



SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
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DEPARTMENT OF AGRICULTURE ENGINEERING

R2019-MACHINE DESIGN

II YEAR IV SEM

UNIT 4 –Fundamentals of Theory of Machines

TOPIC –Linkages & Mechanisms



MECHANICS

Science dealing with motion

DIVISIONS OF MECHANICS

Statics – Deals with systems which are not changing with time.

Dynamics – Deals with systems which are changing with time.



DIVISIONS OF DYNAMICS

KINEMATICS – Deals with Motion and Time
(Kinema – Greek Word – Motion)

KINETICS – Deals with Motion, Time and Forces.

| | | |
|------------------|------------------|----------------|
| Statics | Kinematics | Kinetics |
| STRUCTURE | MECHANISM | MACHINE |



Some Definitions

- Machine – device to transfer or transform energy to do useful work.
- Mechanism – device to transfer or transform given input motion to specified output motion
- Structure – a single body with no motion / combination of bodies with no relative motion

Classification of Mechanisms

Based on the nature of output speed

Uniform motion mechanism

Non-uniform motion mechanism

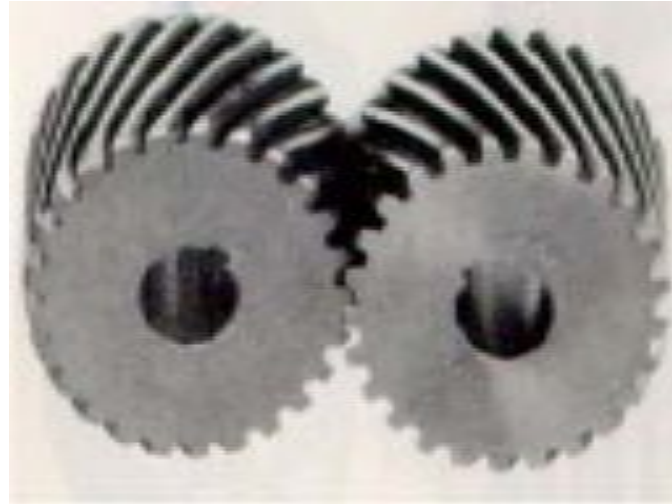


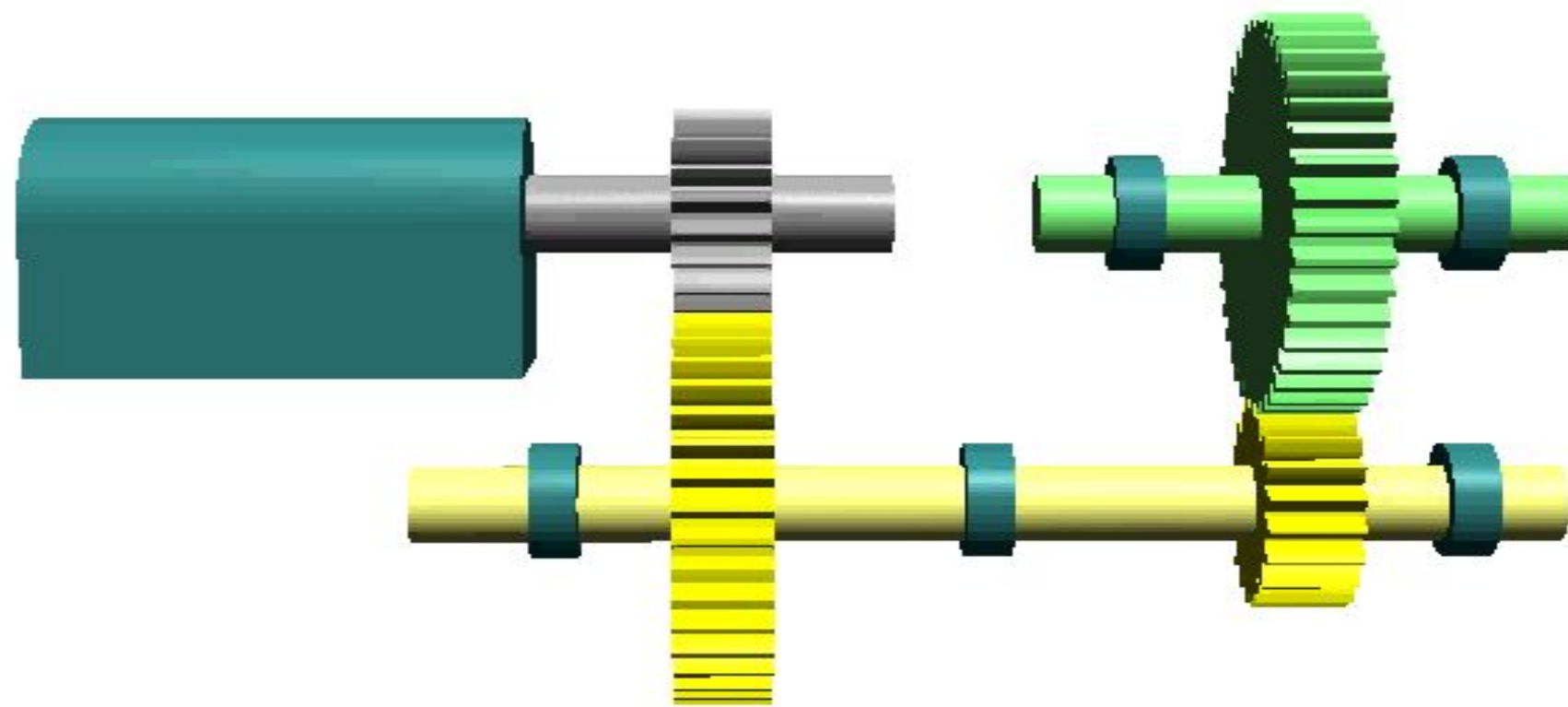
Uniform Motion Mechanisms



Uniform Motion – Equal Displacement For
Equal Time Interval

Examples : All Gear Drives
All Chain Drives
Belt Drives without slip





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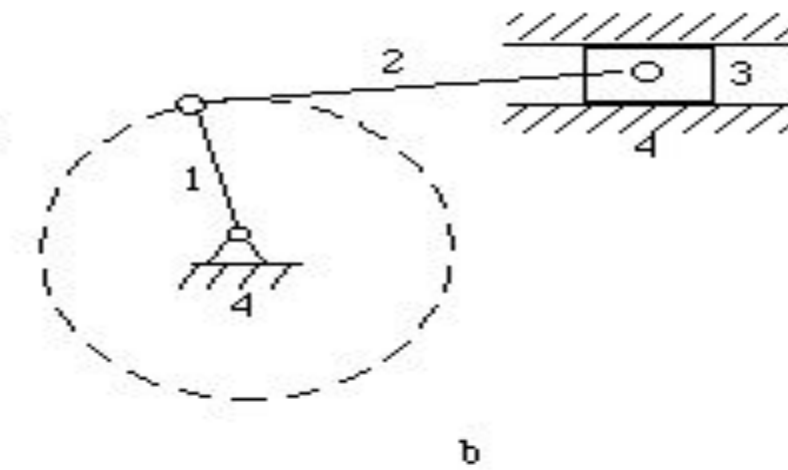
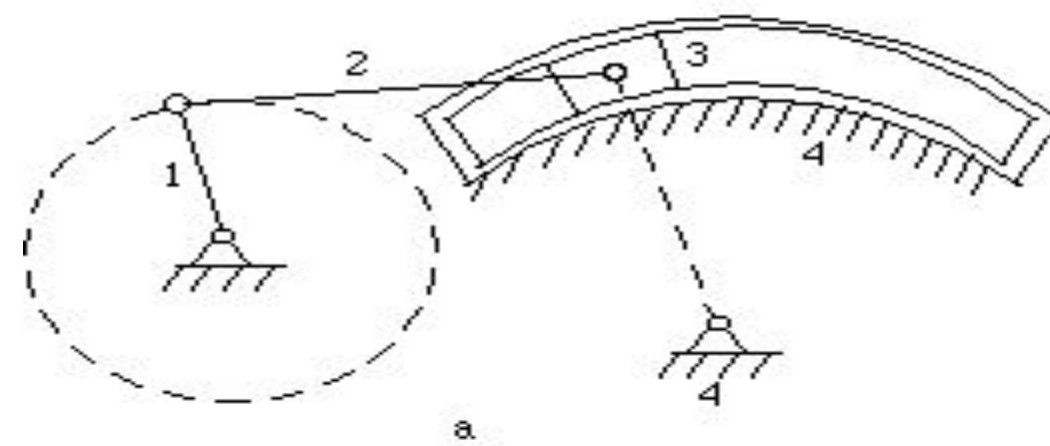
gear_train

