Theory of machine

If you have a smart project, you can say "I'm an engineer"

Staff boarder

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Theory of machine
MDP 234

- **Course aims:**
  - **Understand the Kinematic and Dynamic force Analysis**
  - **Understand the Graphical linkage synthesis**
  - **Create and design the Gear trains and cams.**
- **References**

•Theory of Machines , by R.S. Khurmi, J:K. Gupta, Eurasia Publishing House, 2005. (Ref-01)

•The Theory of Machines and Mechanisms, J.E.Shigley , J.J.Uicker, Second Edition, McGraw –Hill, 1995. (Ref-02)

Course plan

week	Date	Contents	Requirements	Laboratory	References	Marks	Instructor
1	14-2	Syllable/Course specs Introduction to theory of machines			Ref-01		Dr. Mostafa Elsayed
2	21-2	Degree of freedom Types of Mechanisms	Project idea and team names	DC-Motor control			
3	28-2	Absolute velocity and relative velocity Instantaneous center of velocity	Quiz			5/3 quizes	
4	7-3	Constructing velocity and acceleration diagrams		Electrical-mechanical analogy			
5	14-3	Cams Cams profile	Quiz			5/3 quizes	Prof. Dr. AbdelKader
6	21-3	Gear trains	Progress report 1	Filters			
7	28-3	Midterm				15	

Course plan

week	Date	Contents	Requirements	Laboratory	References	Marks	Instructor
8	4-4	Gear trains		DC- motor Kit	Ref-01	5	Prof. Dr. AbdelKader
9	11-4	Static force analysis	Quiz	Operational amplifier circuits		5/3 quizes	Dr. Mohamed Gamel
10	18-4	Dynamic force analysis	Progress report 2		Ref-02		
11	25-4	Balancing of rotating masses-1					
12	2-5	Balancing of rotating masses-2					
13	9-5	Governors				10 for exam 20 for project	
14	16-5	Receive project	Full report				

Evaluation rules

Report Contents

- Research plane
- Aim
- Tools/facilities
- Methodology/control strategy
- Experimental works
- Result/ conclusions

Marks distribution

Marks \ assesments	Assessments		Final Exam	Total
	• MidTerm	20	100	
	• Project	20		
	• Report	5		
	• quizes	5		
TOTAL		50	100	150

Projects

- **Mechanisms and machine projects**

- Wheelchair lift mechanism over curbs. Proj01-MDP234
- Tennis ball server. Proj02-MDP234
- Trash compactor Proj03-MDP234
- Automatic page turner. Proj04-MDP234
- Radial Compressor. Proj05-MDP234
- Rocking chair. Proj06-MDP234
- Oil crane.. Proj07-MDP234
- Flapjack production of pancakes. Proj08-MDP234
- Excavator. Proj09-MDP234
- Stewart platform. Proj10-MDP234
- Exercise machines. Proj11-MDP234
- Baby transport device (stroller) Proj12-MDP234
- Brake mechanism (drum) Proj13-MDP234
- Steering system models (Ackerman). Proj14-MDP234
- Continuous variable transmission. Proj15-MDP234

Projects

- **Mechanisms and machine projects**
  - **Project team**
    - Teams of typically of 10-12 students
    - Immediately begin to develop project ideas
    - Each team prepare a full report.

Theory of machine

- **Lecture aims:**
  - Identify the terminology for theory of machine.
  - Understand the mechanism types.
  - Understand the degree of freedom.

Introduction

Why/How do bodies move?

- **Why?**

  –The configuration of a mechanism changes in time based on **forces and motions applied to its components**

  - **Forces**

  –Internal (reaction forces)

  –External, or applied forces (gravity, compliant forces, etc.)

  - **Motions**

  –Somebody prescribes the motion of a component of the mechanical system

Introduction

Why/How do bodies move?

How?

–They move in a way that obeys Newton's second law

Caveat: there are *additional conditions (constraints) that need to be satisfied by the time evolution of these bodies, and these constraints come from the joints that connect the bodies (to be covered in detail later…)*

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.

- **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.

Introduction

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.

Introduction

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.

Introduction

Definitions

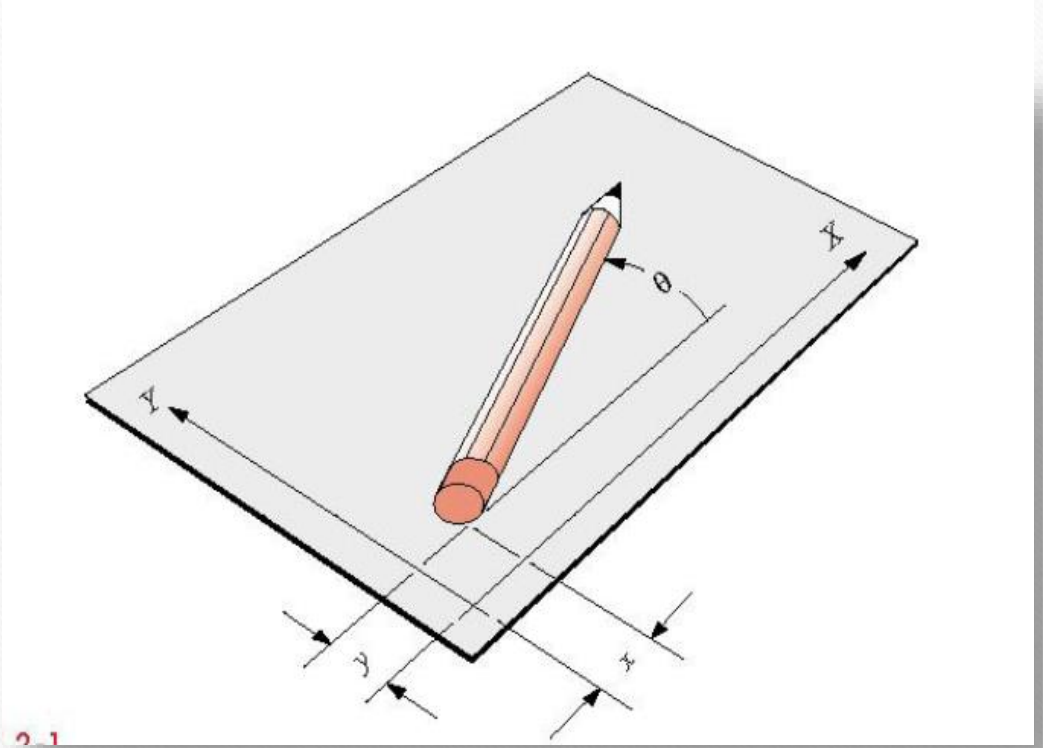
- The analysis of mechanisms is a part of machine design which is concerned with the kinematics and kinetics of mechanisms (or the dynamics of mechanisms)
- **Rigid Body: is that body whose changes in shape are negligible compared with its overall dimensions or with the changes in position of the body 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.**

