SNS COLLEGE OF TECHNOLOGY

(AN AUTONOMOUS INSTITUTION)

Department of Mechanical Engineering

Kinematics of Machinery

Unit – I

BASICS OF MECHANISMS

TOPIC - 2

DEGREES OF FREEDOM FOR PLANE MECHANISMS

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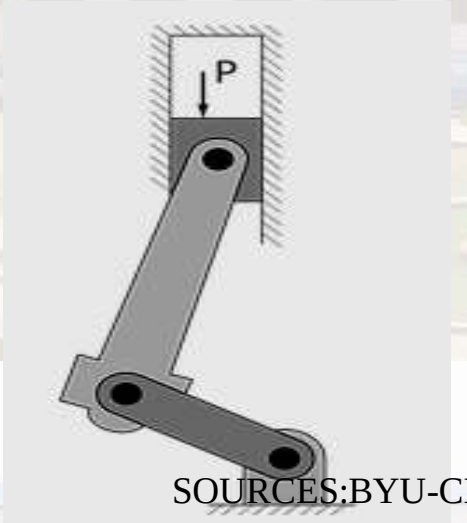
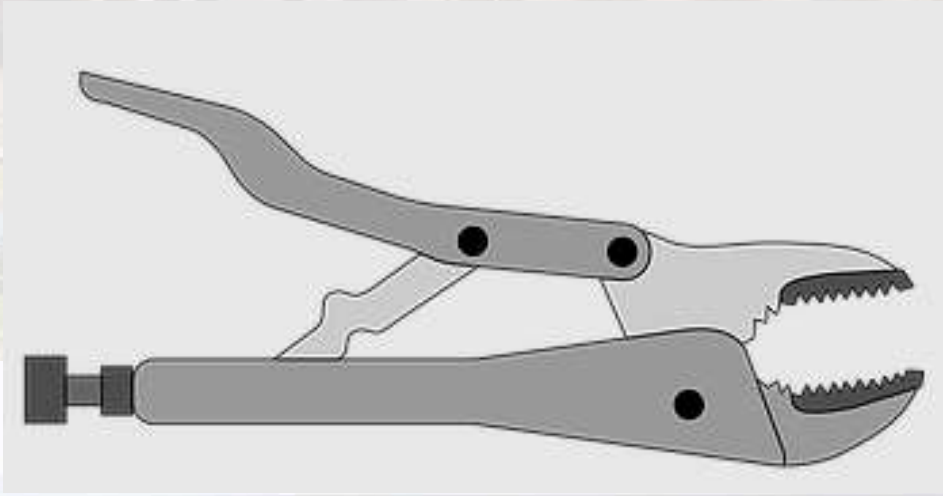
MECHANISM

A mechanism with four links is known as simple mechanism, and the mechanism with more than four links is known as compound mechanism.



SOURCES:BYU-CMR



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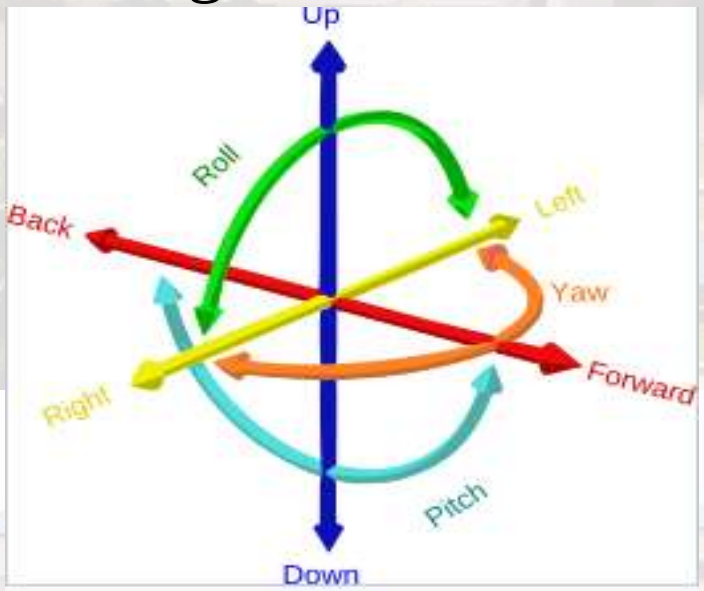
DEGREES OF FREEDOM FOR PLANE MECHANISMS

