

CHAPTER 01

KINEMATIC LINK & PAIRS

KINEMATIC LINK:

- ✘ It is defined as the part of machine which has a relative motion with respect to some other part of same machine is called Kinematic link or element.

KINEMATIC LINKS CAN BE DIVIDED INTO THREE TYPES.

- × 1. **Rigid link-** In this type of link there is no deformation while transmitting the motion. Motion between the piston and crank can be considered as a rigid link.
- × 2. **Flexible link-** In this type of link there is partial deformation while transmitting the motion. Belt drive is an example of flexible link.
- × 3. **Fluid link-** In this type of link the motion is transmitted with the help of fluid pressure. Hydraulic brake is an example of fluid link.

KINEMATIC PAIRS

- ✘ 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. Let us discuss the various types of constrained motions.

CONSTRAINED MOTIONS

- ✘ Types of Constrained Motions
 - ✘ • Completely constrained motion
 - ✘ • Incompletely constrained motion
 - ✘ • Successfully constrained motion

1. COMPLETELY CONSTRAINED MOTION

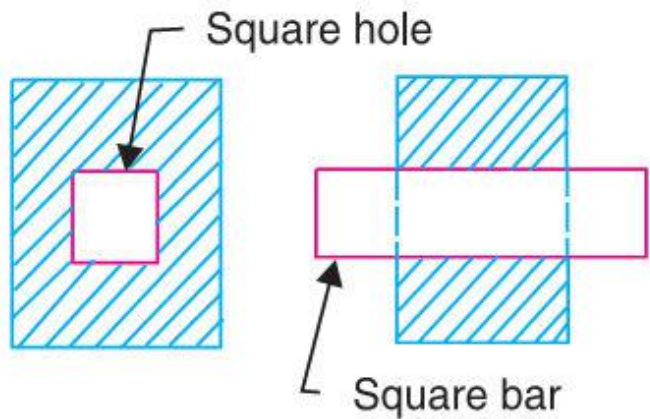


Fig. 5.2. Square bar in a square hole.

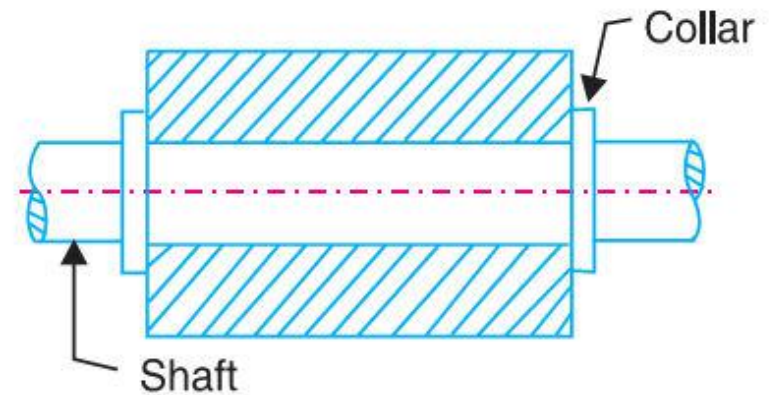


Fig. 5.3. Shaft with collars in a circular hole.