Introduction

Definitions

- **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.**

Degree of Freedom (DOF) or Mobility



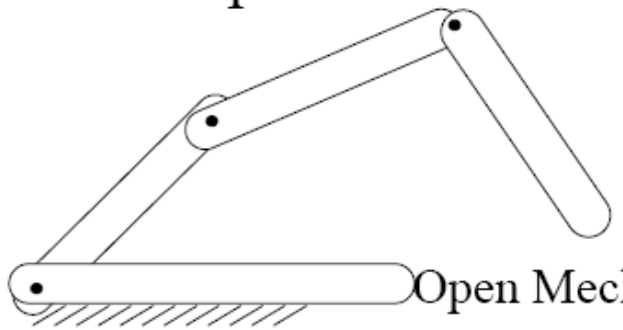
Degree of Freedom (DOF) or Mobility

- DOF –number of independent parameters (measurements) that are needed to uniquely define its position in space at any instant of time.
- Rigid body in a plane has 3 DOF. (x,y,q)
- Rigid body in space has 6 DOF (3 translation, 3 rotation)

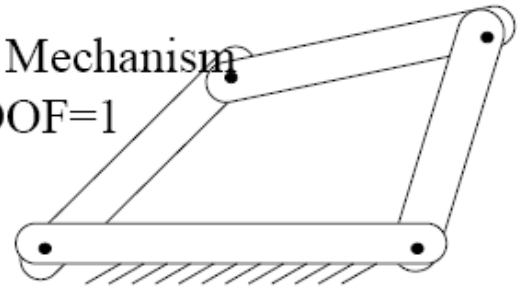
Determining Degree of Freedom

- Degree of Freedom: No. of inputs that need to be provided in order to create a predictable output;

  Also, No. of independent coordinates required to define its position
- For simple mechanisms calculating DOF is simple