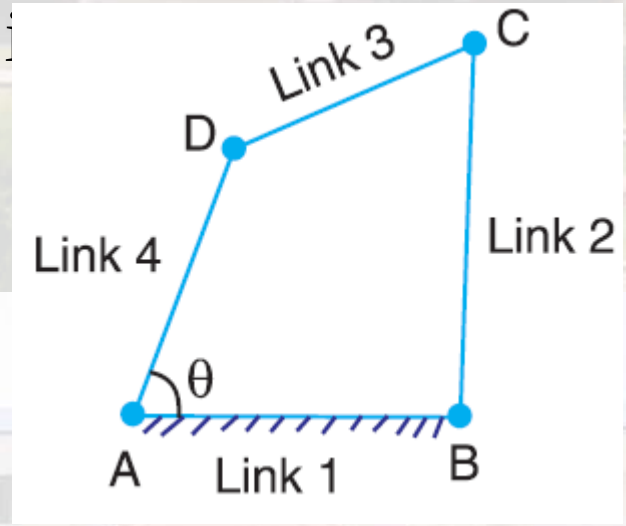
In the design or analysis of a mechanism, one of the most important concern is the number of degrees of freedom (also called movability) of the mechanism.



SOURCE: YAW

DEGREES OF FREEDOM FOR PLANE MECHANISMS

Consider a four bar chain, as shown in Figure (a). A little consideration will show that only one variable such as Θ is needed to define the relative positions of all the links. In other words, we say that the number of degrees of freedom of a four bar chain i

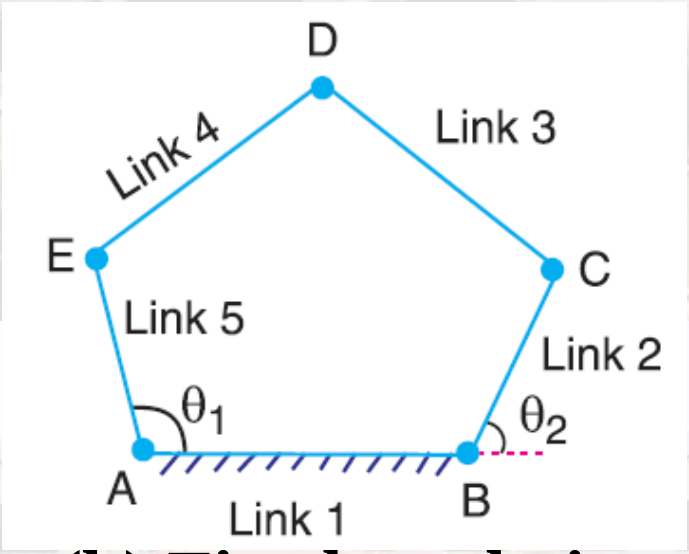


SOURCE: Khurmi R S

(a) Four bar chain

DEGREES OF FREEDOM FOR PLANE MECHANISMS

Let us consider a five bar chain, as shown in Figure (b). In this case two variables such as Θ1 and Θ2 are needed to define completely the relative positions of all the links. Thus, we say that the number of degrees of freedom is two.



SOURCE: Khurmi R S

(b) Five bar chain

APPLICATION OF KUTZBACH CRITERION TO MECHANISMS

We have discussed in the previous article that Kutzbach criterion for determining the number of degrees of freedom or movability (n) of a plane mechanism is

$n = 3(l - 1) - 2j - h$

Where, n = no of degrees of freedom or movability

l = no of links

j = no of joints

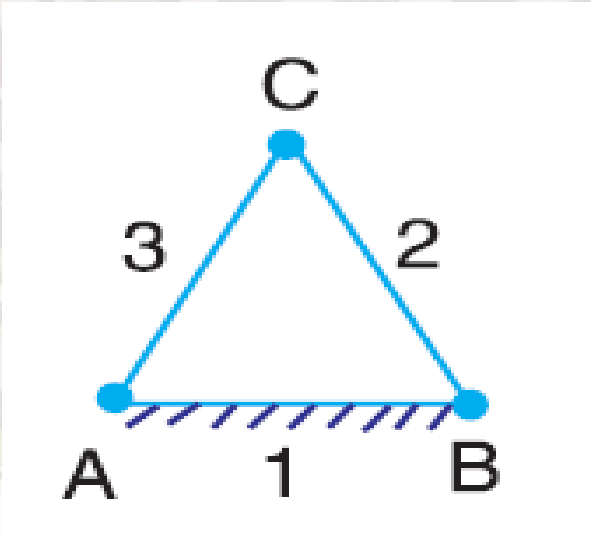
h = no of higher Pairs

APPLICATION OF KUTZBACH CRITERION TO MECHANISMS

1. The mechanism, as shown in Figure (a), has three links and three binary joints, i.e.

$l = 3$ and $j = 3$.