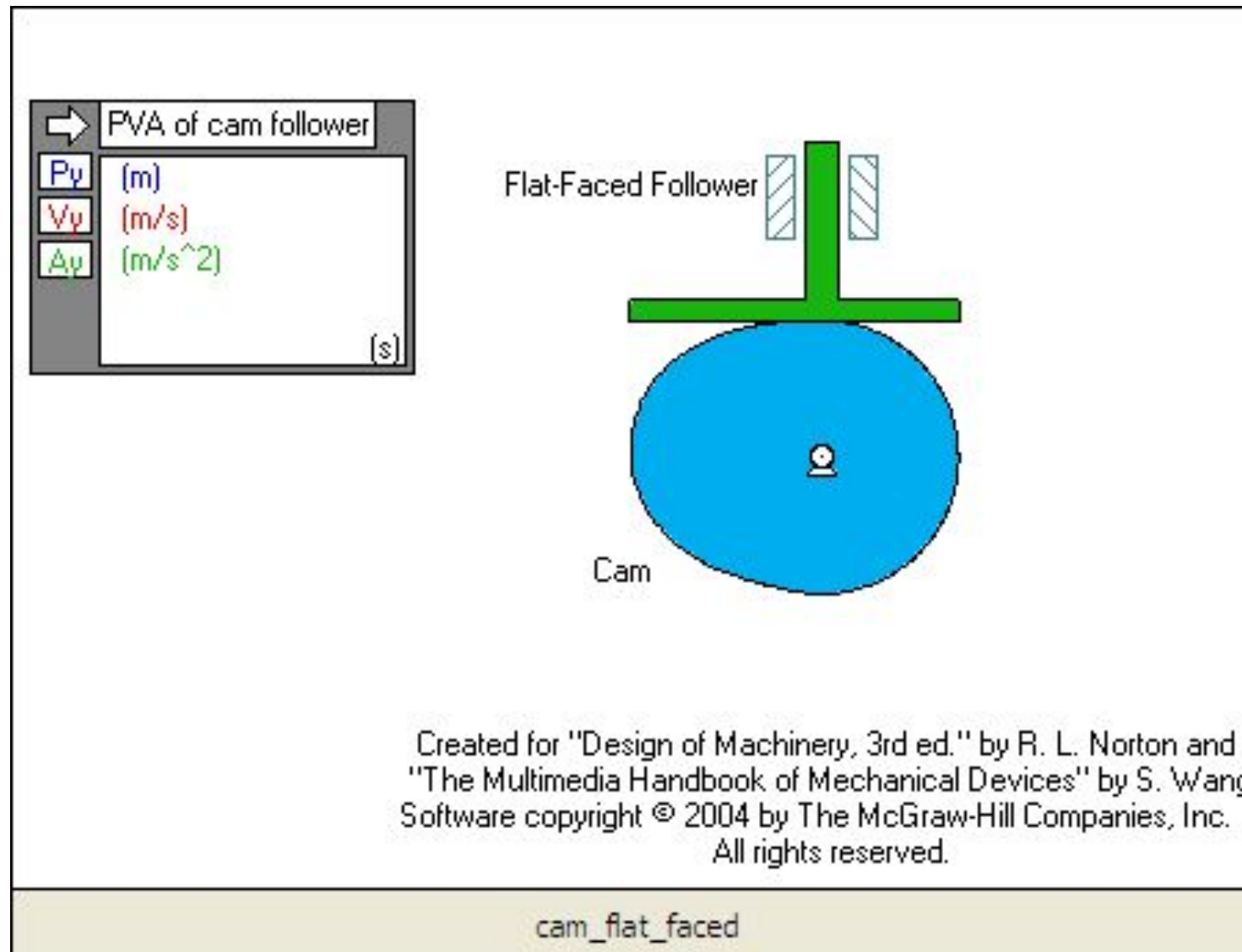


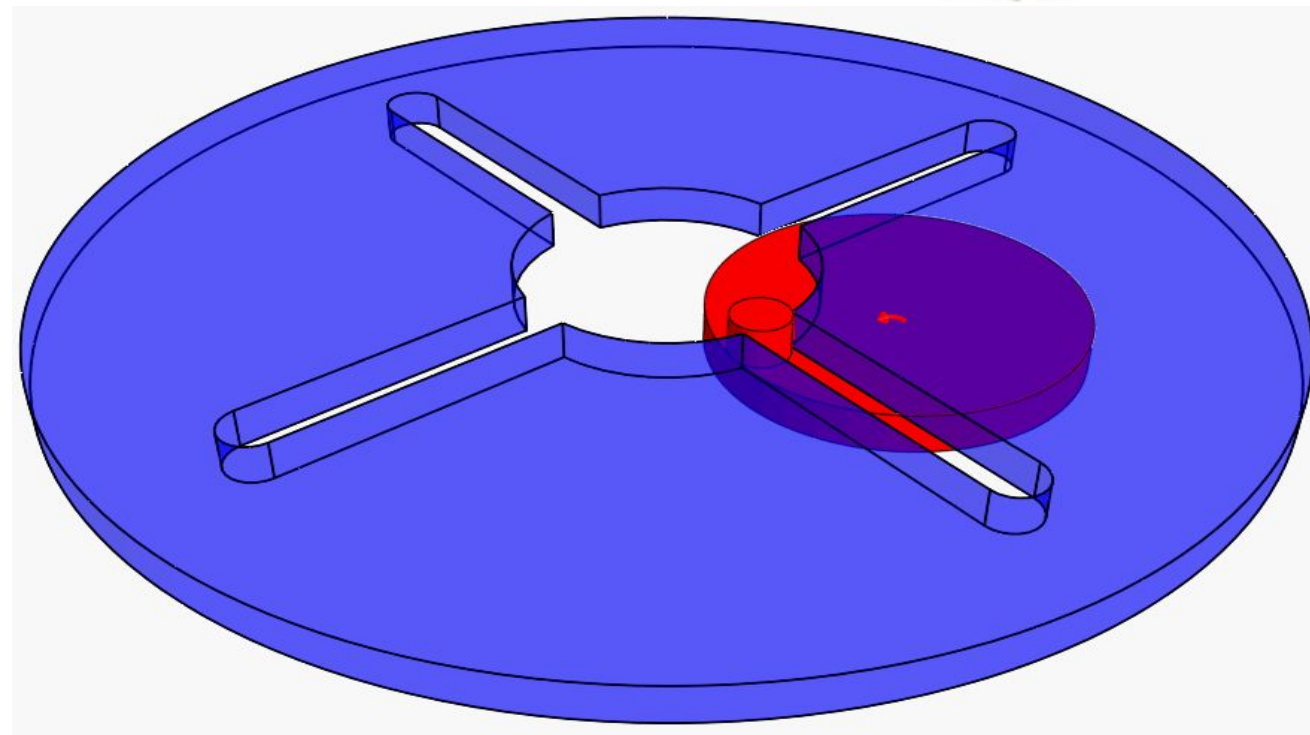