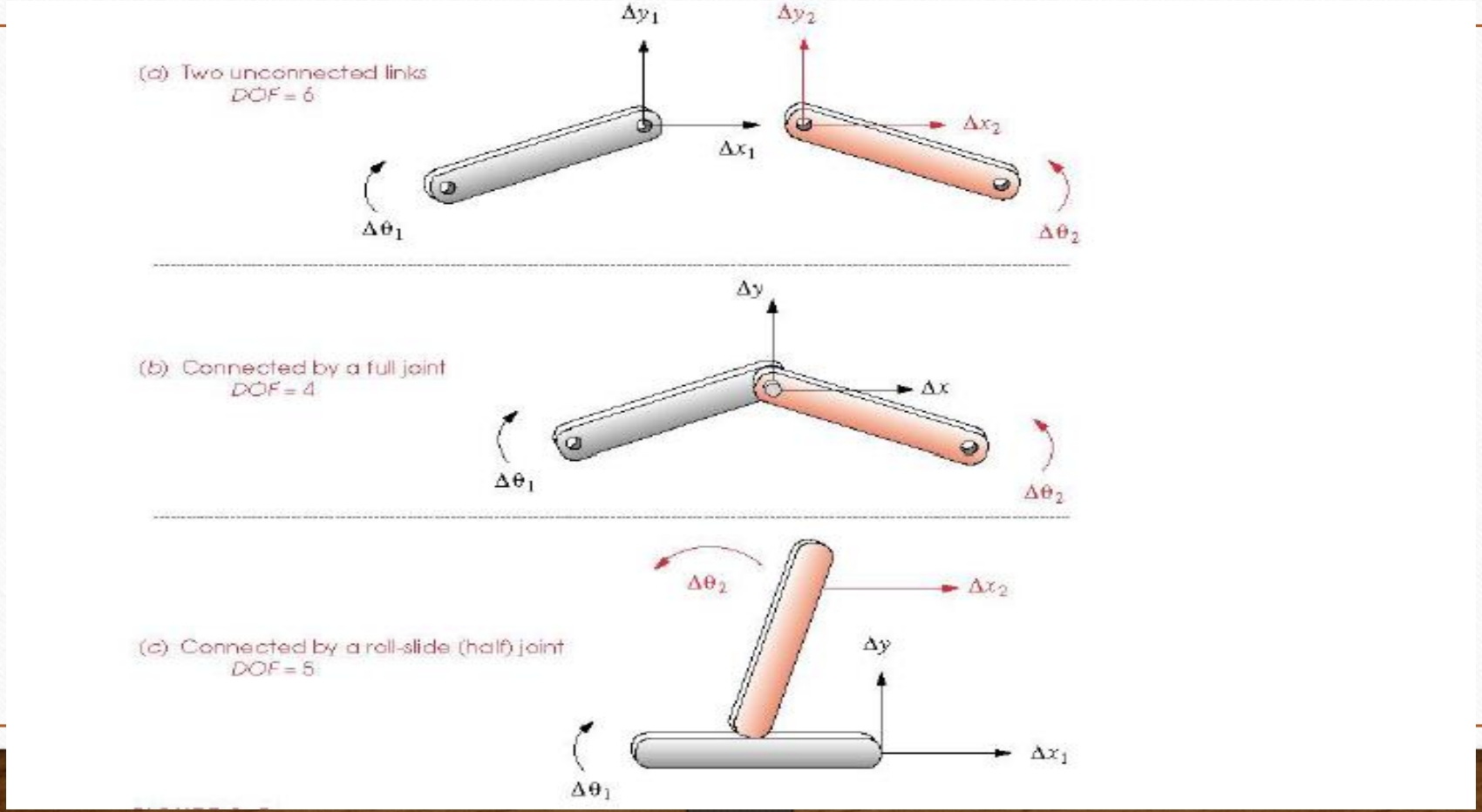


Open Mechanism
DOF=3

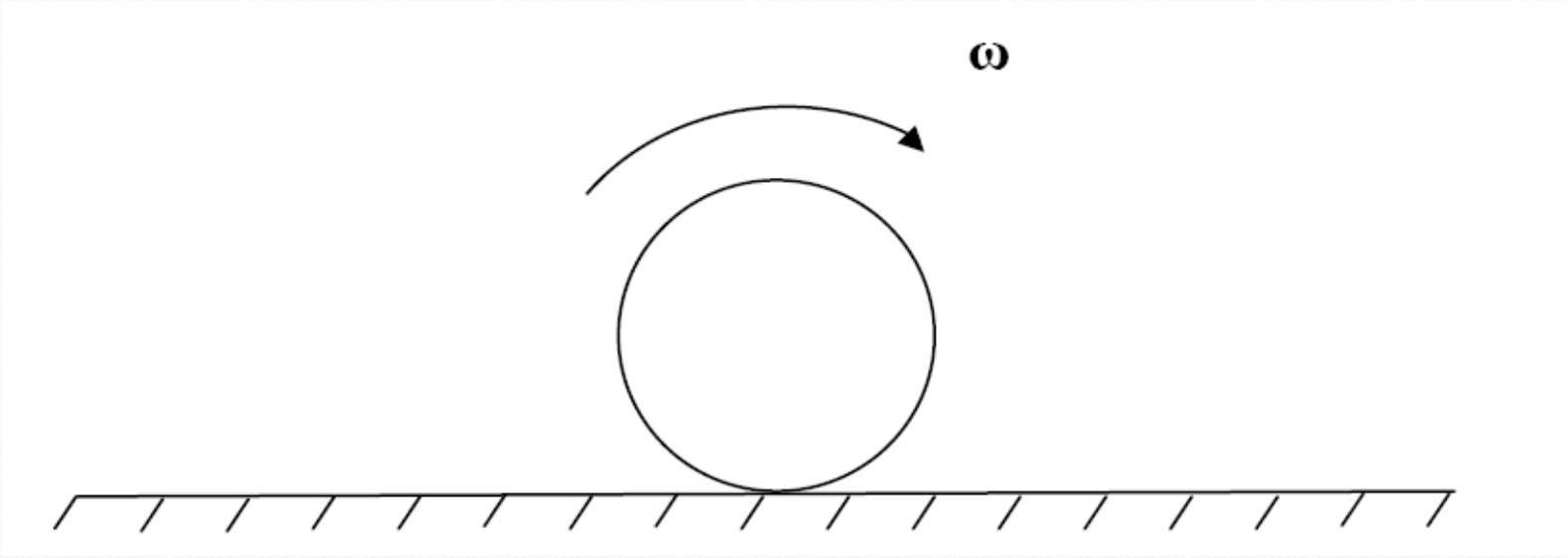


Closed Mechanism
DOF=1

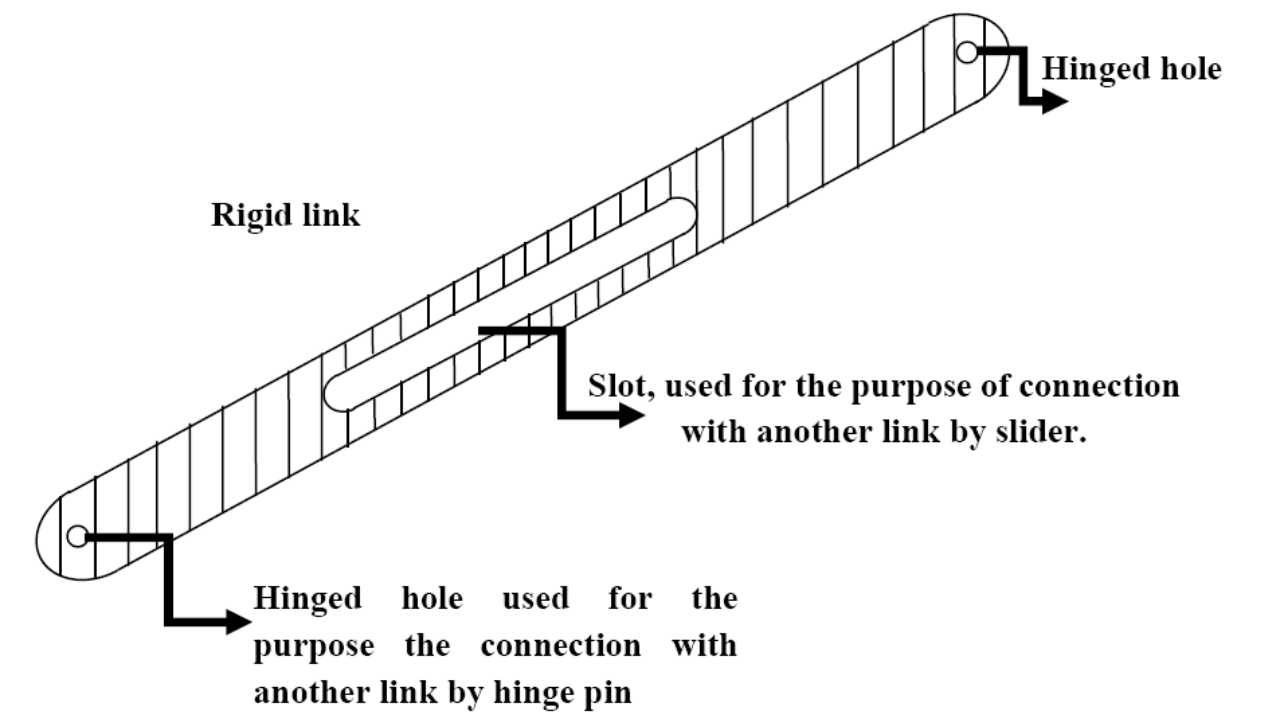
Determining Degree of Freedom



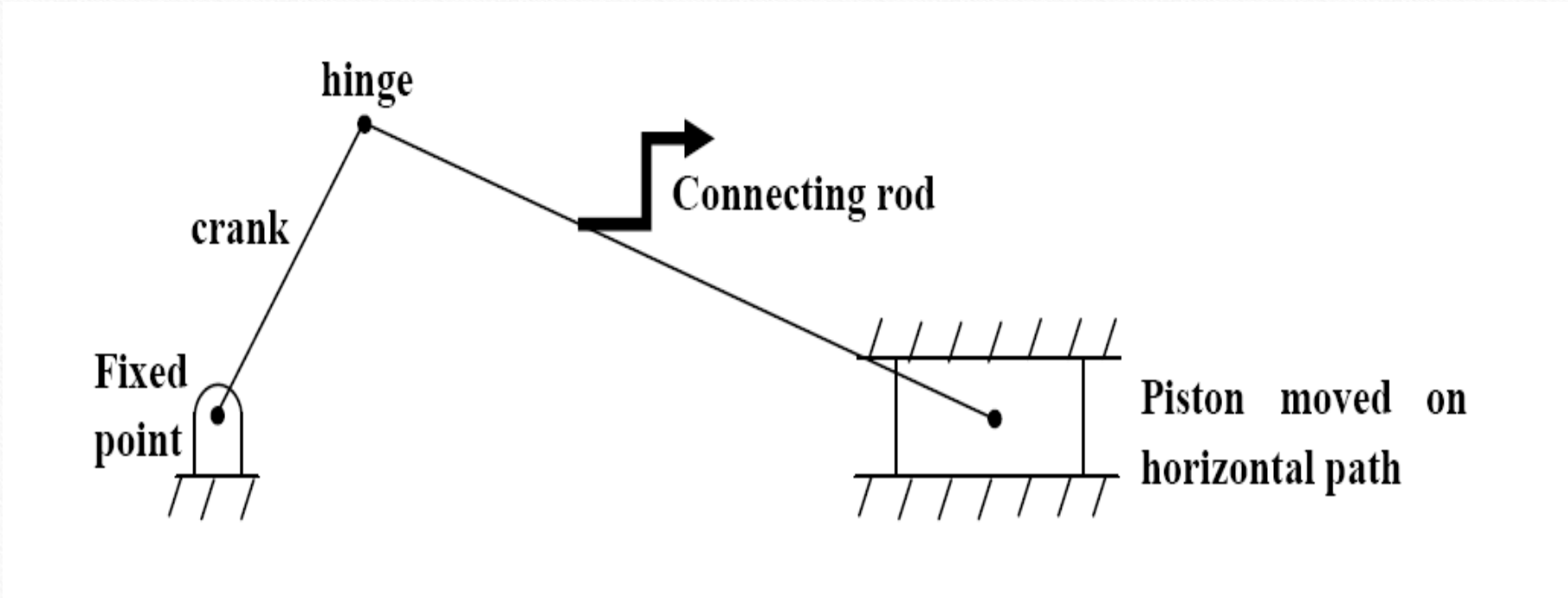
Disc in motion (rigid body)