$n = 3 (3 – 1) – 2 \times 3 = 0$



SOURCE: Khurmi R S

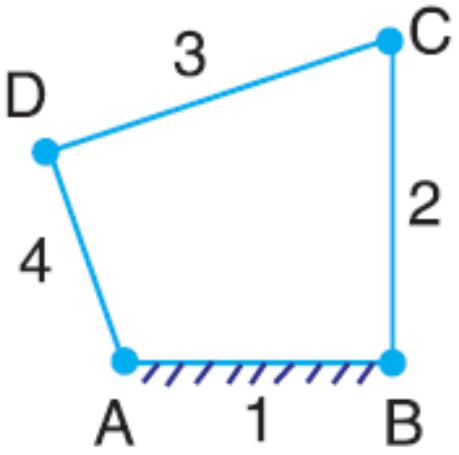
(a) THREE BAR MECHANISM

BOARD USAGE ALSO

APPLICATION OF KUTZBACH CRITERION TO MECHANISMS

2. The mechanism, as shown in Figure (a), has four links and four binary joints, i.e. $l = 4$ and $j = 4$.

$n = 3(4 - 1) - 2 \times 4 = 1$



SOURCE: Khurmi R S

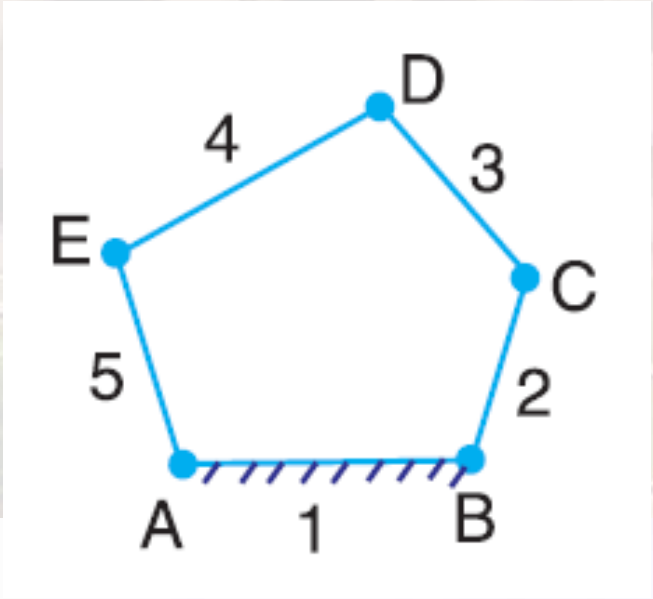
(a) FOUR BAR MECHANISM

BOARD USAGE ALSO

APPLICATION OF KUTZBACH CRITERION TO MECHANISMS

3. The mechanism, as shown in Figure (a), has five links and five binary joints, i.e. $l = 5$, and $j = 5$.

$n = 3(5 - 1) - 2 \times 5 = 2$



SOURCE: Khurmi R S

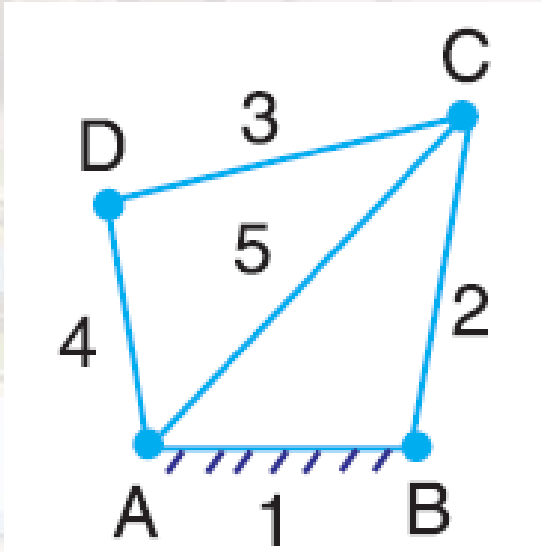
(a) FIVE BAR MECHANISM

BOARD USAGE ALSO

APPLICATION OF KUTZBACH CRITERION TO MECHANISMS

4. The mechanism, as shown in Figure (a), has five links and six equivalent binary joints (because there are two binary joints at B and D, and two ternary joints at A and C), i.e. $l = 5$ and $j = 6$.