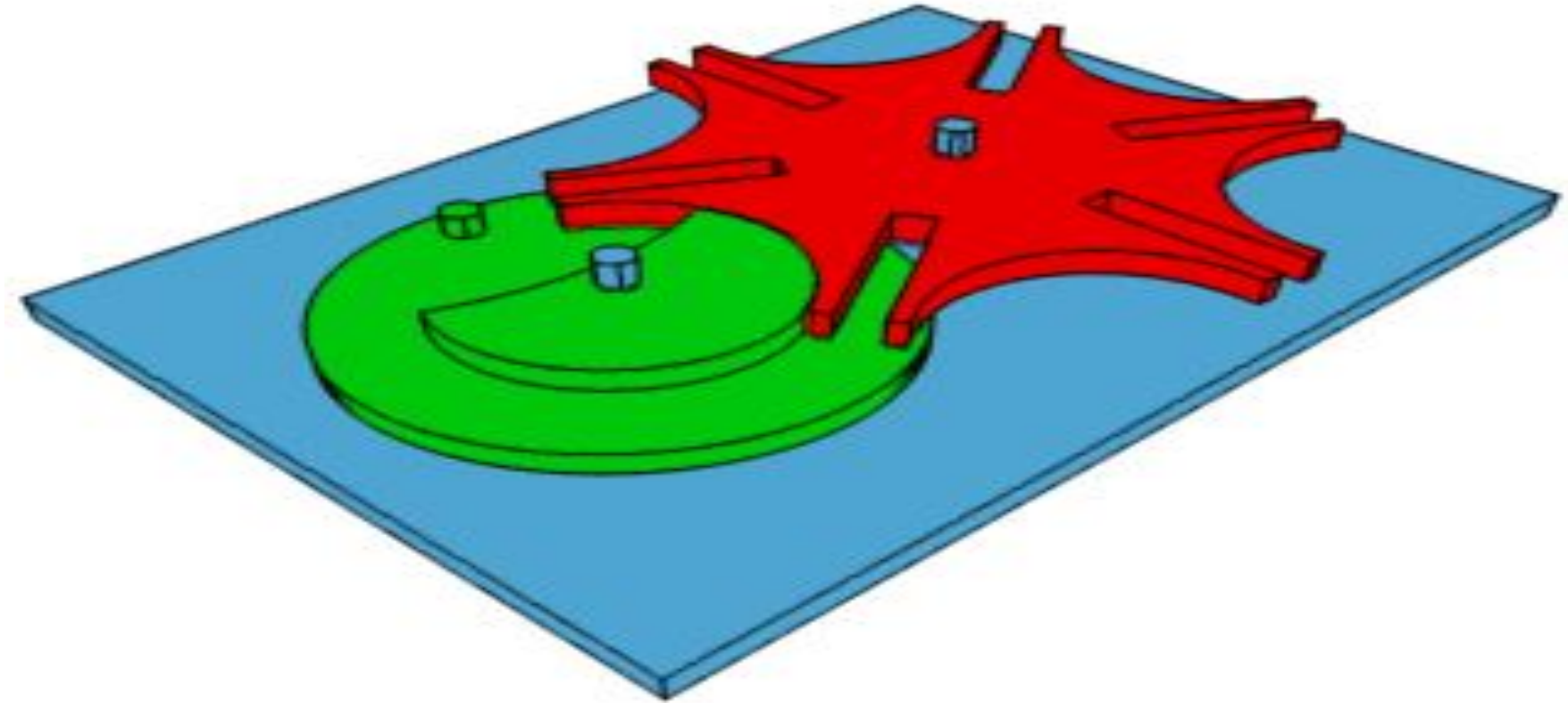
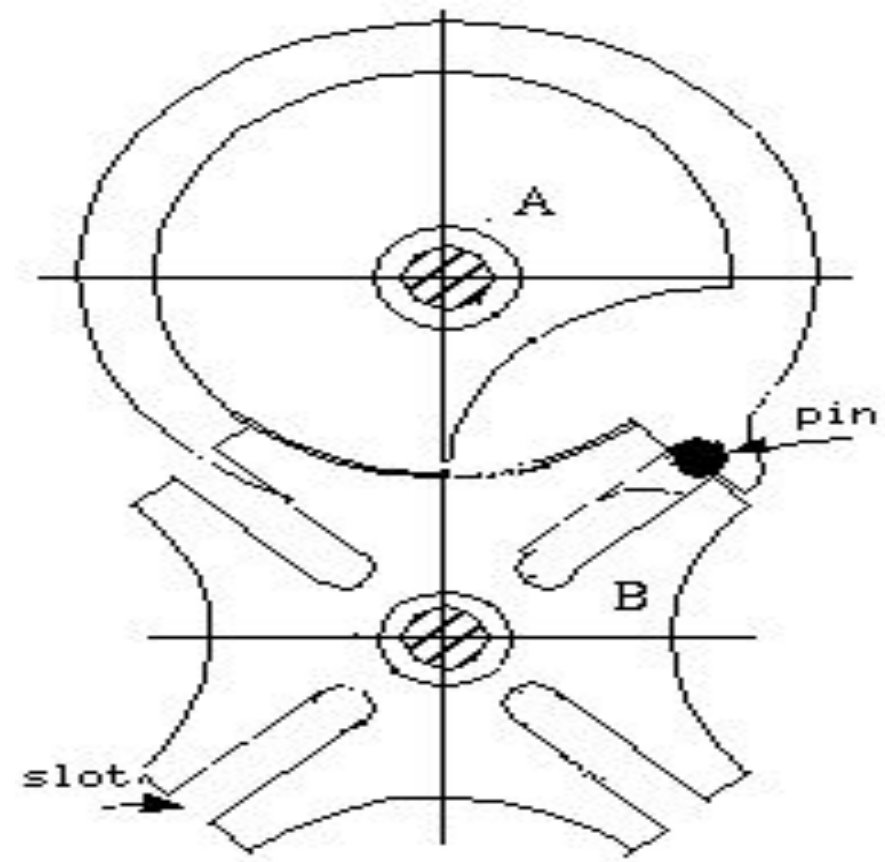
Non-Uniform Motion Mechanisms

