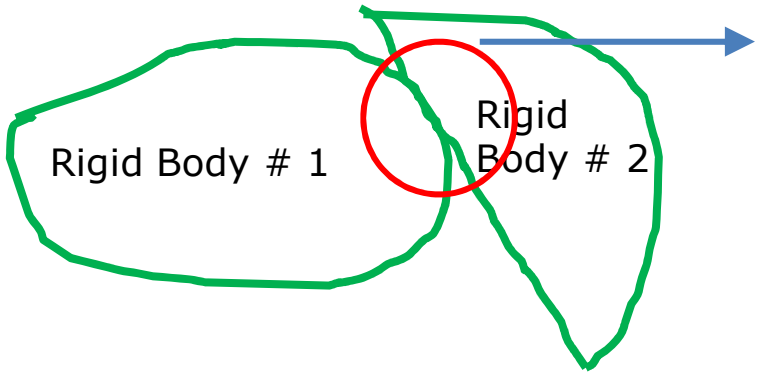
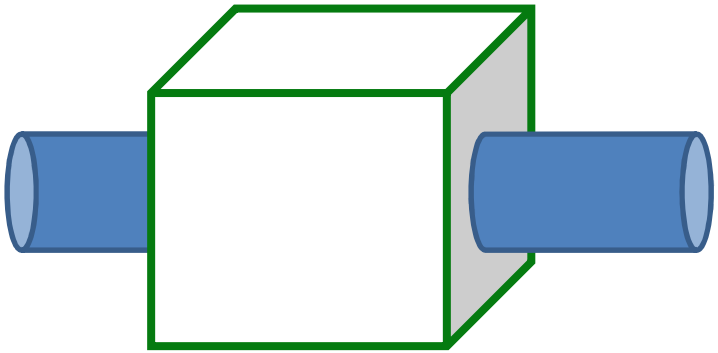
Introduction to Mechanisms

- **Mechanism**: combination of rigid bodies so shaped and connected that they move upon each other with definite relative motion
- **Machine**: Mechanism or collection of mechanism which transmits force from source of power to the resistance (load) to be overcome and thus perform useful work.
- Depending upon the functionality, a system will be termed as *mechanism* or *machine*

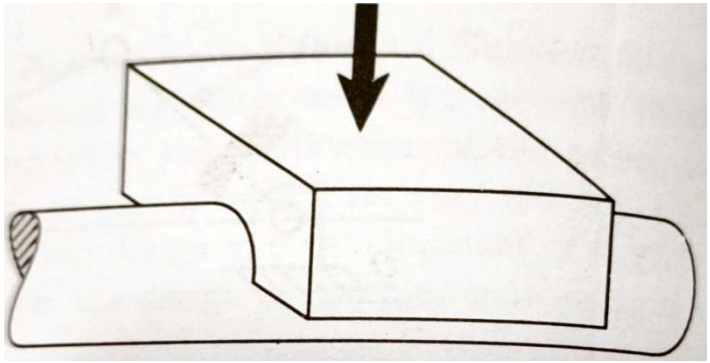


- Connection and its nature
- **Degree of freedom**: Number of independent co-ordinates required to completely specify the relative motion
- Connection is called ***Joint*** or ***Kinematic Pair***
- Different ways to classify/identify Kinematic Pairs. Credit: *Franz Reuleaux*

Kinematic Pair



Form-closed



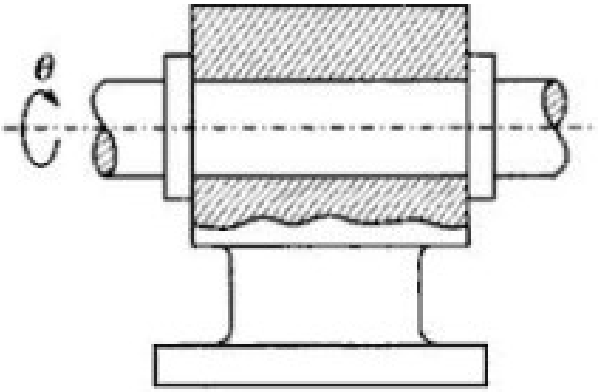
Force-closed

Type of contact:

