

# 052 ME 33 Theory of Machines

## Unit 1: Basics of Mechanisms

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# Contents ..

## Unit I: Basics of Mechanisms

- Terminology and definitions - degree of freedom mobility (Kutzbach criterion & Grashoff's Law)  
Kinematic Inversions of 4-bar chain and slider crank chains – Mechanical advantage – Transmission angle – Description of common mechanisms – single, double and offset slider mechanism – quick return mechanism – snap-action mechanism – Linear actuators – motion adjustment mechanism, clamping mechanisms – ratchets and escapements – Indexing mechanisms, rocking mechanisms – straight line generators – design of crank – rocker mechanisms.



# Learning Objectives...

After completion of this unit, the students should be able to:

- Define underlying terminologies
- Explain basic theory of machine
- Enumerate rigid links and types of joints within mechanisms.
- Calculate mobility (i.e., the number of degrees-of-freedom) of mechanisms.
- State Grashof's law & its applications; and inversions of 4-bar mechanisms
- Determine transmission angle and mechanical advantage
- Describe different kinds of common mechanisms.

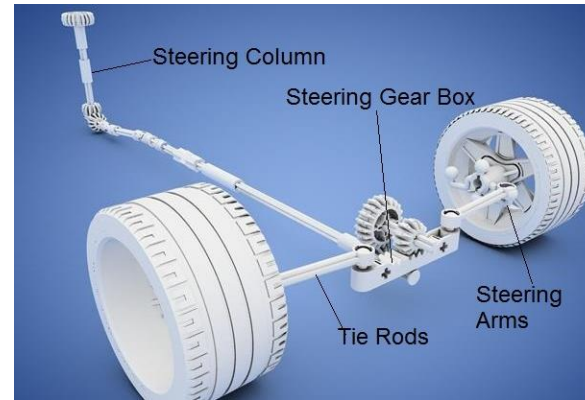


## Lesson 1

# Terminology and Definitions

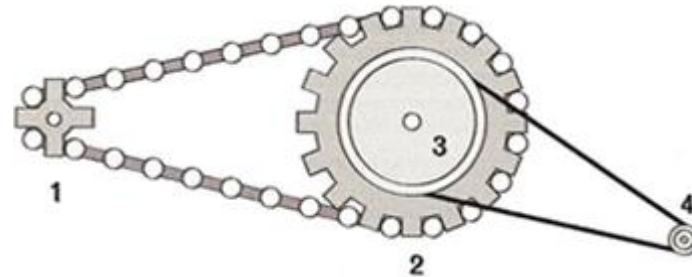


# Terminology and Definitions ...



## Mechanism ..

is a combination of **rigid bodies** which are formed and connected together by some means, so that **they moves to perform some functions**, such as locking doors, steering wheels or driving wheels.



# Terminology and Definitions ...

- **Rigid body:** is a body whose changes in shape are negligible compared with its overall dimensions or with the changes in position of the body as a whole when force is applied, e.g. a **link**, flywheel, .....etc.



- **Links:** are common rigid bodies ... have hinged holes or slots for connecting together the bodies by some means to constitute a mechanism/... to transmit motion or forces ...



# Terminology and Definitions ...

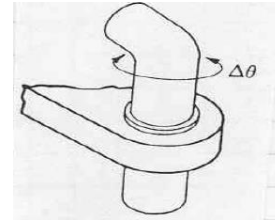
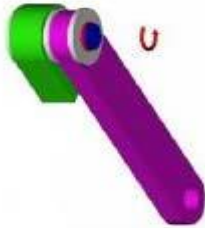
## Terminology of Joints ... ..

- DoF of a rigid body is defined as the **number of independent movements** that the body has.
- A *joint* (also known as *a kinematic pair*) is a connection between *two or more links* at their nodes, which may allow motion between the links.
- A *full joint* has *one DoF*; a *half joint* has *two DoFs*.
- *Full joints* are further categorized as *lower pairs* whilst *half-joints* are *higher pairs* and allow both rotation and translation (roll-slide).
- A *lower pair* is a joint with *surface contact*; a *higher pair* is a joint with *point or line contact*.

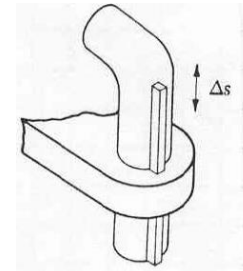
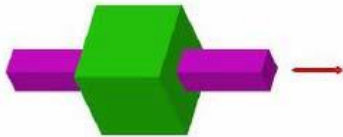


# Terminology and Definitions ...

Joints/kinematic pairs....