Crank-Connecting rod mechanisms



Crank-Connecting rod mechanisms



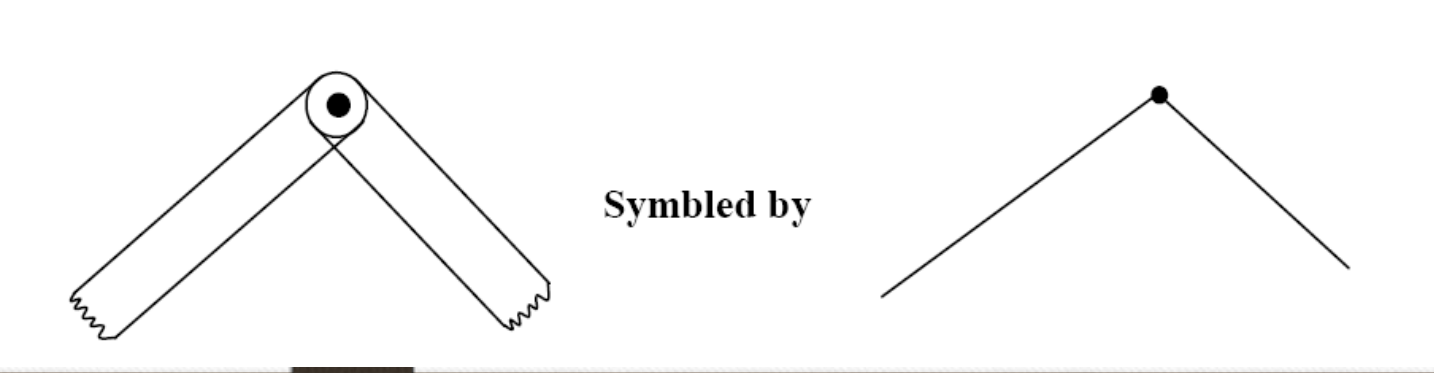
Kinematics of Mechanisms:

1- The connection of mechanism parts:

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

1-1: 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.

