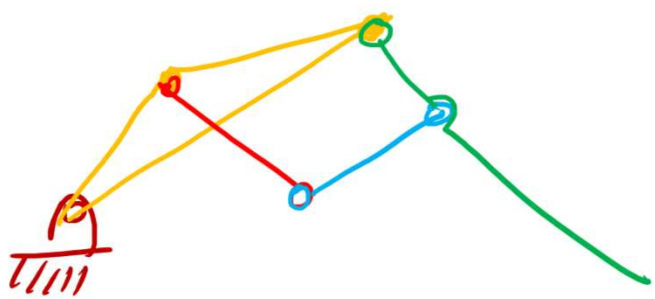


Kinematic Diagram

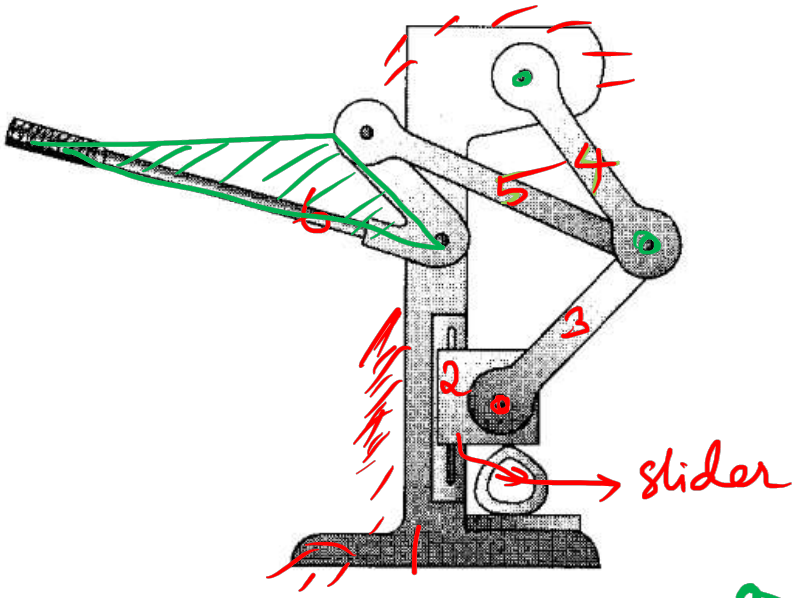




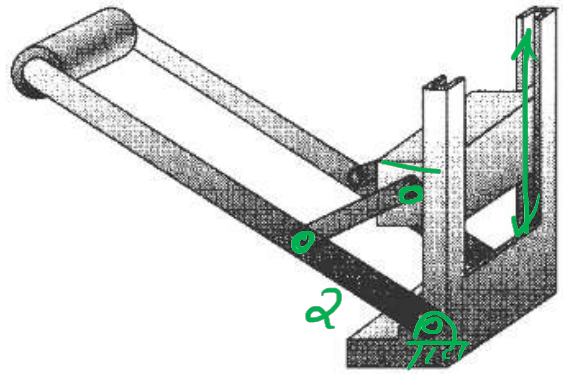
Pantograph

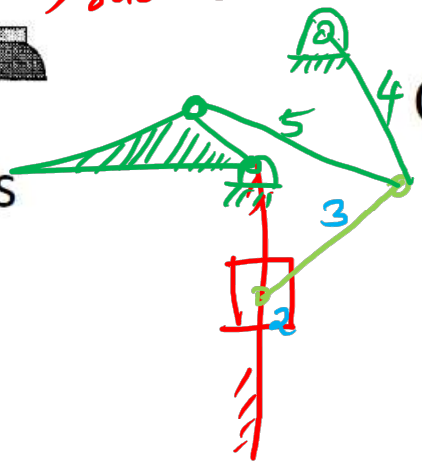
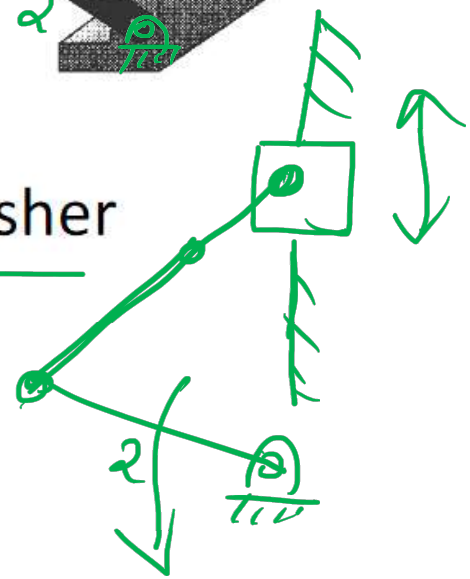


Kinematic Diagram



Simple press





Can crusher