2. INCOMPLETELY CONSTRAINED MOTION

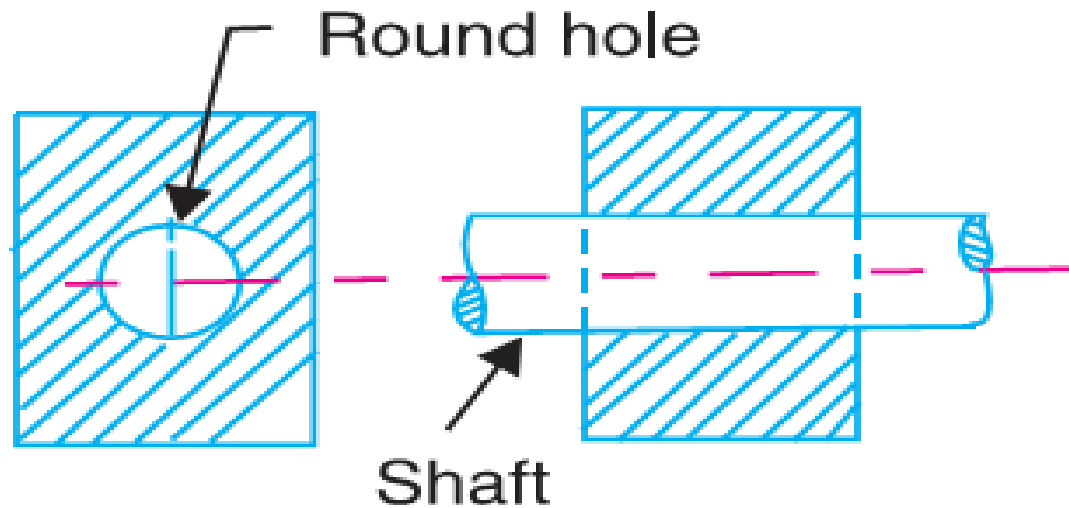


Fig. 5.4. Shaft in a circular hole.

3. SUCCESSFULLY CONSTRAINED MOTION

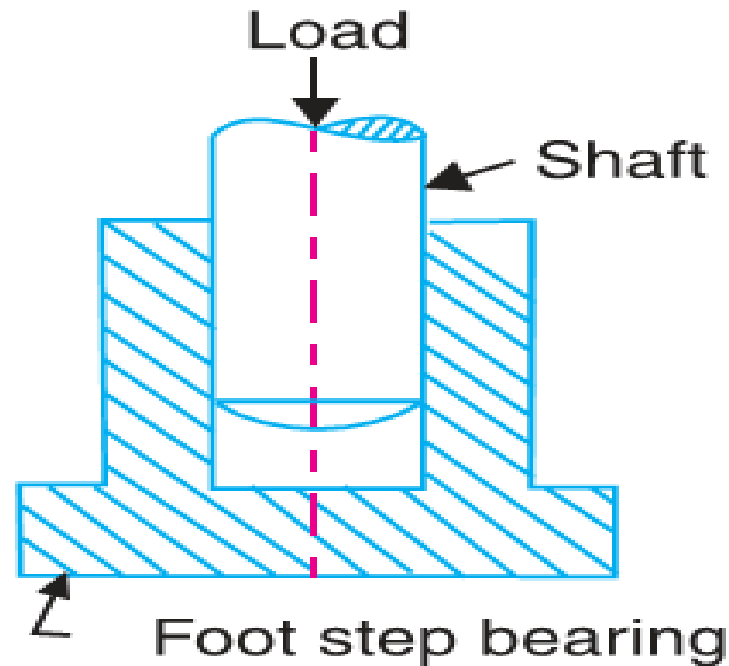


Fig. 5.5. Shaft in a foot step bearing.

TYPES OF KINEMATIC PAIRS

- ✘ 1. According to the type of relative motion between the elements
- ✘ Sliding pair
- ✘ • Turning pair
- ✘ • Cylindrical pair