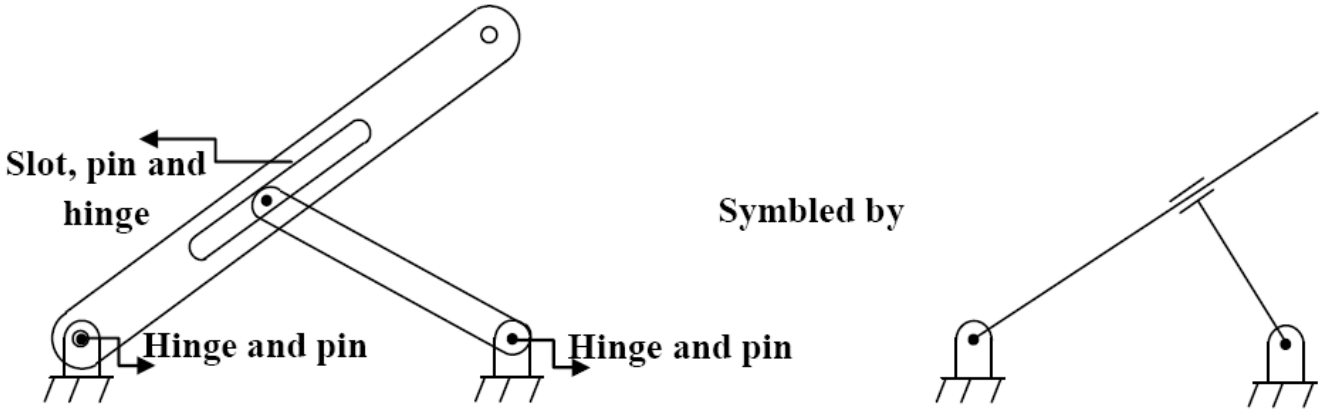


Kinematics of Mechanisms:

1- The connection of mechanism parts:

1-2: Sliding Parts:

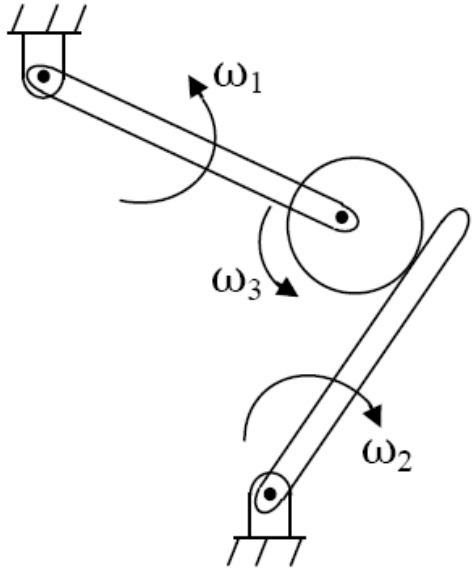
The sliding connection may be used to connect two links rotate about fixed points by means of slot, pin and hinge.



Kinematics of Mechanisms:

1- The connection of mechanism parts:

1-3: Rolling without slipping parts:



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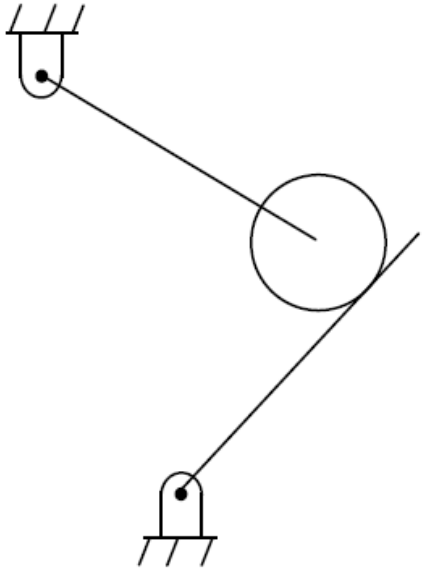


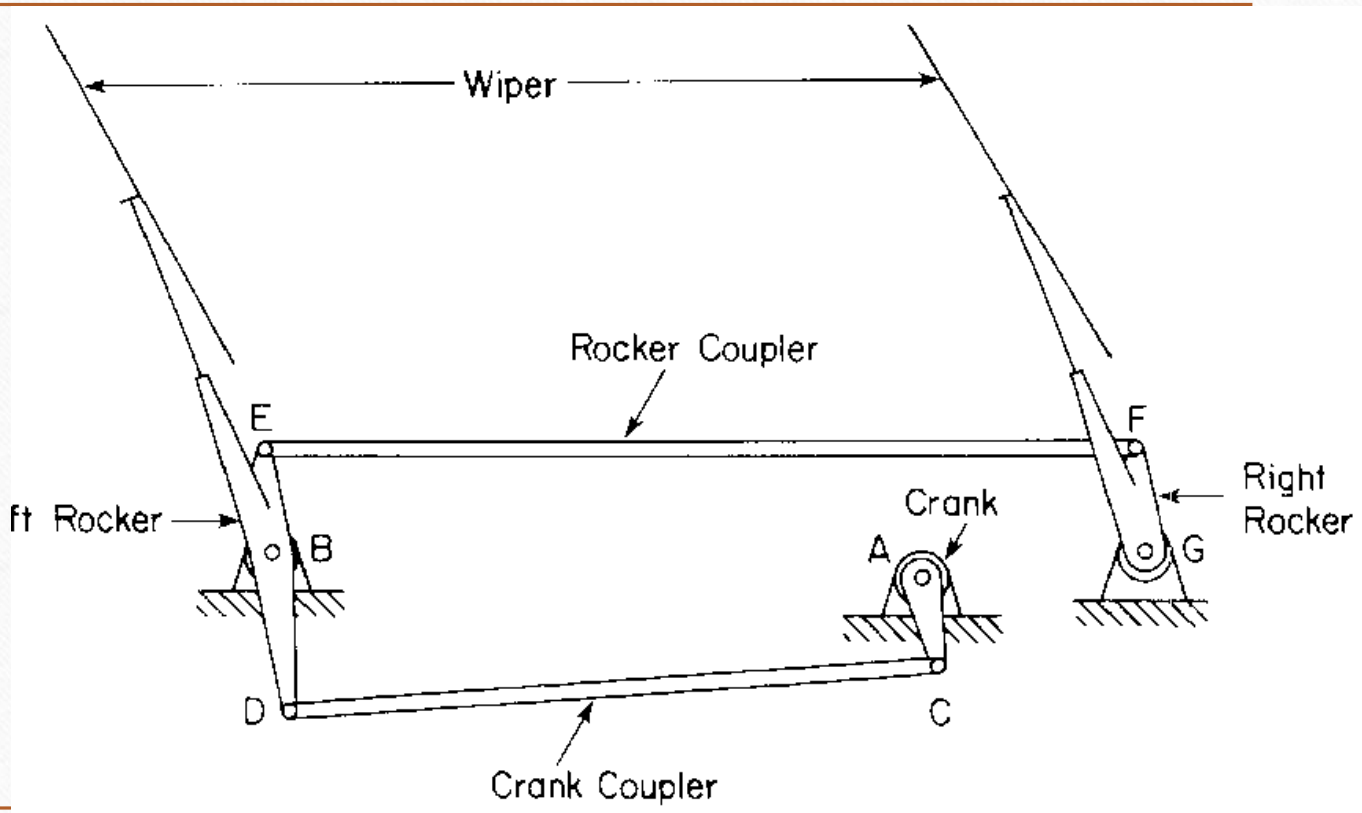
Kinematics of Mechanisms:

2- 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 remain in some configuration during motion; then all the points have the same absolute velocity and acceleration

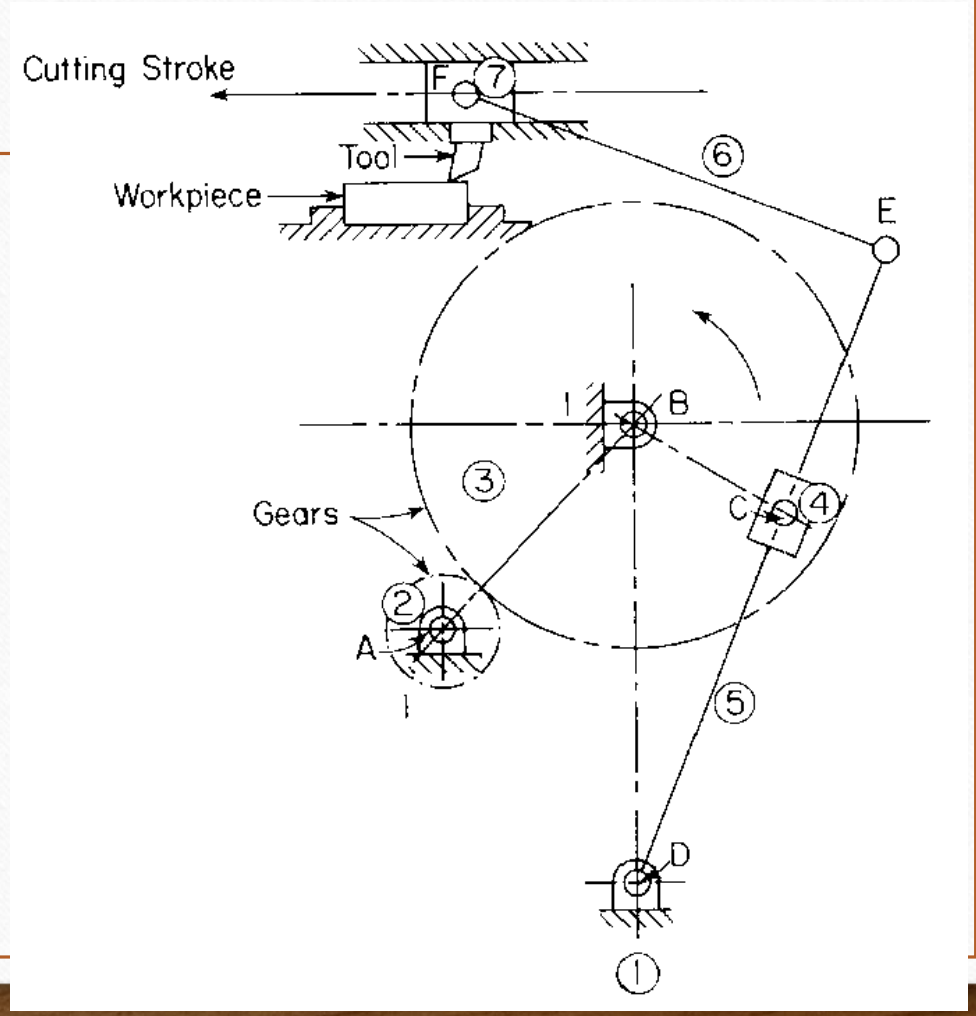
Examples of Mechanisms

Windshield wiper mechanism