Non-Uniform Motion – Unequal Displacement For Equal Time Interval

Examples : Linkage Mechanisms
Cam Mechanisms
Geneva Wheel









Mobility / D.O.F of Mechanism

- No. of inputs required to get a constrained mechanism (or) no. of position variables needed to sketch the mechanism with all link lengths known.

- **KUTZBACH CRITERION FOR PLANAR MECHANISM**

- $$F = 3(n-1) - 2P_1 - 1P_2$$

- F – D.O.F n – No. of links

- P_1 – No. of kinematic pairs with 1 D.O.F.

- P_2 – No. of kinematic pairs with 2 D.O.F.



Classification of mechanisms



Based on mobility (D.O.F) of the mechanism

1. Considering the D.O.F. of output only
 - a) Constrained Mechanism
 - b) Unconstrained Mechanism
2. Considering the sum of the D.O.F. Of input and output motions
 - a) Single (one) d.o.f. mechanism
 - b) Multi-d.o.f. mechanism



Constrained Mechanism



- One independent output motion. Output member is constrained to move in a particular manner only.

Example: Four-bar mechanism

Slider Crank Mechanism

Five-bar mechanism with two inputs



Unconstrained mechanism



- Output motion has more than one D.O.F.

Example: Automobile Differential during turning the vehicle on a curve

Five-bar mechanism with one input



Single D.O.F Mechanism

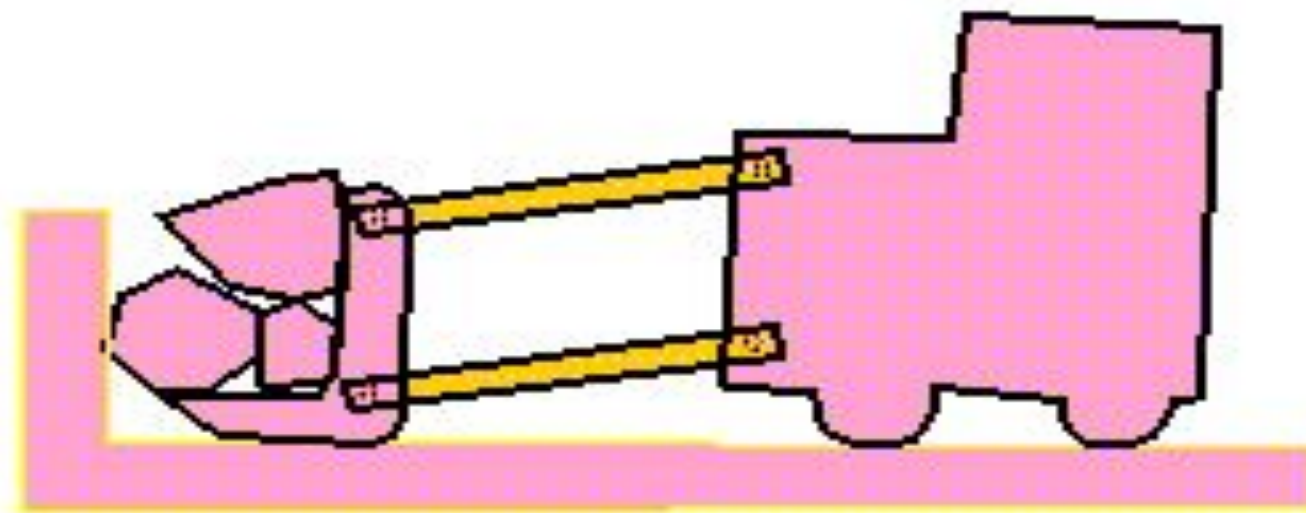


Sum of the input and output D.O.F. is two.