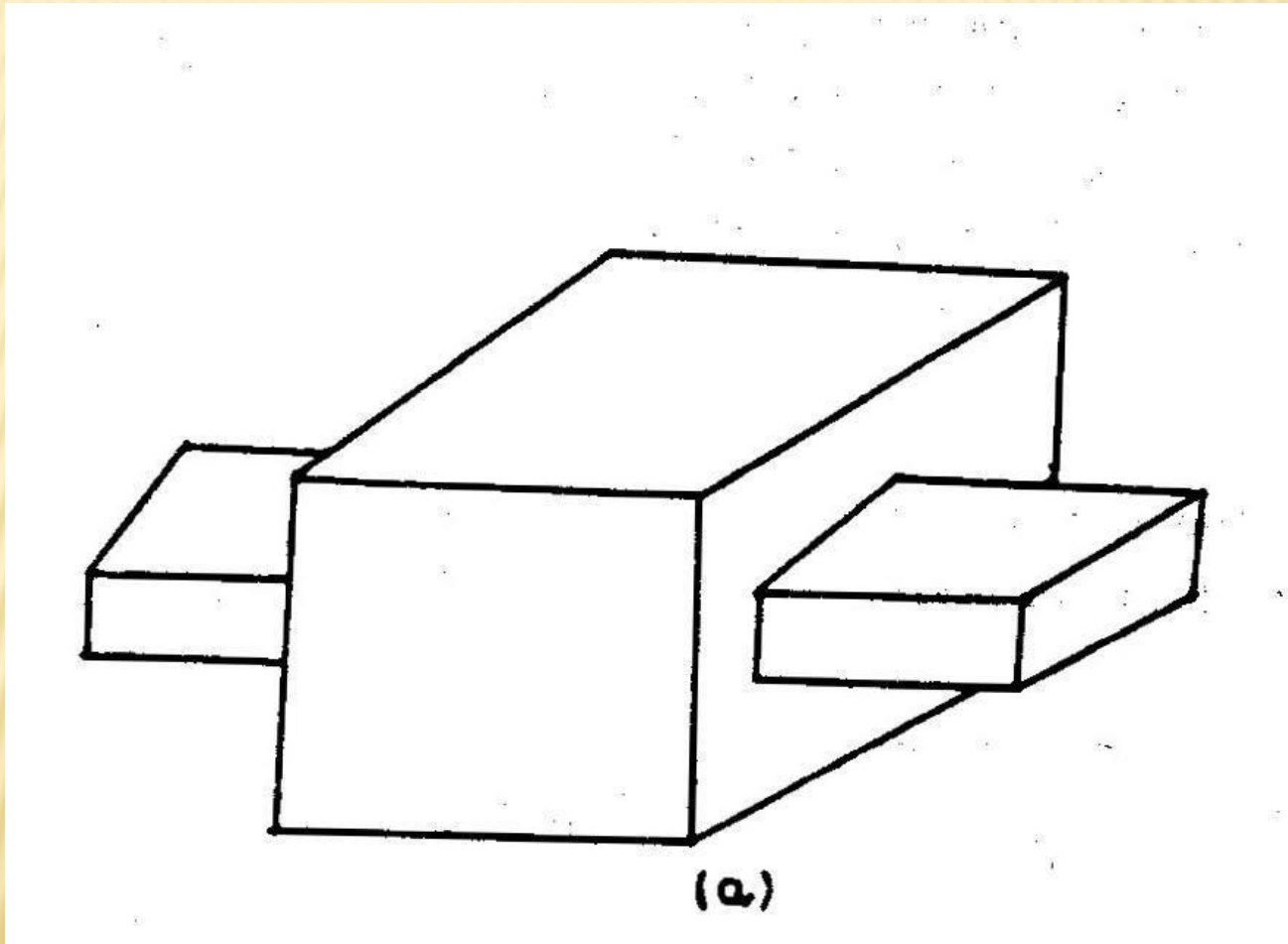
CONTDD...

- ✘ Rolling pair
- ✘ • Spherical pair
- ✘ • Helical pair or screw pair

(A) SLIDING PAIR.

- ✘ *When the two elements of a pair are connected in such a way that one can only slide relative to the other, the pair is known as a sliding pair.*
- ✘ The piston and cylinder, cross-head and guides of a reciprocating steam engine, ram and its guides in shaper, tail stock on the lathe bed etc.
- ✘ are the examples of a sliding pair. A little consideration will show that a sliding pair has a completely
- ✘ constrained motion.