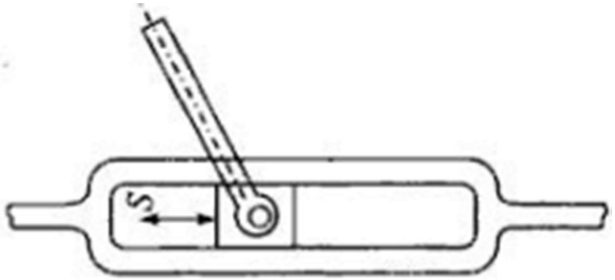
a) **Lower – surface contact**

- **Turning/Revolute Pair (Hinged joint):**

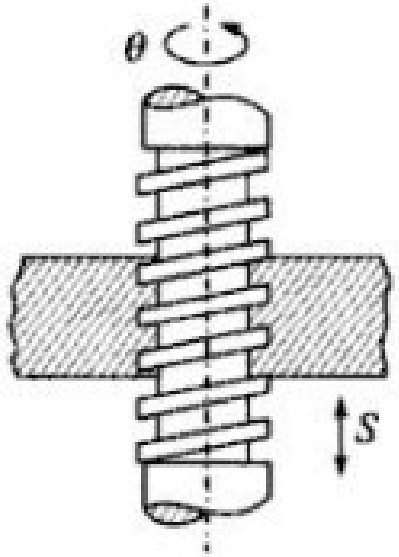
  Relative rotation. 1 D.O.F - θ



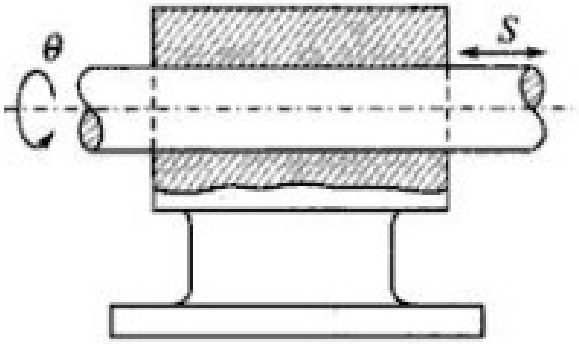
- **Prismatic Pair (Slider joint):** Relative translation. 1 D.O.F - S



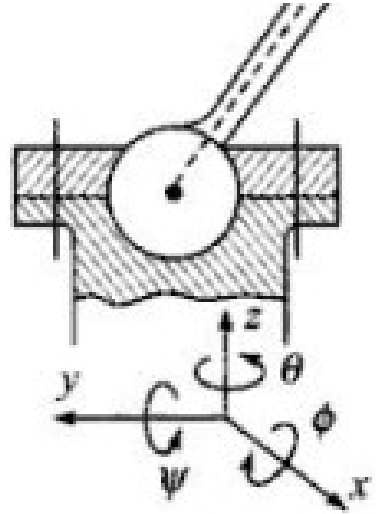
- **Screw/Helical Pair:** Relative motion. 1 D.O.F – θ/S



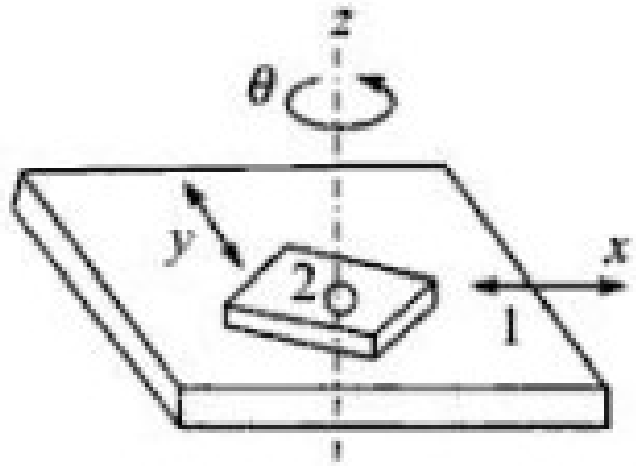
- **Cylindrical Pair:** Relative rotation & translation. 2 D.O.F – θ, S



- **Spherical Pair:** Relative rotation along 3 axes. 3 D.O.F – θ, φ, ψ



- **Planar Pair:** Relative translation along 2 axes and rotation along a axis. 3 D.O.F – x, y, θ



