



**Taibah University – Yanbu Branch
College of Engineering at Yanbu
Mechanical Engineering Department**

ME 341 Mechanics of Machines

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- Text Book

Design of Machinery, 3rd Edition, by Robert L. Norton, McGraw Hill Inc.

- Grading Policy

Quizzes + Assignments + Mini Project 35%

Mid Term Exam 25%

Final Exam Theory 40%



- Introduction
- Kinematics Fundamentals
- Graphical Linkage Synthesis
- Position Analysis
- Analytical Linkage Synthesis
- Velocity Analysis
- Acceleration Analysis
- Cam Design
- Gear Trains
- Dynamics Fundamentals
- Dynamic Force Analysis
- Balancing



- Kinematics:
The study of motion without regard to forces
- Kinetics:
The study of forces on systems in motion



- Mechanism

A mechanism is a device that transforms motion to some desirable pattern and typically develops very low forces and transmits little power

Examples: camera shutter, analogue clock, folding chair

- Machine

A machine typically contains mechanisms that are designed to produce significant forces and transmit significant power

Examples: food blender, automobile transmission, a bulldozer, a robot etc



- Mechanism: a system of elements arranged to transmit **motion** in a predetermined fashion
- Machine: a system of elements arranged to transmit **motion and energy** in a predetermined fashion



- Chapter 1
 - The design process
 - Units

SI Unites

Imperial Units

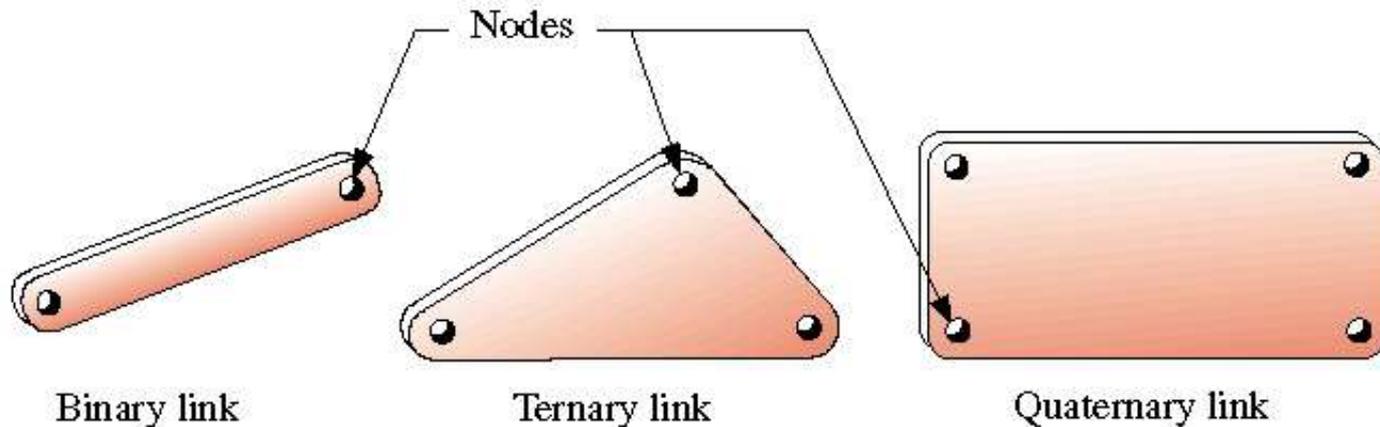


- This chapter will present
 - Definitions of a number of terms concepts and terms fundamental to the synthesis and analysis of mechanism
 - Some very simple but powerful analysis tools that are useful in the synthesis of a mechanism



Links

- Links – building blocks
- Node – attachment points
 - Binary link – two nodes
 - Ternary link – three nodes
 - Quaternary link – four nodes





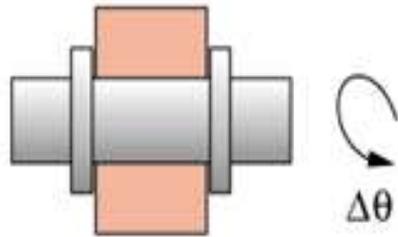
- Ground – fixed w.r.t. reference frame
- Crank – pivoted to ground, makes complete revolution
- Rocker – pivoted to ground, has oscillatory motion
- Coupler - link has complex motion, not attached to ground