Single D.O.F. Motion - One Independent Input motion and one independent output motion

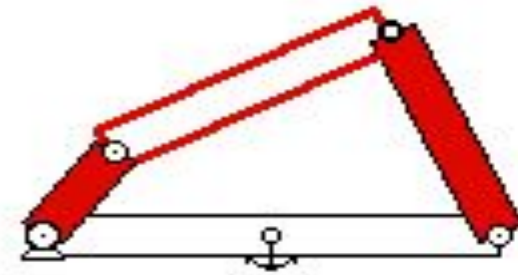
Examples : Four-Bar Mechanism

Cam-Follower Mechanism

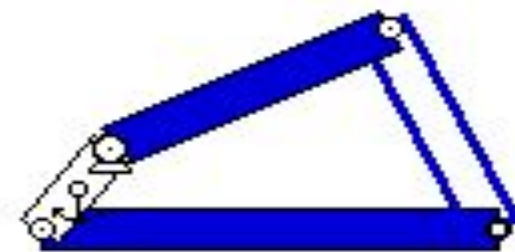
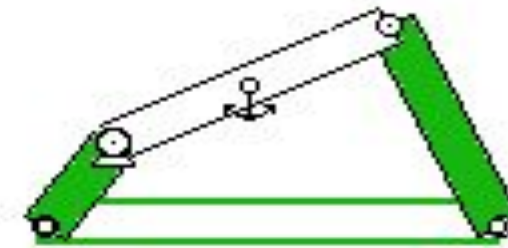




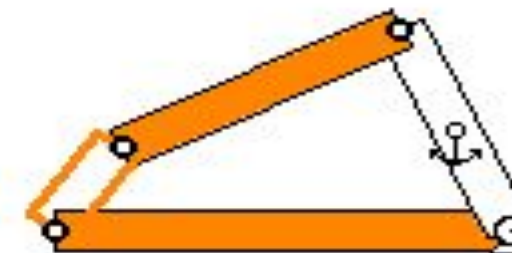
All inversions of the Grashof fourbar linkage