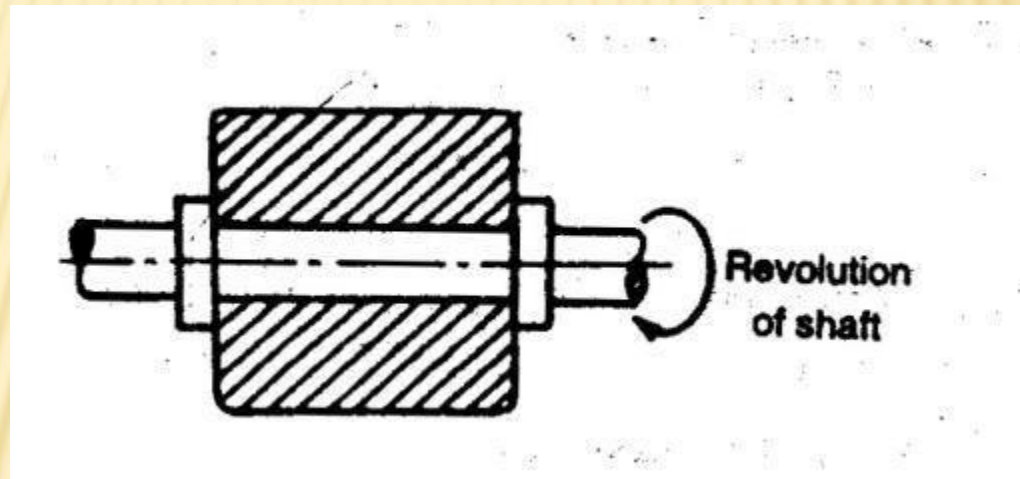
(A) SLIDING PAIR [DOF = 1]



(B) TURNING PAIR.

- ✘ *When the two elements of a pair are connected in such a way that one can only turn or revolve about a fixed axis of another link, the pair is known as turning pair.*
- ✘ A shaft with collars at both ends fitted into a circular hole, the crankshaft in a journal bearing in an engine, lathe
- ✘ spindle supported in head stock, cycle wheels turning over their axles etc. are the examples of a
- ✘ turning pair. A turning pair also has a completely constrained motion

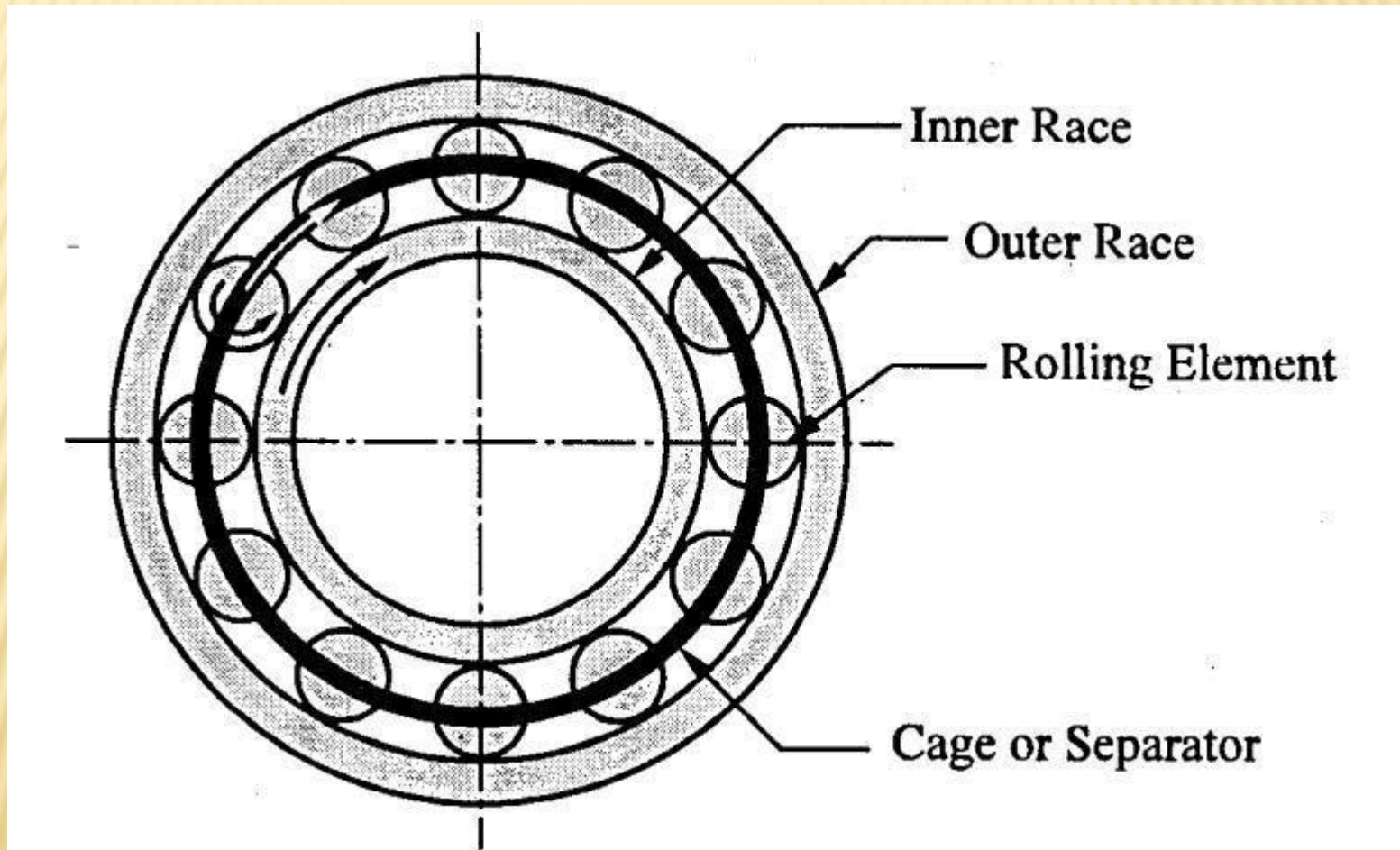
(B) TURNING PAIR (REVOLUTE PAIR) [DOF = 1]



