

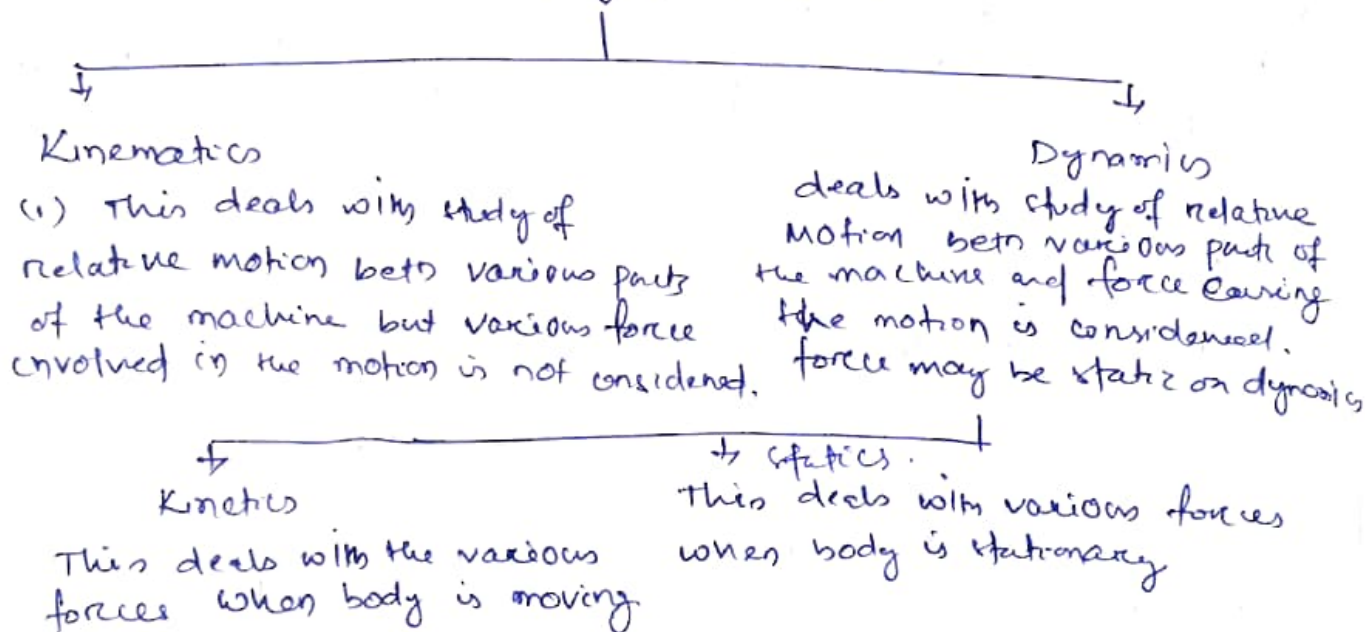
Prepared by

Binendra Kishan
Leet (Mech).

Simple mechanism

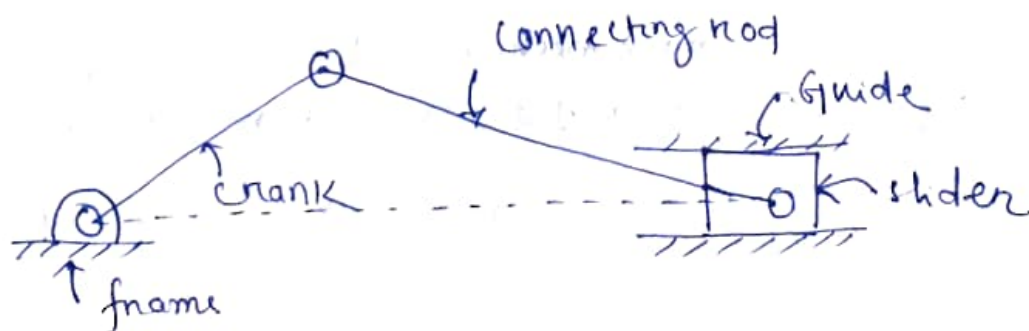
- Theory of machine is the branch of science which deals with the study of relative motion between various parts of a machine and forces act on them.