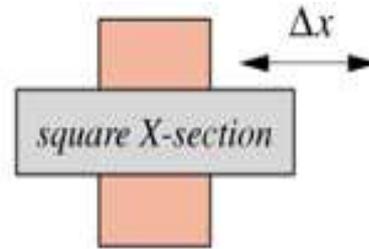
- A connection between two or more links (at their nodes), which allows some motion between the connected links
- Joints (also called kinematic pairs) can be classified in several ways
 - By the type of contact between the elements, line, point, or surface
 - By the number of degree of freedom allowed at the joint
 - By the type of physical closure of the joint: either force or form closed
 - By the number of links joined (order of the joint)



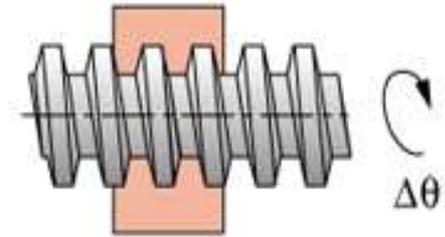
- Lower pair: joints with surface contact
- Higher pair: joints with point or line contact



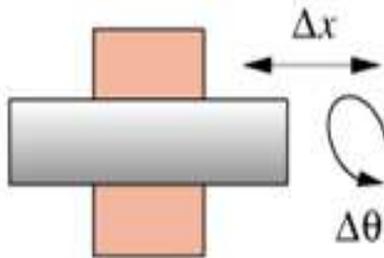
Revolute (R) joint—1 *DOF*



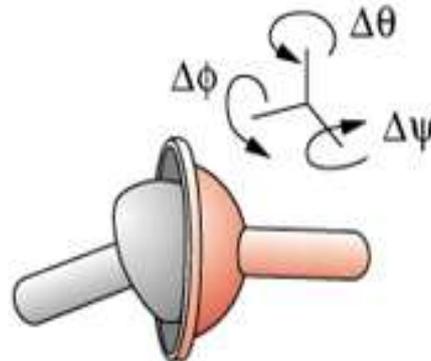
Prismatic (P) joint—1 *DOF*



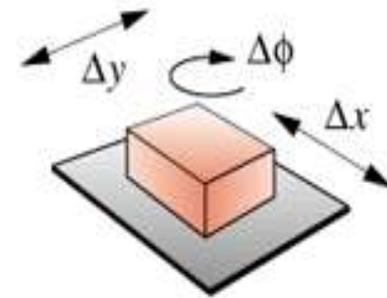
Helical (H) joint—1 *DOF*



Cylindric (C) joint—2 *DOF*



Spherical (S) joint—3 *DOF*

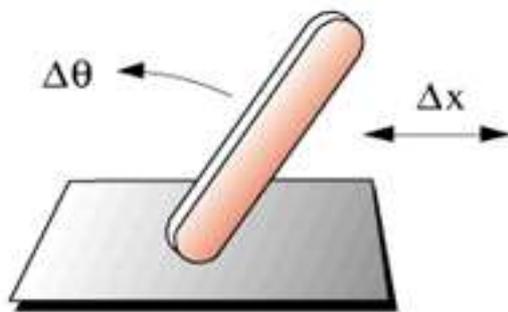


Planar (F) joint—3 *DOF*

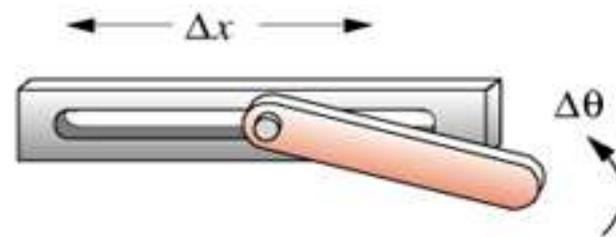
FIGURE 2-3

(a) The six lower pairs

Joints (pairs) of various types



Link against plane (force closed)