(C) ROLLING PAIR

- ✘ . *When the two elements of a pair are connected in such a way that one rolls over*
- ✘ another fixed link, the pair is known as rolling pair. Ball and roller bearings are examples of rolling pair.

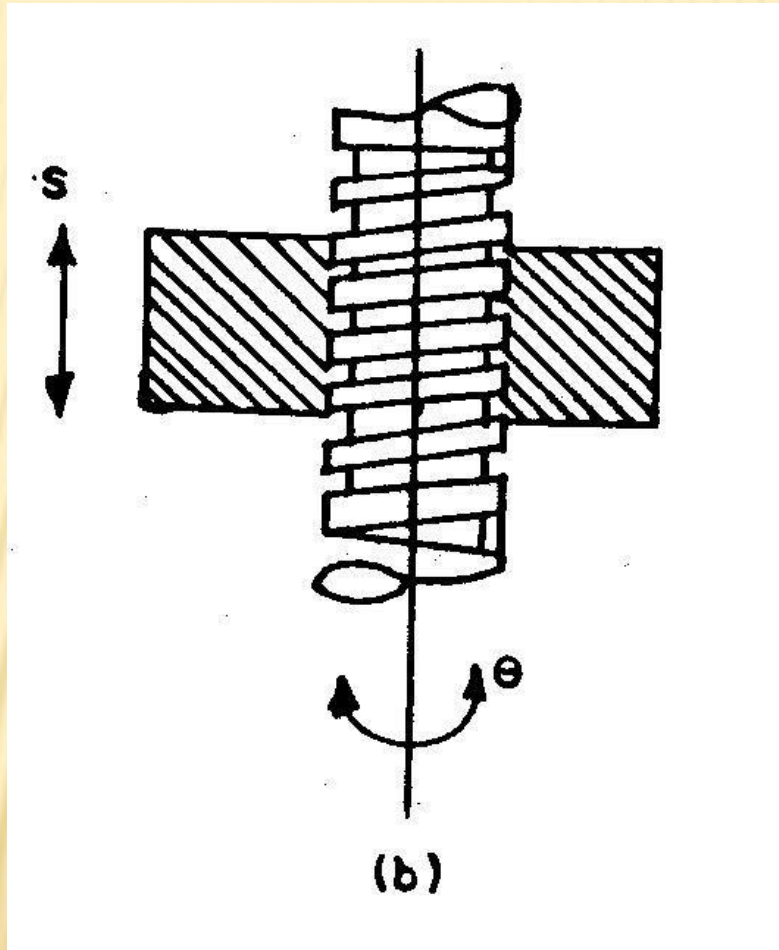
(C) ROLLING PAIR [DOF = 1]



