

# Introduction to Dynamics

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## Mechanism

An assembly of machine components (kinematic links) designed to obtain a desired motion from an available motion while transmitting appropriate forces and moments.

## Simple mechanisms

- Lever
- Pulley
- Gear trains
- Belt and chain drive
- Four bar linkage

## Other mechanisms

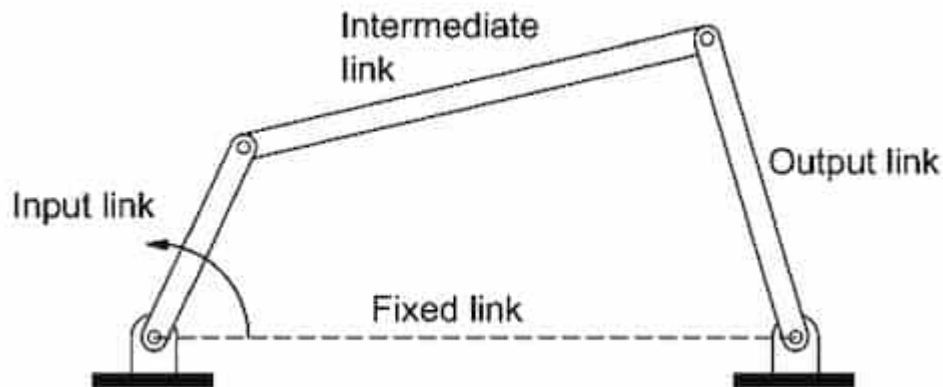
- Lock stitch mechanism (used in sewing machine)
- Geneva mechanism  
Constant rotational motion to intermittent rotational motion. mostly used in watches.
- Scotch yoke mechanism  
Constant rotational motion to linear motion (vice versa.). Mainly used as valve actuators in high pressure gas pipelines.

# Four bar linkage

Four bar-shaped members connected to each other in one plane.

Usually:

- 1 fixed link + 3 moving links
- 4 pin joints
- 2 moving pivots + 2 fixed pivots



- **input link** - usually denoted in the left.
- **output link** - usually denoted in the right.
- **coupler** - intermediate link
- **frame** - fixed link

## Grashof's law

A four bar mechanism has at least one revolving link **if**  $l_0 + l_3 \leq l_1 + l_2$ .

Here:  $l_0, l_1, l_2, l_3$  are the length of four bars from shortest to longest.

## Modes of motions

| Mechanism     | Action                            |
|---------------|-----------------------------------|
| Crank rocker  | Shortest link is the input link   |
| Double crank  | Shortest link is the fixed link   |
| Double rocker | Shortest link is the coupler link |

**crank** means a link that makes a full revolution. **rocker** means a link that doesn't make a full revolution.

## Crank rocker mechanism

Shortest link rotates a full revolution. Output link oscillates.

## Double crank mechanism

Shortest link is fixed. Both input and output links rotates a full revolution.

## Double rocker mechanism

Shortest link make full resolution. Input and output links makes a full revolution.

## Special cases

$$l_0 + l_3 = l_1 + l_2.$$

| Mechanism                                           | Orientation                            |
|-----------------------------------------------------|----------------------------------------|
| Parallelogram linkage or anti-parallelogram linkage | Equal links are opposite to each other |
| Deltoid linkage                                     | Equal links are adjacent to each other |

## Parallelogram linkage

Double crank mechanism. Opposite links are equal and parallel. Angular velocity of input crank & output crank is same. Orientation of the coupler doesn't change during the motion.

## Anti-parallelogram linkage

Double crank mechanism. Angular velocity of input crank is different to output crank.

## Deltoid linkage

- Longest link is fixed: crank rocker mechanism
- Shortest link is fixed: double crank mechanism

## Non-Grashof's condition

A four bar mechanism with the property **if**  $l_0 + l_3 > l_1 + l_2$ .

Here:  $l_0, l_1, l_2, l_3$  are the length of four bars from shortest to longest.

Three links are in oscillation.