Type of contact:

b) **<u>Higher – point/line contact</u>**

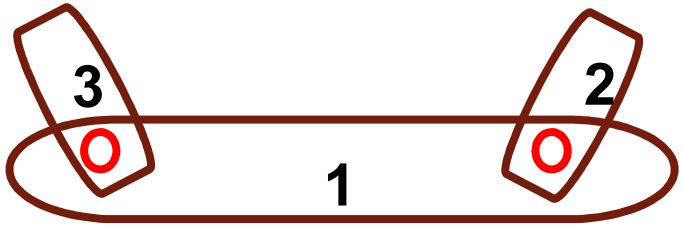
Example: Ball bearing (Point); Roller Bearing (Line), Gears (Line), Cam-Follower

c) **<u>Wrapping</u>**

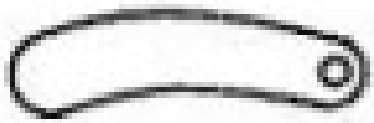
Example: Belt drive, Chain drive

Elements of a mechanism

- **Plane and space mechanism**
- **Link:** Body common to two or more kinematic pair

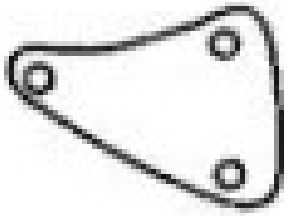


- **Kinematic Chain:** Series of links connected by a kinematic pair
- **Closed link**: Every link is connected to at least two other links
- **Open link**: Robotics, manipulators, weighing machine

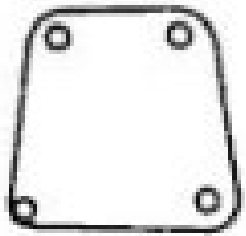


Singular link

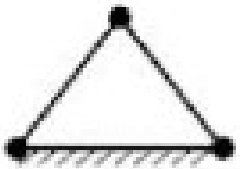
Binary link



Ternary link

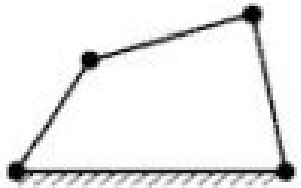


Quaternary link



DOF = 0

- Simple closed chain: 3 links with 3 kinematic pairs/joints
- Structure

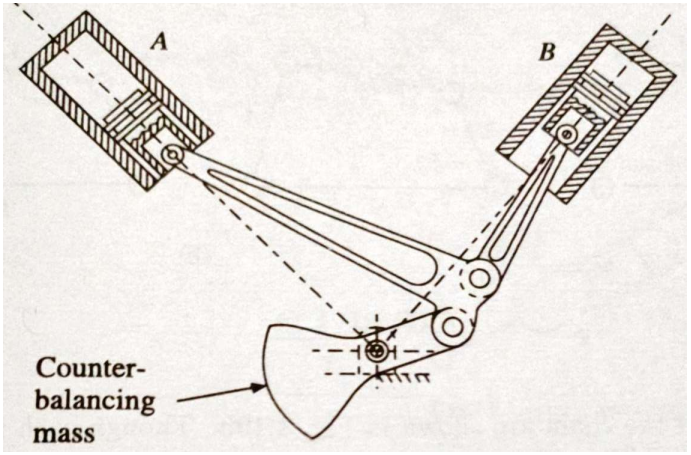


DOF = 1

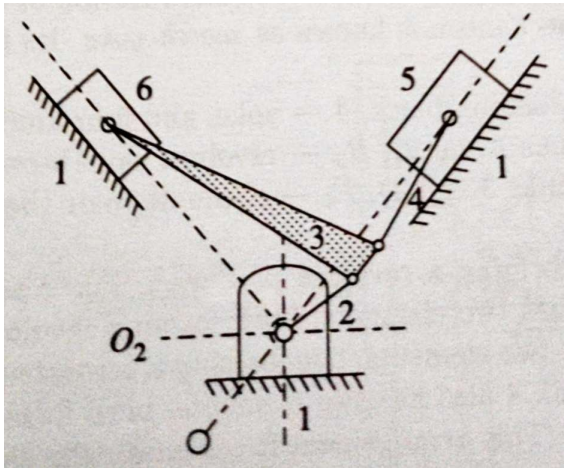
- Simplest mechanism
- 4 links with 4 revolute joints

Mechanism: closed kinematic chain in which one link is fixed

Kinematic Diagram – Equivalent model



V-twin internal combustion engine



Equivalent representation

- Allows for kinematic analysis
- Quicker option prior to a detailed analysis

- **Different variants of mechanism (~220) collected by Franz Reuleaux are available at http://kmoddl.library.cornell.edu**
- **The website also contains collection of machines and gear trains**

Degree of Freedom/Mobility (DOF)

- **DOF** is the number of inputs needed in order to create a predictable output/number of independent co-ordinates required to define its position
- Usually DOF > 1 for Open Links
- Kutzbach Equation and Grubler's criterion