Two non-distinct crank-rocker inversions



Double-crank inversion
(drag link)



Double-rocker inversion
(coupler rotates)

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grashof_inversion



Multi D.O.F. Mechanism



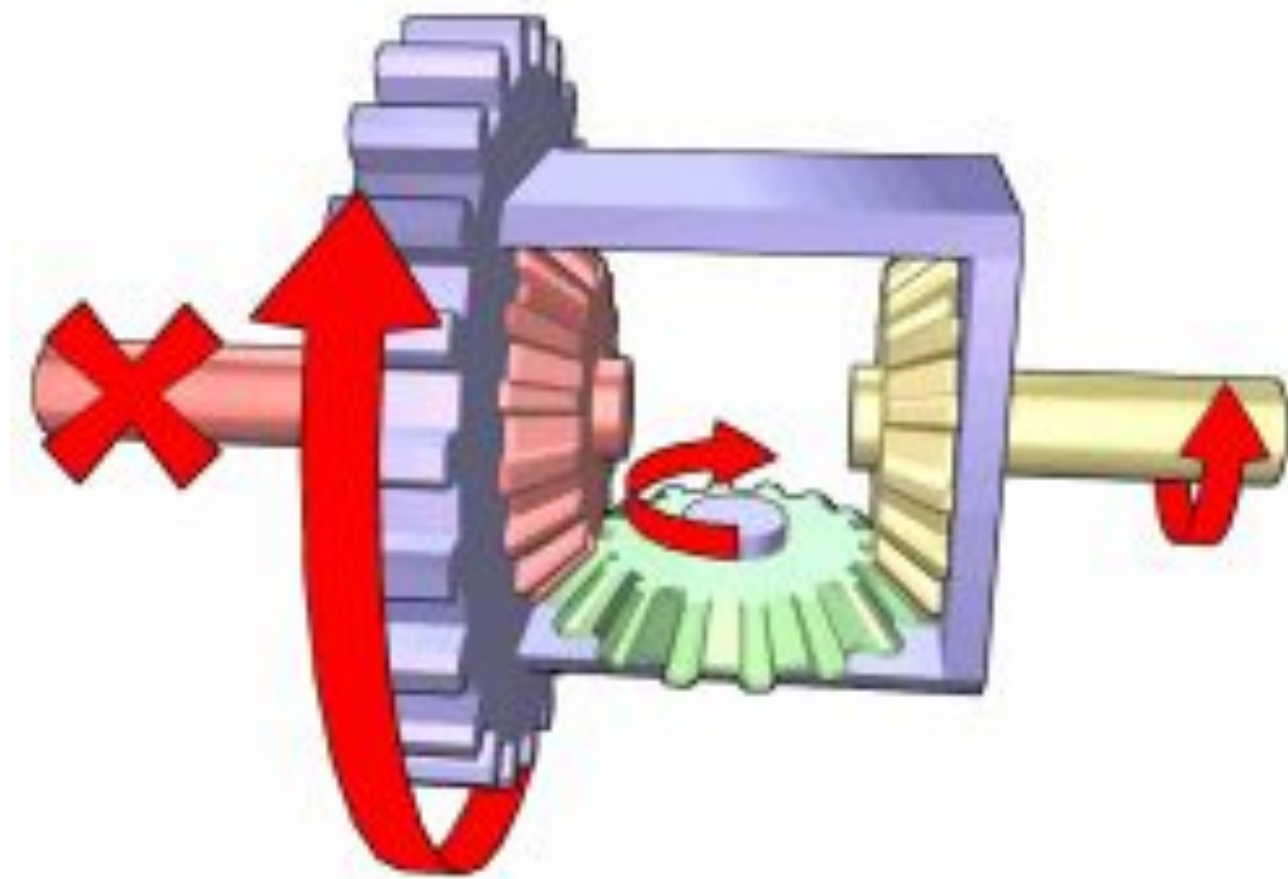
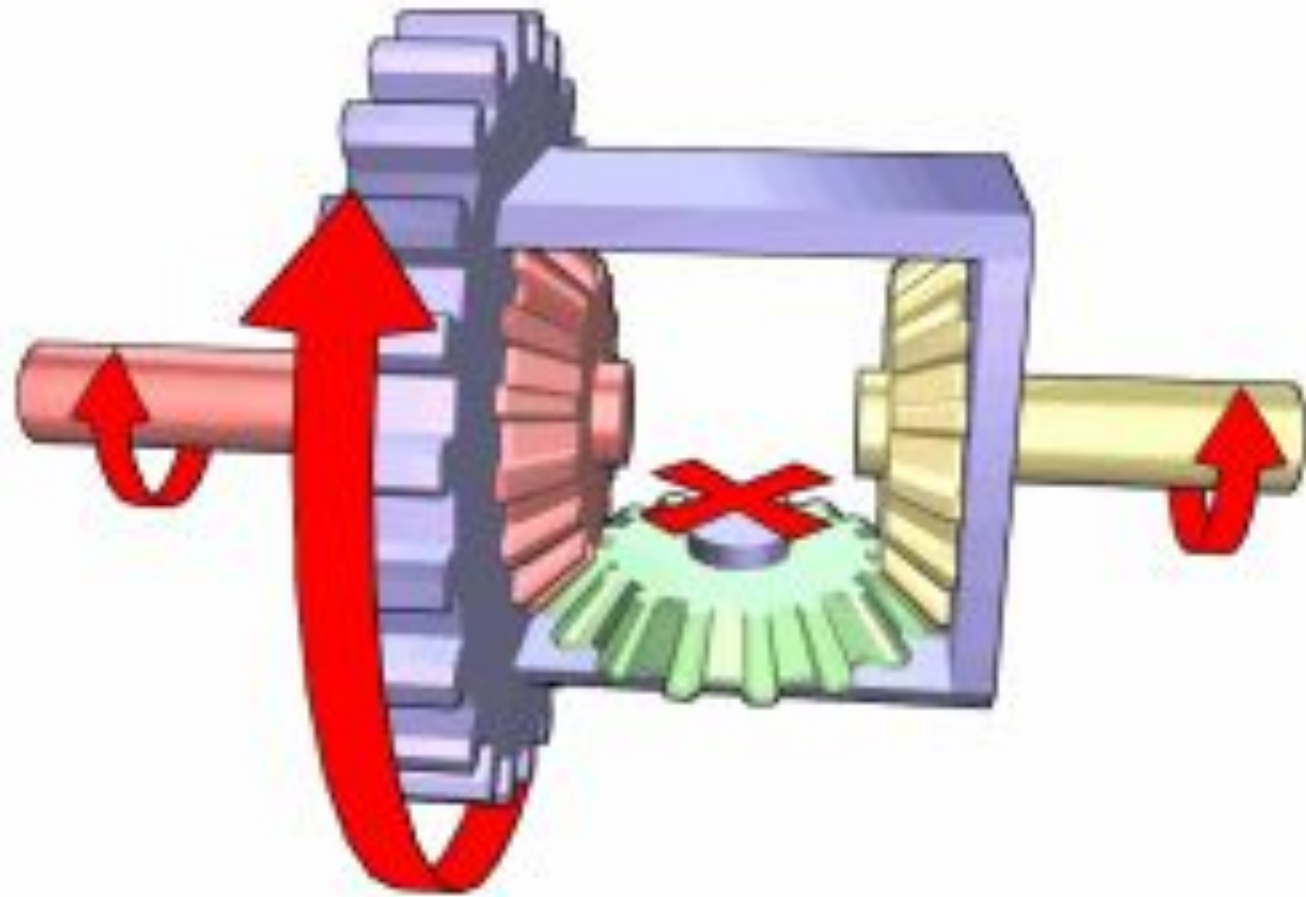
Sum of the input and output motion D.O.F. is more than two.