Theory of machine



Mechanism

A combination of rigid or restraining bodies which are so shaped and connected that they move upon each other with definite relative motion, known as mechanism.



The slider-crank mechanism converts reciprocating motion of the slider into ~~one~~ rotary motion of the crank or vice versa.

Machine

A machine is a mechanism or combination of mechanisms which not only imparts definite motion to the parts but also modifies the available mechanical energy into some kind of useful energy.

- The slider crank mechanism will become a machine when it is used in automobile engine by adding valve mechanism.

In that case it converts the available energy (force on the piston) into desired energy (torque on the shaft). The torque will make the vehicle.

Link

A link is defined as a member or a combination of members, connecting other members and having motion relative to them.

- A slider crank mechanism consists of 4 links
(i) frame (ii) crank (iii) connecting rod (iv) piston

Kinematic pair

A joint of 2 links, having relative motion between them is known as kinematic pair.

- In slider-crank mechanism link 2 rotates relative to link 1, hence link 1 & 2 is a kinematic pair.
- Similarly link 2 is having sliding motion relative to link 3, hence link 2 and 3 is also a kinematic pair.
- 3, 4 & 4-1 also a kinematic pair.

Classification of Kinetic pair

- (1) Accⁿ to nature of contact betⁿ the links
- (ii) Accⁿ to type of relative motion betⁿ the links
- (iii) Accⁿ to nature of mechanical constraints betⁿ the links.

Accⁿ to nature of contact

(i) Lower pair (ii) Higher pair

A Kinematic pair is known as lower pair if the two links has surface contact or area contact betⁿ them:

- Example:- shaft rotating in a bearing
 - Nut turning on a screw
 - universal joint.

- A Kinematic pair is known as higher pair, if the two links has point contact or line contact betⁿ them.

- EX:- cam and follower, teeth gear, roller bearing
- Ball bearing, Roller bearing

(ii) Accⁿ to the type of relative motion betⁿ the 2 links

or sliding pair (ii) Turning pair (iii) Rolling pair

(iv) screw pair (v) spherical pair

- A Kinematic pair is known as sliding pair, if the 2 links have a sliding motion relative to each other

- EX:- Link 4 & 1 are having sliding motion relative to each other.
- Rectangular rod in a rectangular hole.

b) Turning Pair

A Kinematic pair is known as turning pair, if one link has a turning or revolving motion relative to each other.

- EX: - In slider and crank mechanism, the link 2 ~~has~~ is having turning motion relative to the link 1 hence link 1 & 2 constitute a turning pair.
- Link 2 & 3 forms a turning pair.

(c) Rolling Pair

A Kinematic pair is known as rolling pair if one link has a rolling motion relative to each other.

- Rolling wheel on a flat surface forms a rolling pair.
- In ball bearing, ball and bearing forms a rolling pair.

(d) Screw Pair

A Kinematic pair is known as screw pair, if the two link have turning as well as sliding motion between them.

EX: - The lead screw and the nut of a lathe.

- bolt and nut

(e) Spherical Pair

A Kinematic pair is known as spherical pair if one link is in the form of a sphere ~~forms~~ inside a fixed link.

- The ball and socket joint.

(1) Accⁿ to nature of mechanical constraint betⁿ the 2 links

as closed pair
by unclosed pair

- In case of closed pair, the two elements of the pair are held together mechanically

EX:- All the lower pair, screw pair

where as in case of unclosed pair, the elements of the pair are in contact due to force of gravity or due to spring action.

EX:- cam and follower, flat belt running on a pulley

Kinematic chain

A kinematic chain is defined as the combination of kinematic pair in such a way that each link forms a part of two pair and the motion relative to each other is definite.
OR

When the kinematic pairs are coupled in such a way that the last link is ~~coupled~~ joined to the first link to transmit definite motion, it is called as kinematic chain.

EX:- In slider crank mechanism, link 1 forms kinematic pair with link 2 and link 4. Hence link 1 forms a part of 2 pair.