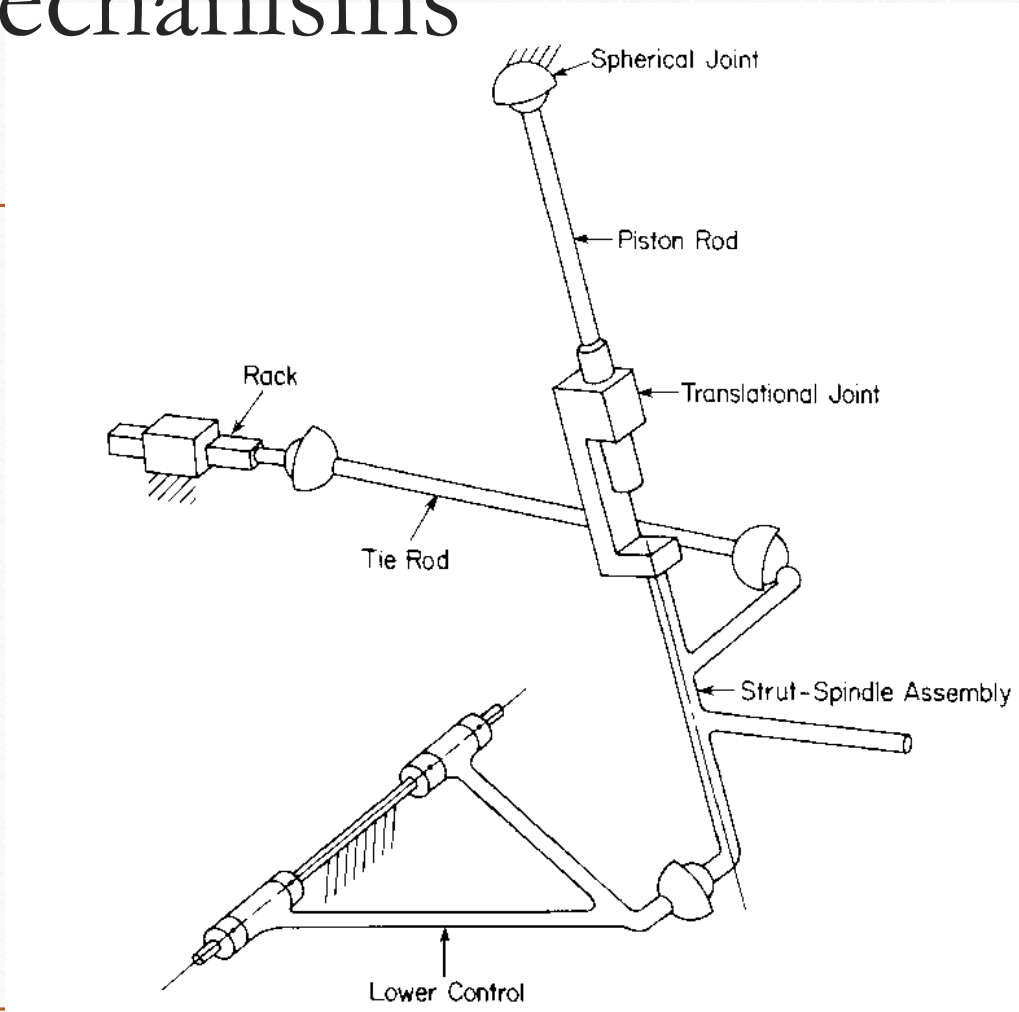
Examples of Mechanisms

Quick-return shaper mechanism



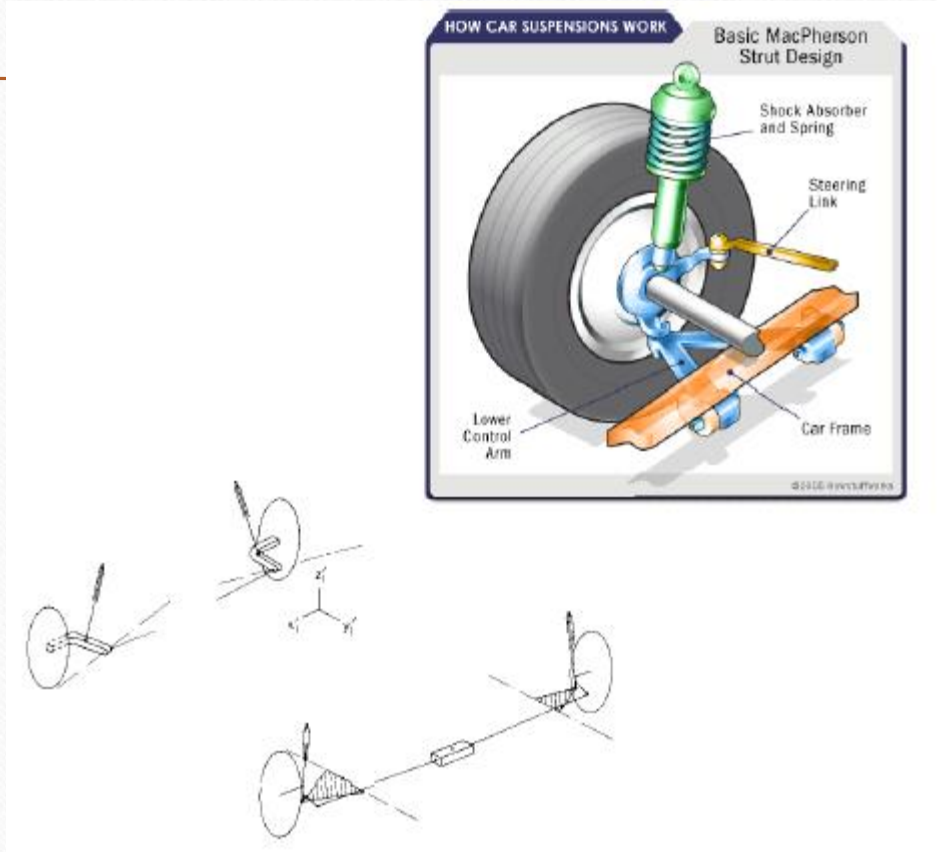
Examples of Mechanisms

McPherson Strut Front Suspension



Examples of Mechanisms

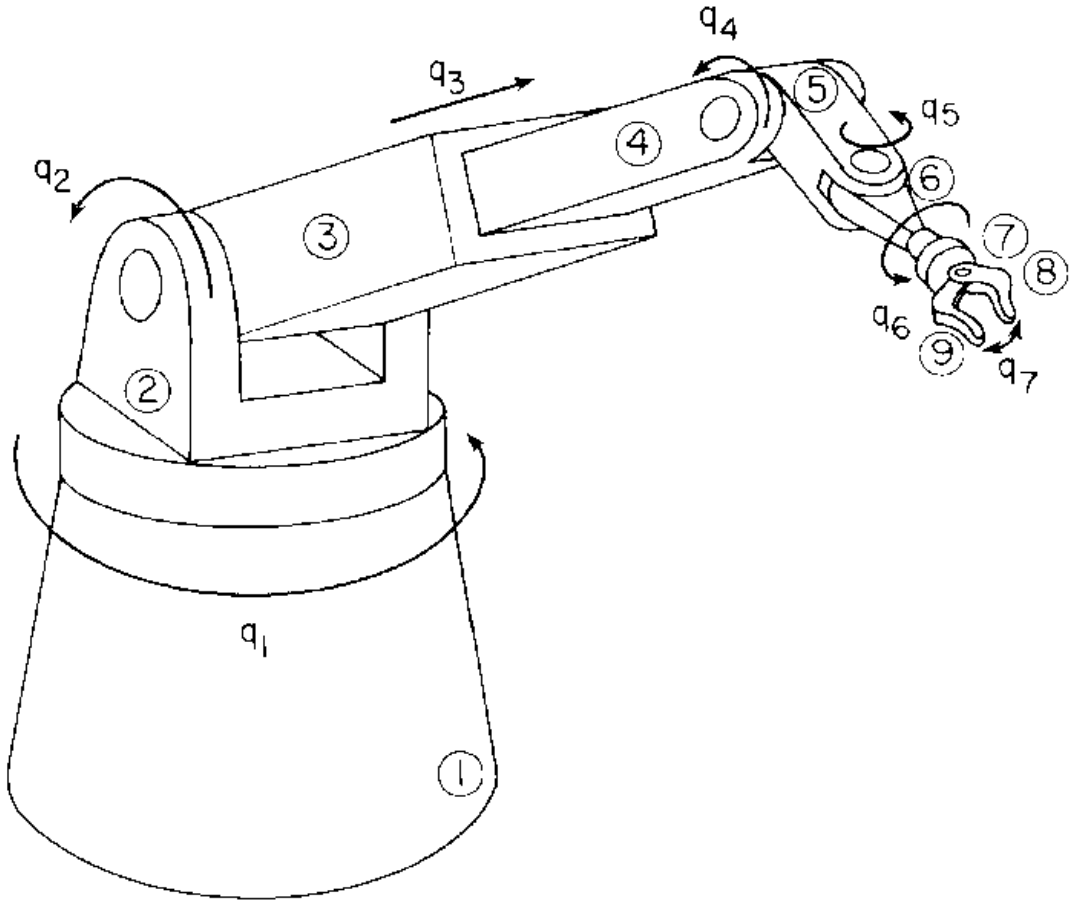
Schematic of car suspension