Multi D.O.F. Motion – More than one Independent Output / Input Motions

Examples : Automobile Differential

3-D Cam Mechanism (Camoid)

Five-Bar Mechanism





Classification of Mechanisms



Based on position occupied in space

- Planar Mechanism
- Spherical Mechanism
- Spatial Mechanism



Planar Mechanism



Planar Motion – Particles/Points of Members move in parallel planes

Examples : Planar Four-Bar Mechanism

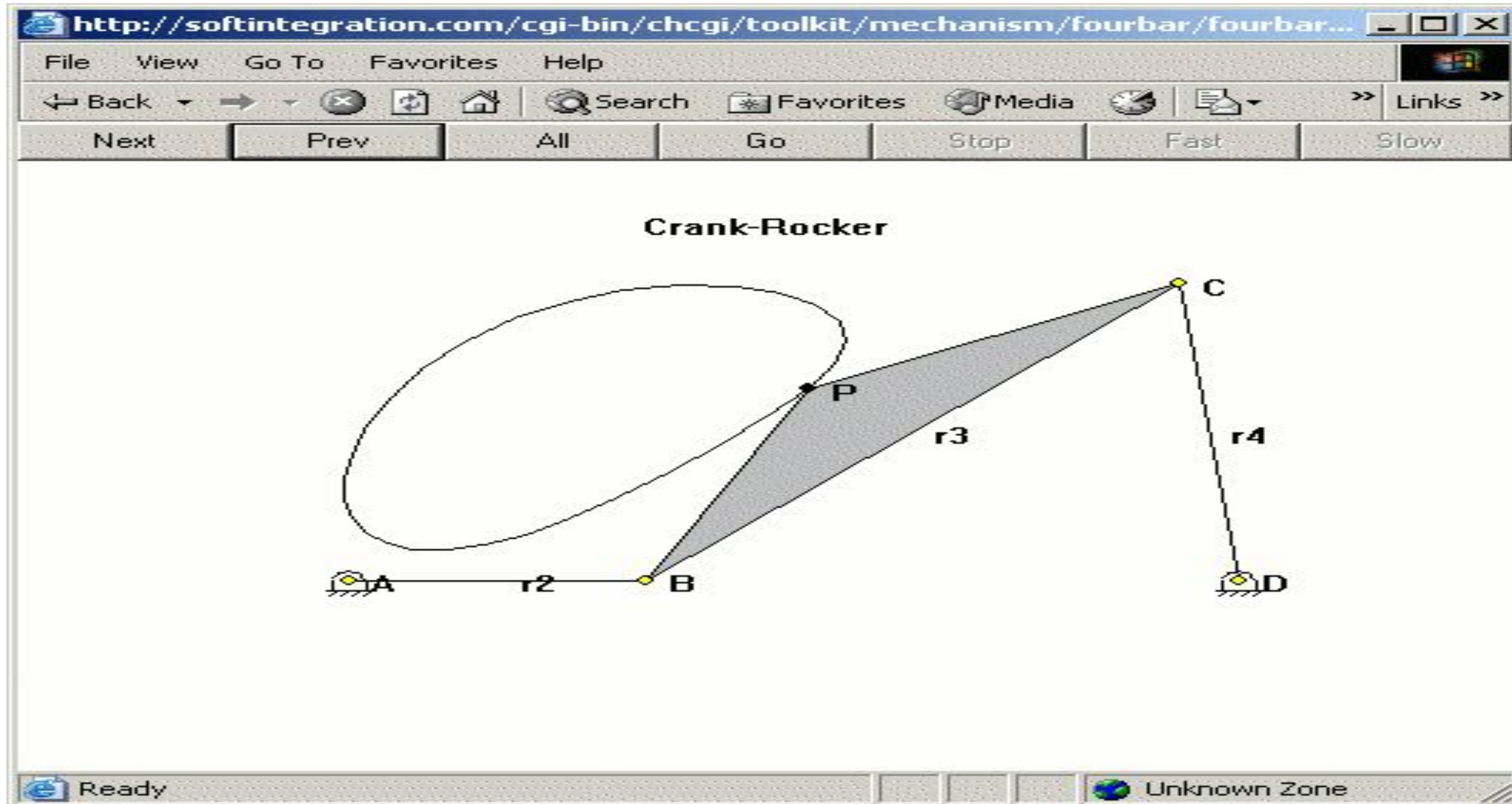
Slider Crank Mechanism

Cam-Follower Mechanism

Spur/Helical Gear Drives

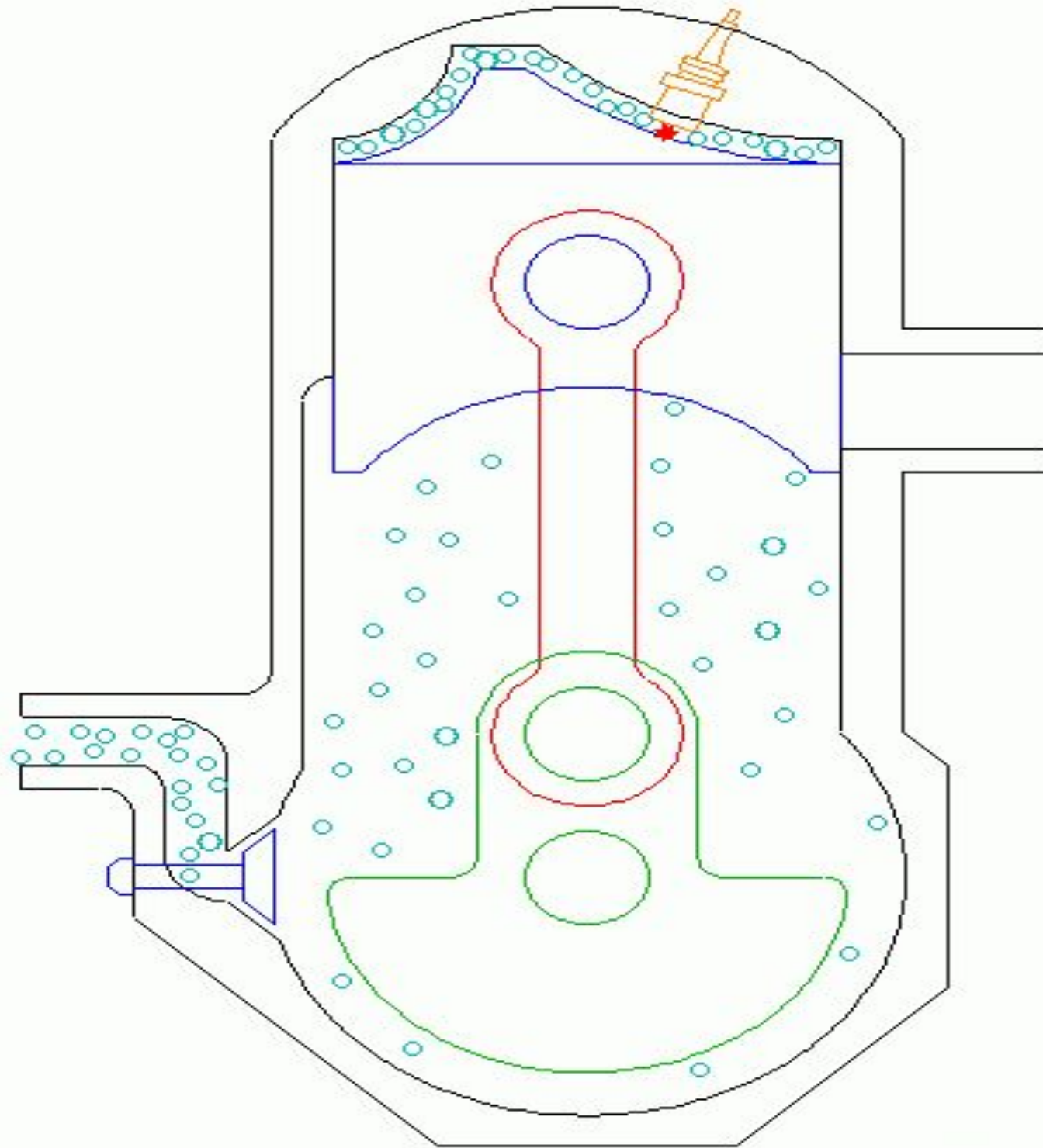


Four-bar Crank Rocker and Coupler Curve

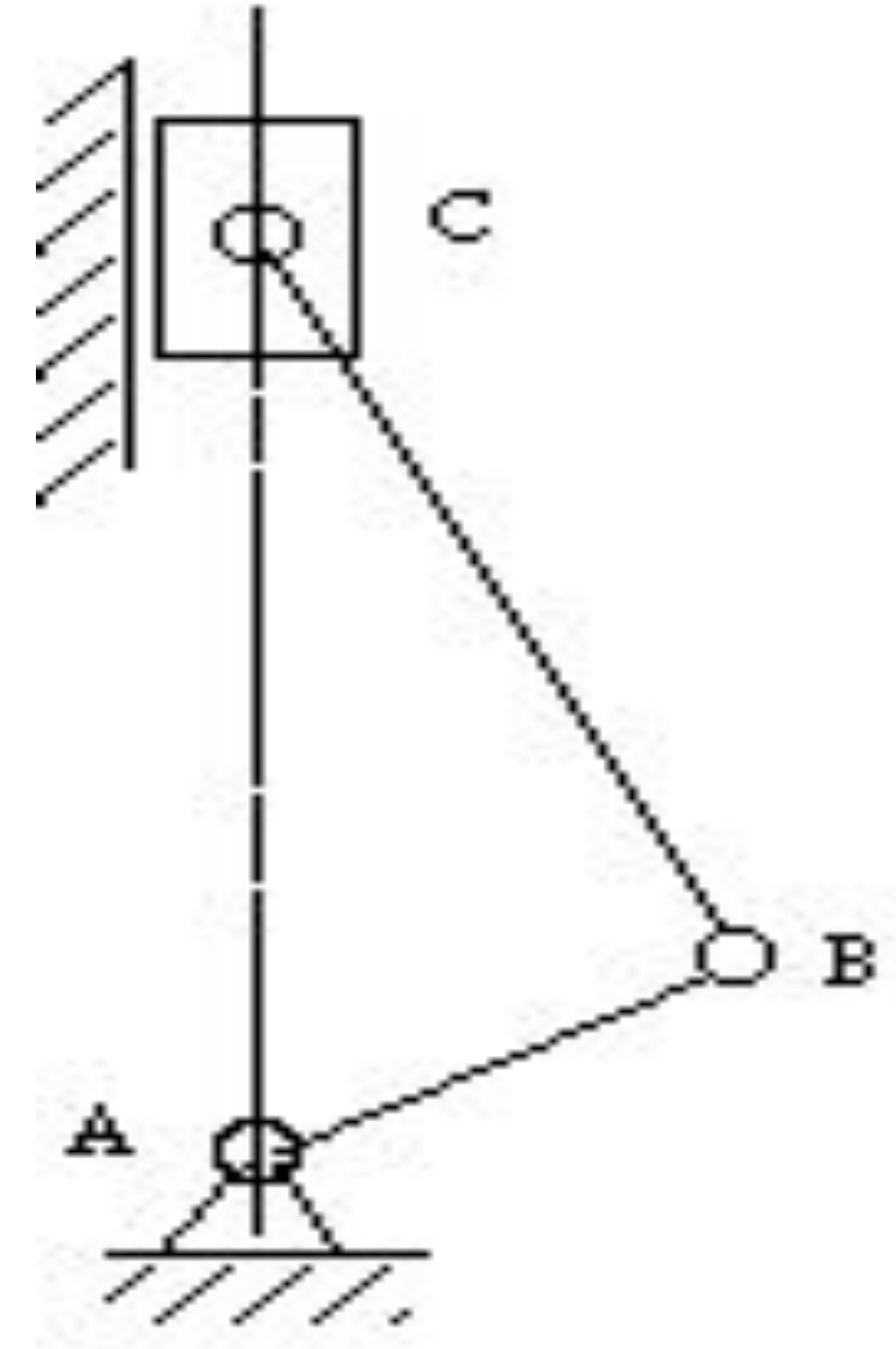




Two Stroke Engine