$n = 3(5 - 1) - 2 \times 6 = 0$



SOURCE: Khurmi R S

(a) FIVE BAR MECHANISM

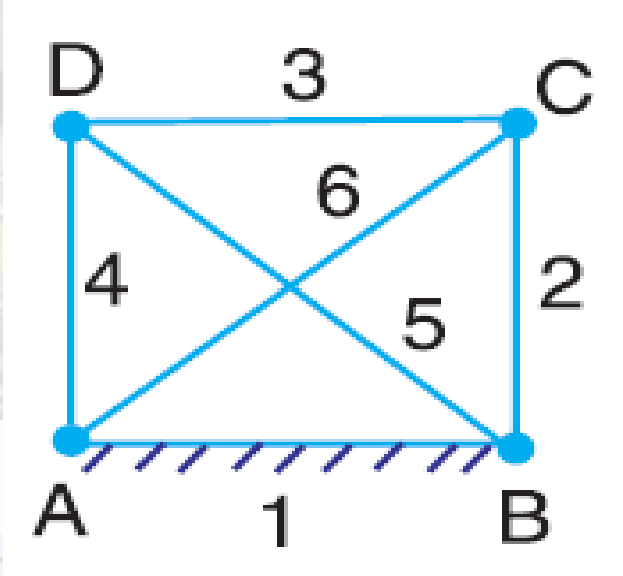
BOARD USAGE ALSO

APPLICATION OF KUTZBACH CRITERION TO MECHANISMS

5. The mechanism, as shown in Figure (a), has six links and eight equivalent binary joints (because there are four ternary joints at A, B, C and D),

i.e. $l = 6$ and $j = 8$.

$n = 3(6 - 1) - 2 \times 8 = -1$



SOURCE: Khurmi R S

(a) SIX BAR MECHANISM

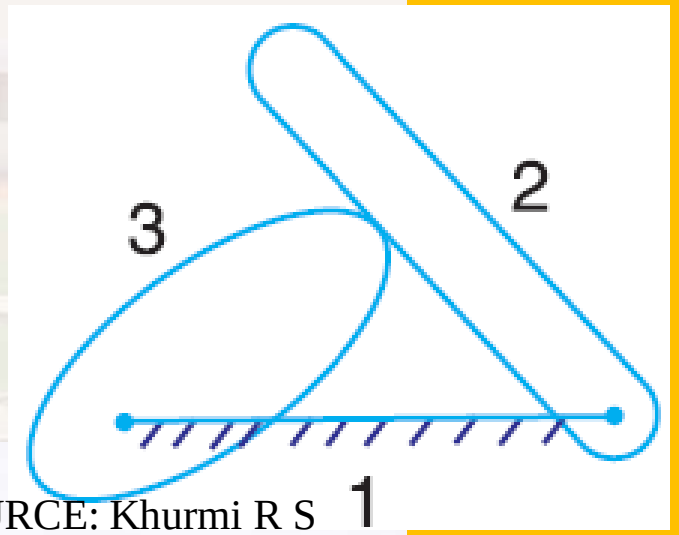
BOARD USAGE ALSO

APPLICATION OF KUTZBACH CRITERION TO MECHANISMS

The application of Kutzbach's criterion applied to mechanisms with a higher pair or two degree of freedom joints is shown in Figure (a).

In Figure (a), there are three links, two binary joints and one higher pair, i.e. $l = 3$, j = 2 and h = 1.

$$n = 3 (3 - 1) - 2 \times 2 - 1 = 1$$



SOURCE: Khurmi R S

FIGURE (a)

BOARD USAGE ALSO

SOURCE: Khurmi R S

ASSESMENT QUESTION

1. Calculate the number of degrees of freedom involved in Figure (a)

SOURCE: Khurmi R S

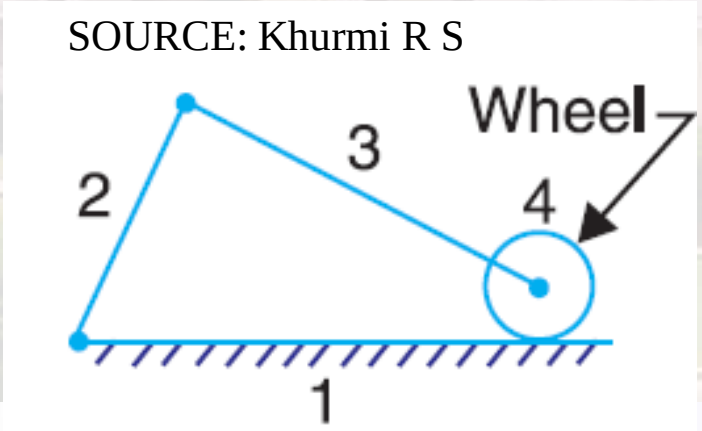


FIGURE (a)

SOURCE: WEB