Examples of Mechanisms

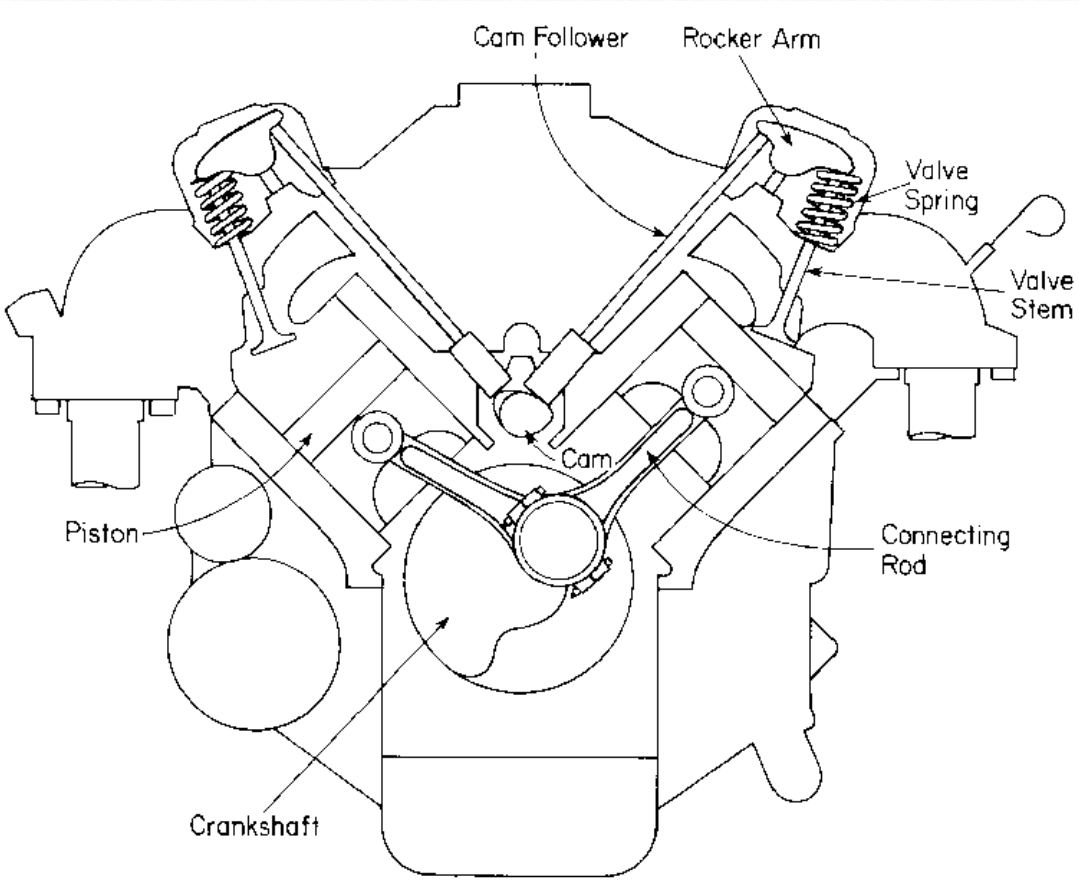
Robotic Manipulator

- Interest here is in controlling the time evolution of these mechanical systems:



Examples of Mechanisms

Cross Section of Engine



Model Examples

- Paintball gun

Thank you