(D) SCREW PAIR.

- ✘ *When the two elements of a pair are connected in such a way that one element can turn about the other by screw threads, the pair is known as screw pair. The lead screw of a lathe with nut, and bolt with a nut are examples of a screw pair*

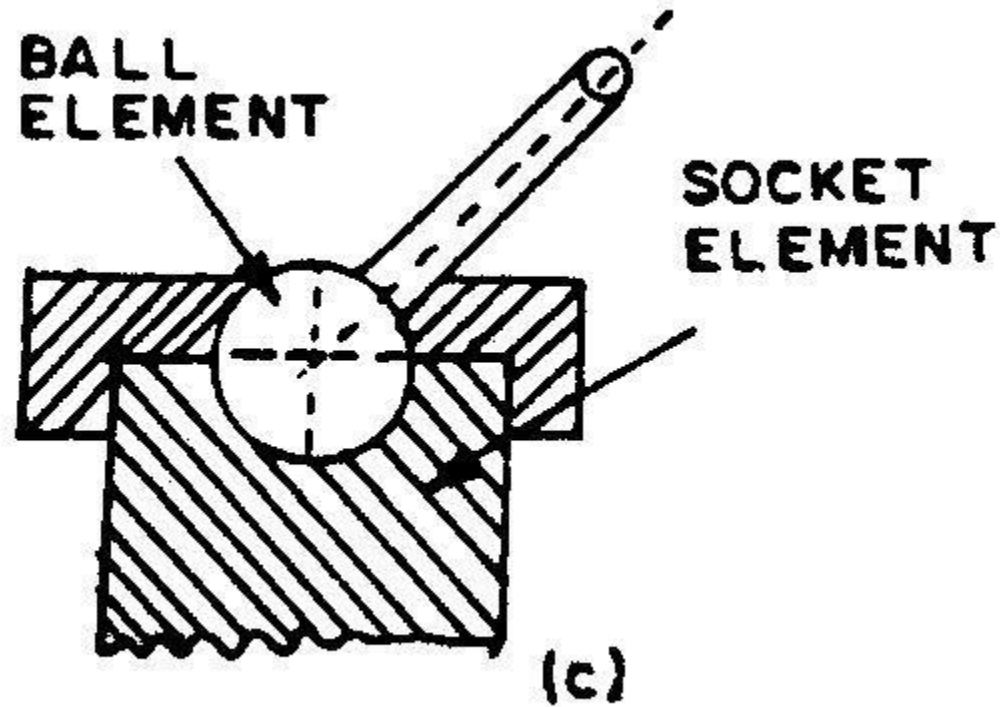
(D) HELICAL PAIR OR SCREW PAIR [DOF = 1]



E) SPHERICAL PAIR

- ✘ *When the two elements of a pair are connected in such a way that one element (with spherical shape) turns or swivels about the other fixed element, the pair formed is called a*
- ✘ *spherical pair. The ball and socket joint, attachment of a car mirror, pen stand etc., are the examples of a spherical pair*