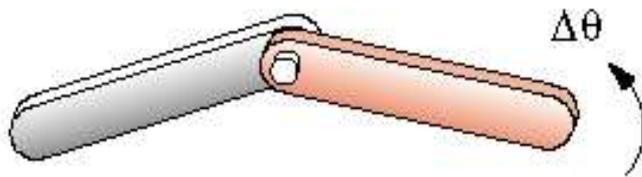
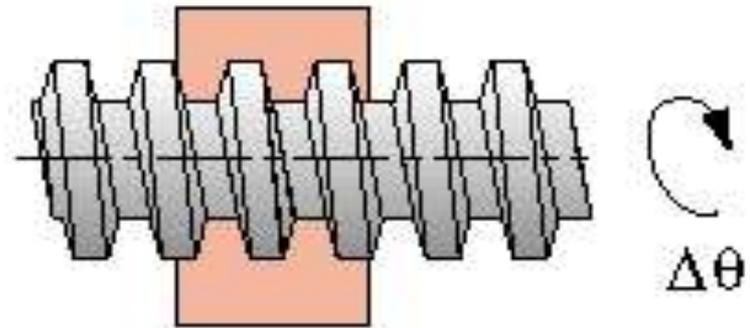
Pin in slot (form closed)

(c) Roll-slide (half or RP) joints - 2 DOF (higher pairs)

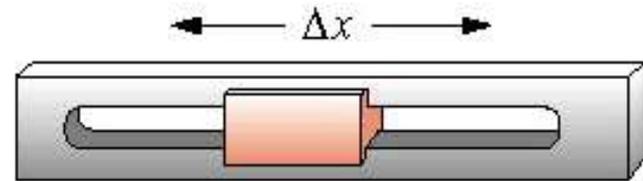


- One-degree of freedom: also called full joints (i.e., full = 1 DOF)
- Two-degree of freedom joint: also called half joint (Half also refers to more than two DOF)

- Pin joint allows 1 DOF
- Linear slider
- Threaded nut
- Tire on dry ground



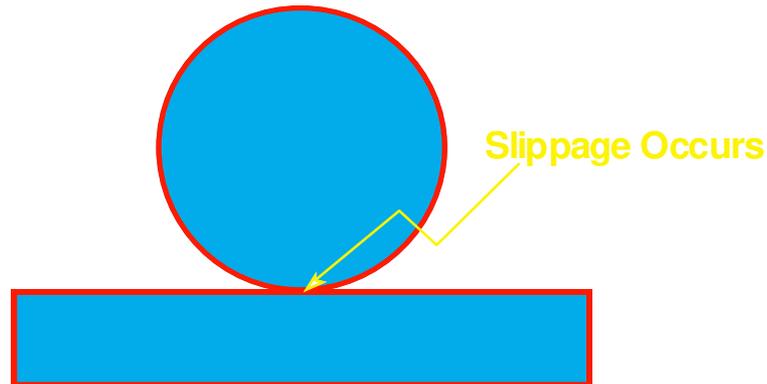
Rotating full pin (R) joint (form closed)

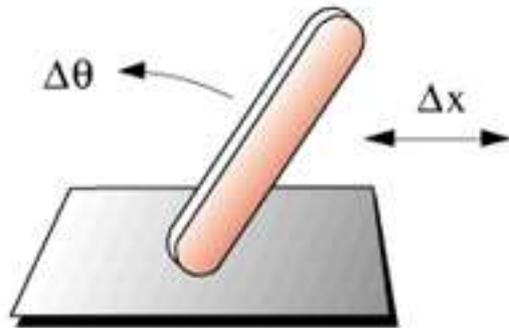


Translating full slider (P) joint (form closed)

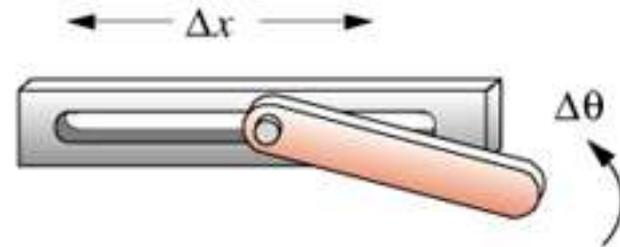


- Collar on rod
- Tire on ice - friction determines the DOF





Link against plane (force closed)