→ Similarly link 2 forms kinematic pair with 3 and link 1. Hence link 2 forms a part of 2 pair.

The relation betⁿ number of pair (P) and number of link (L) in a four link kinematic chain is given by

$$L = 2P - 4$$

The relation betⁿ number of Link (L) and number of Joints (j) forming a planar Link Kinematic chain is given by

$$j = \frac{3}{2}L - 1.$$

Q

LHS > RHS, then chain is locked.

LHS = RHS, then chain is unconstrained.

LHS < RHS, then chain is overconstrained.

- Constrained motion means motion betⁿ a pair in a definite direction irrespective of the direction of force applied is known as constrained kinematic chain.
- EX:- Square bar in a square hole.
 - Shaft with collar in a circular hole.
- ~~Q~~ If motion betⁿ a pair that can take place in more than one direction then it is called as unconstrained motion.
- EX:- shaft in a circular hole.

~~shaft in a circular hole~~

Inversion of Four Bar Mechanism

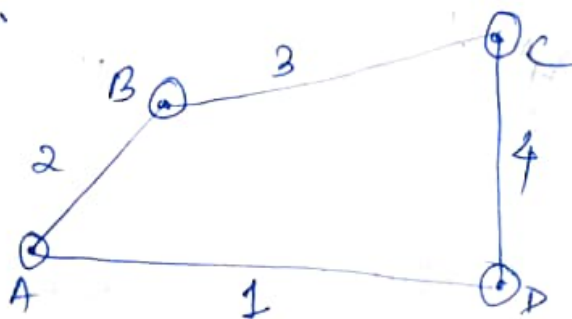
- ~~Mechanism~~ is a kinematic
- ~~Mechanism~~ ^{Mechanism} is a kinematic chain in which one link is fixed. By fixing the link of a kinematic chain, one at a time, we get as many different mechanism as the number of link in the chain.
- the method of obtaining different mechanism by fixing different link of the same kinematic chain, is known as inversion of the mechanism.

Different types of Kinematic chains and their Inversion:-

- (i) four bar chain
- (ii) single slider crank chain
- (iii) double slider crank chain

Four Bar Chain

- This is the simplest kinematic chain. It consist of 4 rigid links which are connected in the form of a quadrilateral by four pin joints.



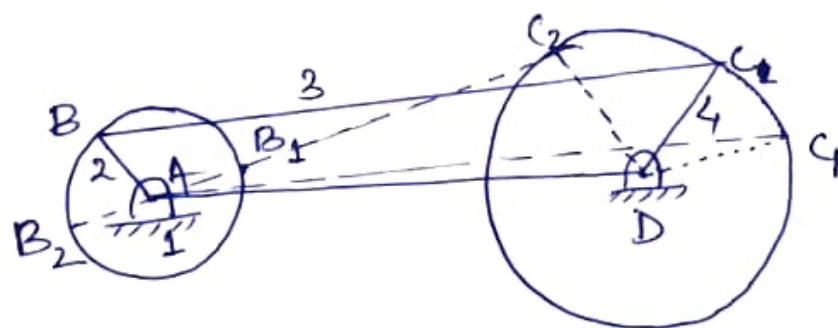
- It consist of 4 turning pair. Link 1 & Link 2 forms 1st turning pair, 2-3, 3-4, 4-1 forms turning pair.

- A link that makes complete revolution is known as crank.
- The fixed link is known as frame of the mechanism.
- The link opposite to the fixed link is known as coupler or connecting rod.
- The fourth link is known as lever or rocker (if it oscillates) or another crank (if it rotates).

Application of 4-bar chain

- crank and lever mechanism (oscillatory motion)
- Double crank mechanism (complete revolution of the crank and the follower)
- Coupled wheel of a locomotive (double crank)
- Pantograph (double lever mechanism)

4 crank-lever mechanism



The four links of the bar chain are 1, 2, 3, 4. The link 1 is fixed and the lengths of the links 2, 3, and 4 are proportionate in such a way that the crank BA is able to rotate completely.