(E) SPHERICAL PAIR [DOF = 3]
EG. BALL AND SOCKET JOINT

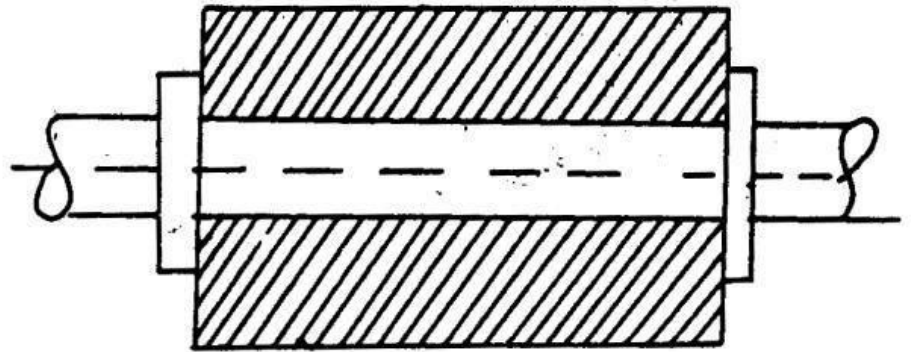
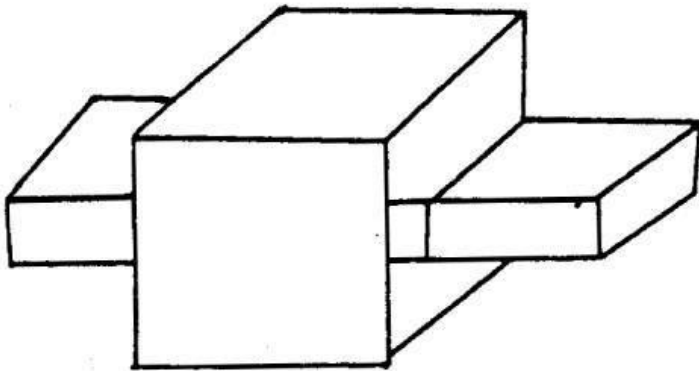