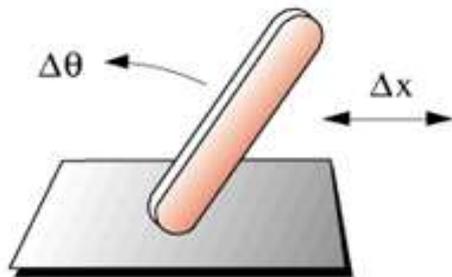
Pin in slot (form closed)

(c) Roll-slide (half or RP) joints - 2 DOF (higher pairs)

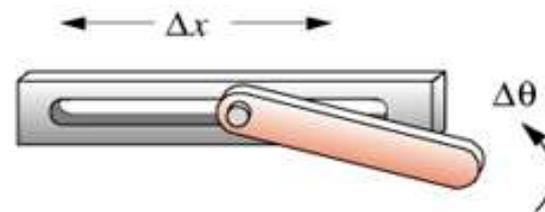


Joints: type of physical closure of the joint

- Form closed: when the design of the joint is holding one link in a specific place
- Force closed: when a force (e.g. gravity) is tending the link to be closed



Link against plane (force closed)



Pin in slot (form closed)

(c) Roll-slide (half or RP) joints - 2 DOF (higher pairs)



- The order of the link is defined as the number of links joined minus one
- It takes two links to make a single joint; thus the simplest joint combination of two links has joint order one

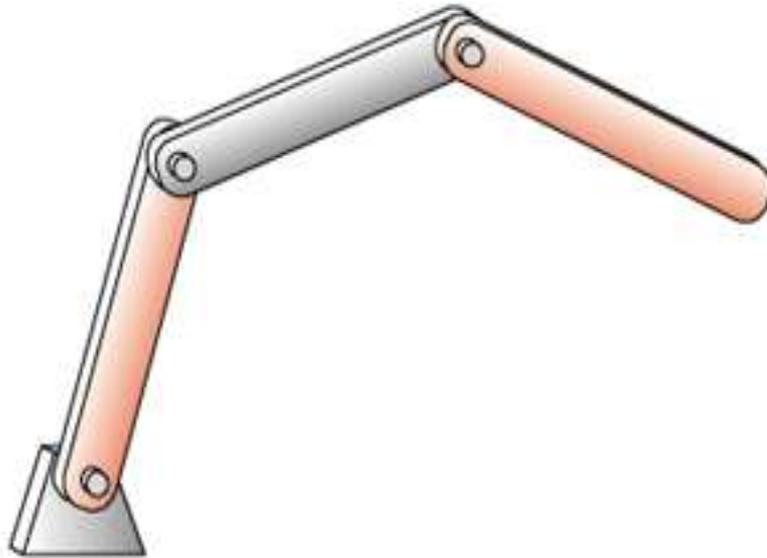


- A kinematic chain: an assemblage of links and joints, interconnected in a way to provide a controlled output motion in response to a supplied input motion
- A Mechanism: a kinematic chain in which at least one link has been grounded or attached to the frame of reference (which itself may be in motion)

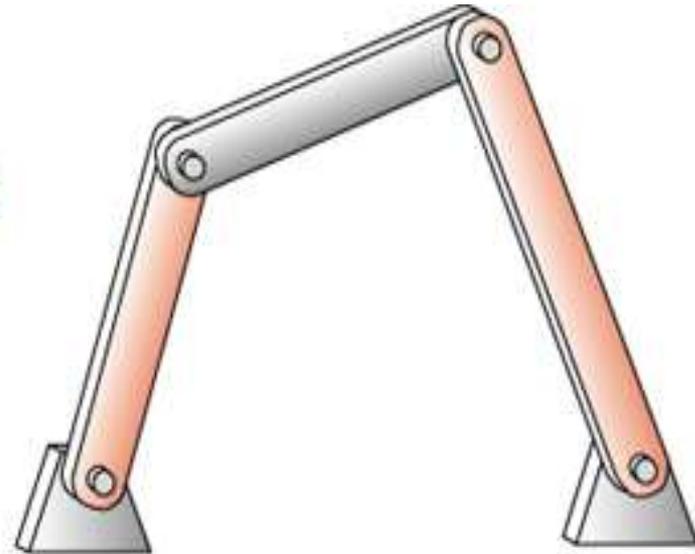


Kinematic Chain

Open
Closed



(a) Open mechanism chain



(b) Closed mechanism chain