- A turning or revolute pair : 1 DoF, permits only relative rotation

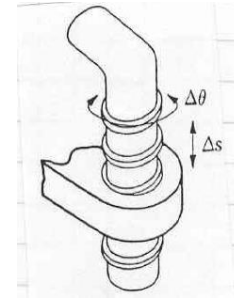
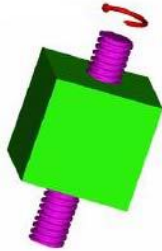


- Prismatic pair: 1 DoF, permits only relative sliding motion (often a sliding joint)

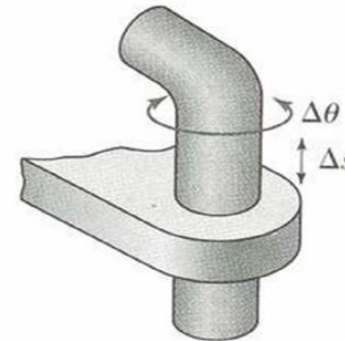
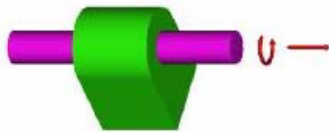


# Terminology and Definitions ...

Joints/kinematic pairs....



- A screw/helix/helical pair: 1 DoF (because the sliding and rotational motions are related by helix angle & thread)

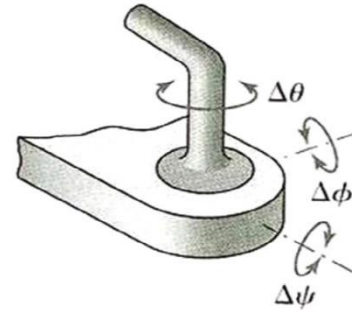


- A cylindrical joint has: 2 DoF (1 translational, 1 rotational), permits both angular and an independent sliding motion

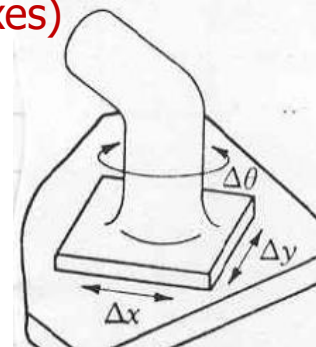
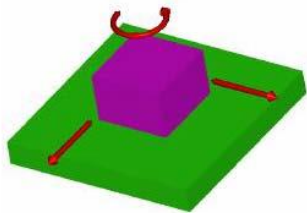


# Terminology and Definitions ...

Joints/kinematic pairs....



- A spherical/globular joint has: 3 DOF (ball and socket joint that has rotation about each of the coordinate axes)

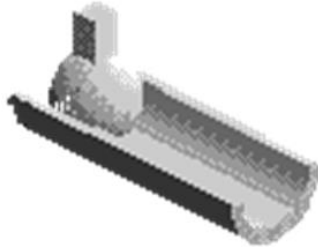


- A flat/planar pair: 3 DoF (1 rotation, 2 translations), seldom found in common mechanisms

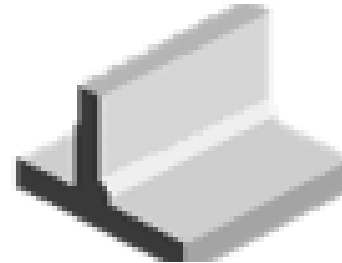
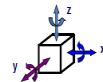


# Terminology and Definitions ...

Joints/kinematic pairs....



- A 4 DoF joint/pair



- A 0 DoF joint/pair



- A 5 DoF joint/pair

Kinematic Pair	Symbol	Joint DOF	Rotational	Translational
Revolute	$R$	1	1	0
Prismatic	$P$	1	0	1
Cylindric	$C$	2	1	1
Helical	$H$	1	1	coupled
Spherical	$S$	3	3	0
Plane	$E$	3	1	2
Gear Pair	$G$	2	1	1
Cam Pair	$C_p$	2	1	1



# Summary

End...

Any Questions?



# Lesson 1 Revision Problems

1. Define the following terms:

- a) Rigid body
- b) Link
- c) Degree of freedom
- d) Full joint
- e) Revolute pair