2. ACCORDING TO THE TYPE OF CONTACT BETWEEN THE ELEMENTS

- ✘ Lower pair
- ✘ Higher pair

LOWER PAIR

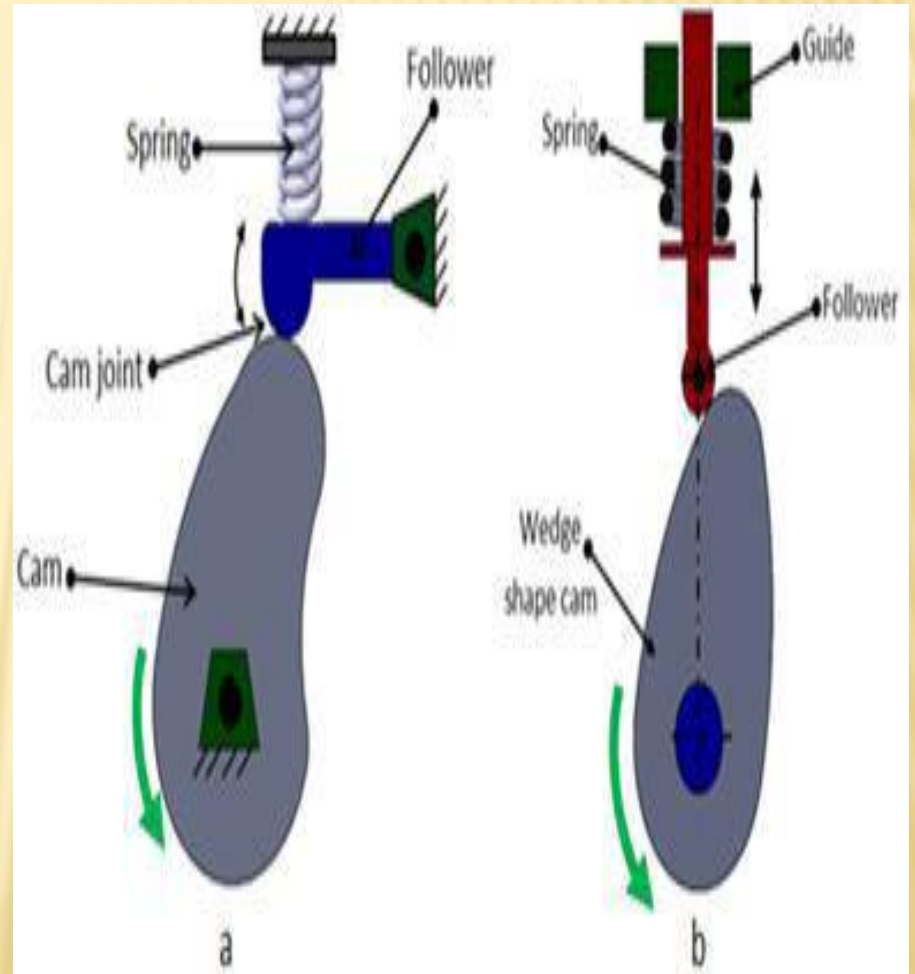
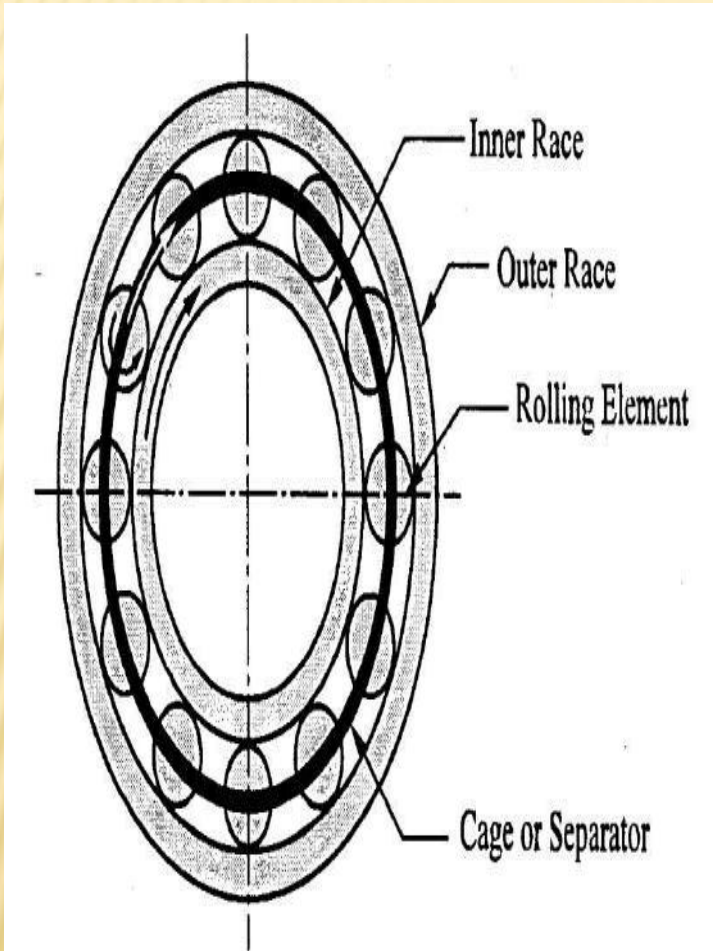
- ✘ When the two kinematic links are connected such that they have a surface contact between the two links it is called as lower pair.
- ✘ Or
- ✘ The joint by which two members are connected has surface contact.



HIGHER PAIR

- ✘ When the two kinematic links are connected such that they have a line or point contact between the two links it is called as higher pair

1. BALL BEARING 2. CAM AND FOLLOWER



3. ACCORDING TO THE TYPE OF CLOSURE OR MECHANICAL CONNECTIONS

- × **(A) Self closed pair.** *When the two elements of a pair are connected together mechanically in such a way that only required kind of relative motion occurs, it is then known as self closed pair. The lower pairs are self closed pair*

(B) FORCE - CLOSED PAIR

- ✘ *When the two elements of a pair are not connected mechanically but are kept in contact by the action of external forces, the pair is said to be a force-closed pair.*
- ✘ The cam and follower is an example of force closed pair, as it is kept in contact by the forces exerted by spring and gravity

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**.