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Spherical Mechanism

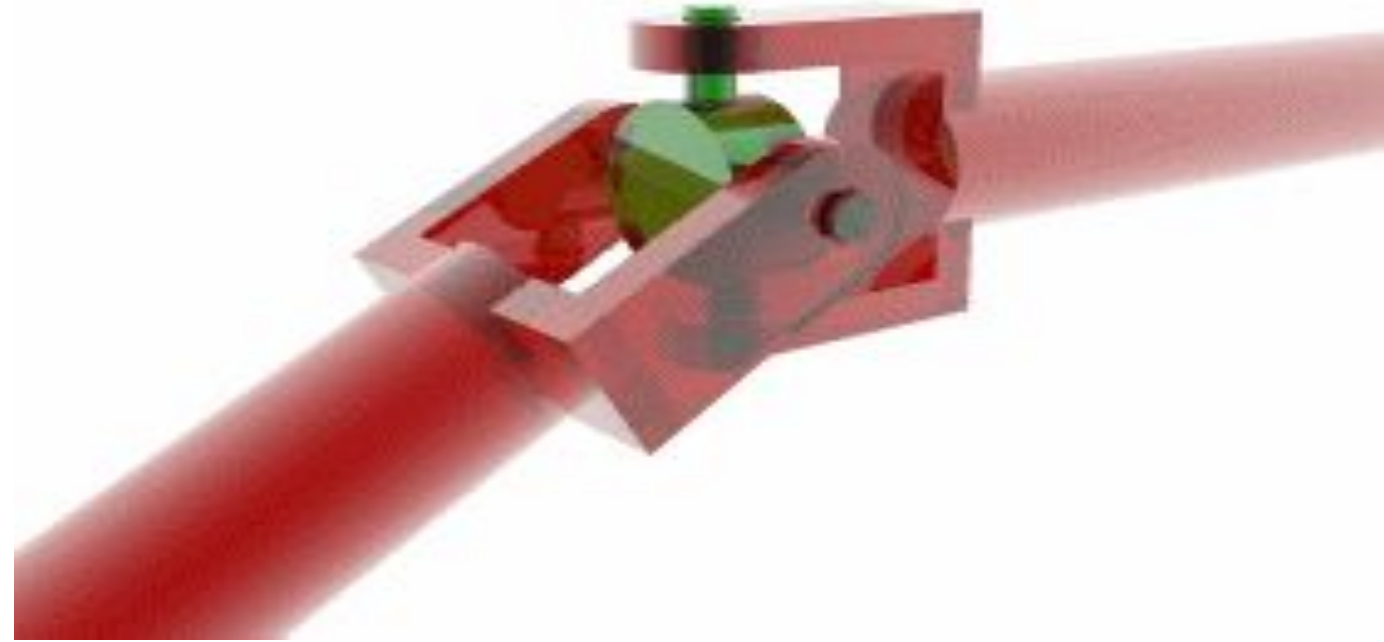


Spherical Motion – Points maintain Constant Distance w.r.t. a Common Centre Point in any position during motion.

Examples : Universal Joint

Bevel Gear Drive

Spherical Four-Bar Mechanism





Spatial Mechanism



- Spatial Motion – Points can occupy any position in space
- Examples :
 - Spatial Four-Bar Mechanism
 - Worm Gear Drive
 - Serial Manipulators





Classification of mechanisms



- Based on the connection of the output member

Open mechanism

Closed mechanism



Open Mechanism



- Output member not connected to the fixed link / frame

Robot arms

Arms of earth movers





Thank You