**Lecture Two**

**Kinematics and Kinetics of Mechanisms**

**Introduction:**

**Theory of Machines:** may be defined as that branch of engineering science, which deals with the study of relative motion between the various parts of machine, and forces which act on them. The knowledge of this subject is very essential for an engineer in designing the various parts of a machine.

**Sub- divisions of theory of Machines:**

They Theory of Machines may be sub- divided into the following four branches:

1- **Kinematics:** is that branch of theory of machines which is responsible to study the motion of bodies without reference to the forces which are cause this motion, i.e it’s relate the motion variables (displacement, velocity, acceleration) with the time.

2- **Kinetics:** is that branch of theory of machines which is responsible to relate the action of forces on bodies to their resulting motion.

3- **Dynamics:** is that branch of theory of machines which deals with the forces and their effects, while acting upon the machine parts in motion.

4- **Statics:** is that branch of theory of machines which deals with the forces and their effects, while the machine parts are rest.

There are some definitions which are concerned with this subject, must be known:

**Mechanism:** is a combination of rigid bodies which are formed and connected together by some means, so that they are moved to perform some functions, such as the crank- connecting rod mechanism of the I.C. engines, steering mechanisms of automobiles……. etc.

The analysis of mechanisms is a part of machine design which is concerned with the kinematics and kinetics of mechanisms (or the dynamics of mechanisms).

**Rigid Body:** is that body whose changes in shape are negligible compared with its overall dimensions or with the changes in position of the body as a whole, such as rigid link, rigid disc…..etc.

**Links:** are rigid bodies each having hinged holes or slot to be connected together by some means to constitute a mechanism which able to transmit motion or forces to some another locations.

**Absolute motion:** the motion of body in relative to another body which is at rest or to a fixed point located on this body.

**Relative motion:** the motion of body in relative to another moved body.

**Scalar quantities:** are those quantities which have magnitude only e.g. mass, time, volume, density etc.

**Vector quantities:** are those quantities which have magnitude as well as direction e.g. velocity, acceleration, force etc.

**Mechanism:** is a combination of rigid bodies which are formed and connected together by some means, so that they are moved to perform some functions, such as the crank- connecting rod mechanism of the I.C. engines, steering mechanisms of automobiles……. etc.

**Structure:** is an assemblage of resistant bodies which are not kinematic links because there is no relative motion between the links. There is only straining action due to forces acting on them, for example roof truss. Machine frames etc., are the examples of a structure.

**Kinematic Pair:** The two links or elements of a machine, when in contact with each other, are said to form a pair. If the relative motion between them is completely or successfully constrained (*i.e*. in a definite direction), the pair is known as *kinematic pair*.

**Kinematic Chain:** When the kinematic pairs are coupled in such a way that the last link is joined to the first link to transmit definite motion (*i.e.* completely or successfully constrained motion), it is called a ***kinematic chain.*** In other words, a kinematic chain may be defined as a combination of kinematic pairs, joined in such a way that each link forms a part of two pairs and the relative motion between the links or elements is completely or successfully constrained. For example, the crank shaft of an engine forms a kinematic pair with the bearings which are fixed in a pair, the connecting rod with the crank forms a second kinematic pair, the piston with the connecting rod forms a third pair and the piston with the cylinder forms a fourth pair. The total combination of these links is a kinematic chain.

A mechanism with four links it is called a Simple Mechanism. A mechanism with more than four links it is called a Compound Mechanism**.**

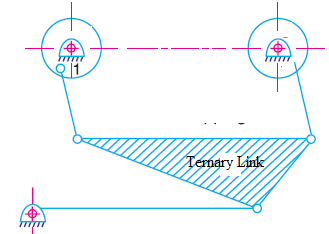
Link

Binary Link

Ternary Link

Quaternary Link

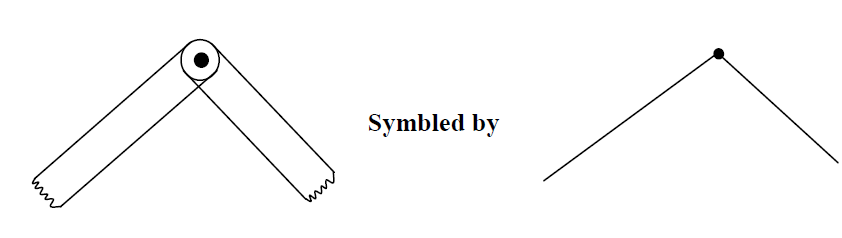
**Example**

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**The connection of mechanism parts**

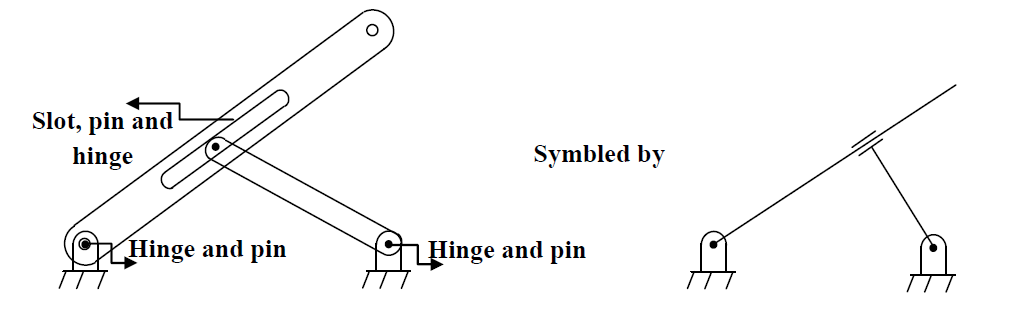
The mechanism is a combination of rigid bodies which are connected together using different methods:

**Hinged part:** The hinge connection may be used to connect the links together or connect a link to a fixed point, piston, disc ….. etc, the connection is achieved using pin, which is pass through the hinge holes

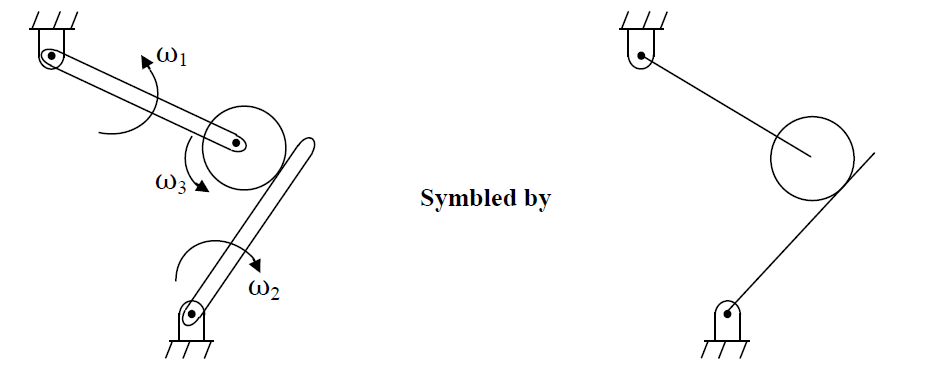


**Sliding Parts:**

The sliding connection may be used to connect two links rotate about fixed points by means of slot, pin and hinge.



**Rolling without slipping parts:**



**Translated bodies:**

There are some bodies in the mechanism which are constrained to move in translation manner, such as the piston of crank- connecting rod mechanism, the body is used to be in translation motion, if any line remains in some configuration during motion; then all the points have the same absolute velocity and acceleration.

