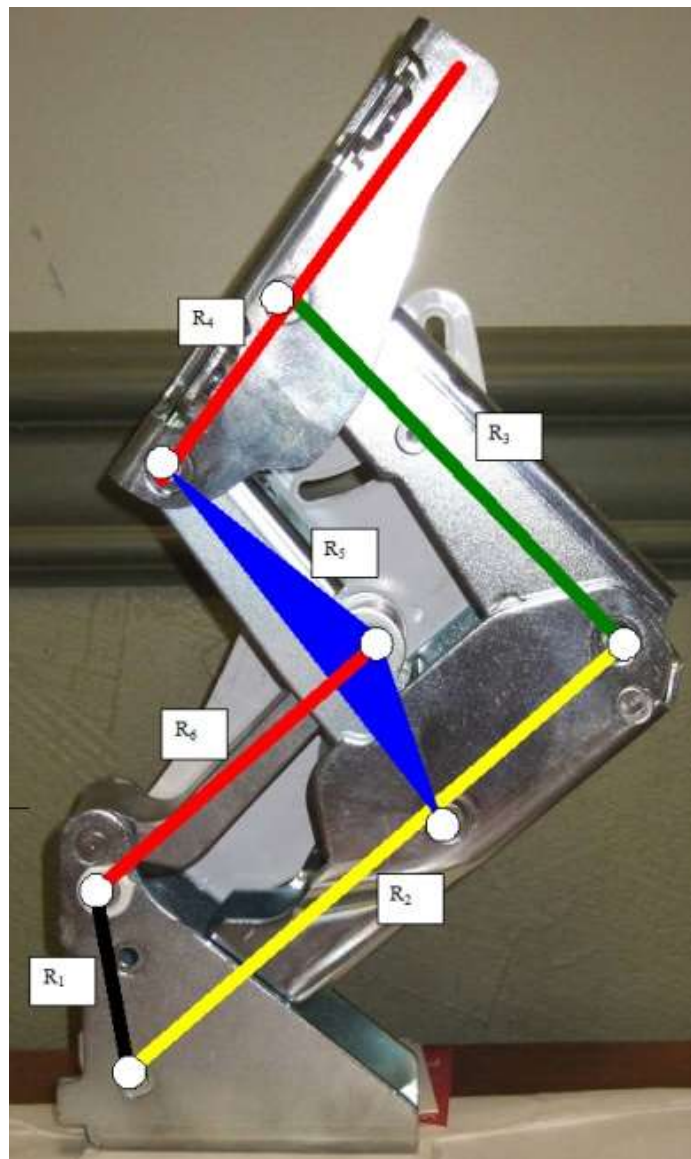# An Atlas of Structures, Mechanisms, and Robots

Dr. Bob Williams, williar4@ohio.edu

Mechanical Engineering, Ohio University
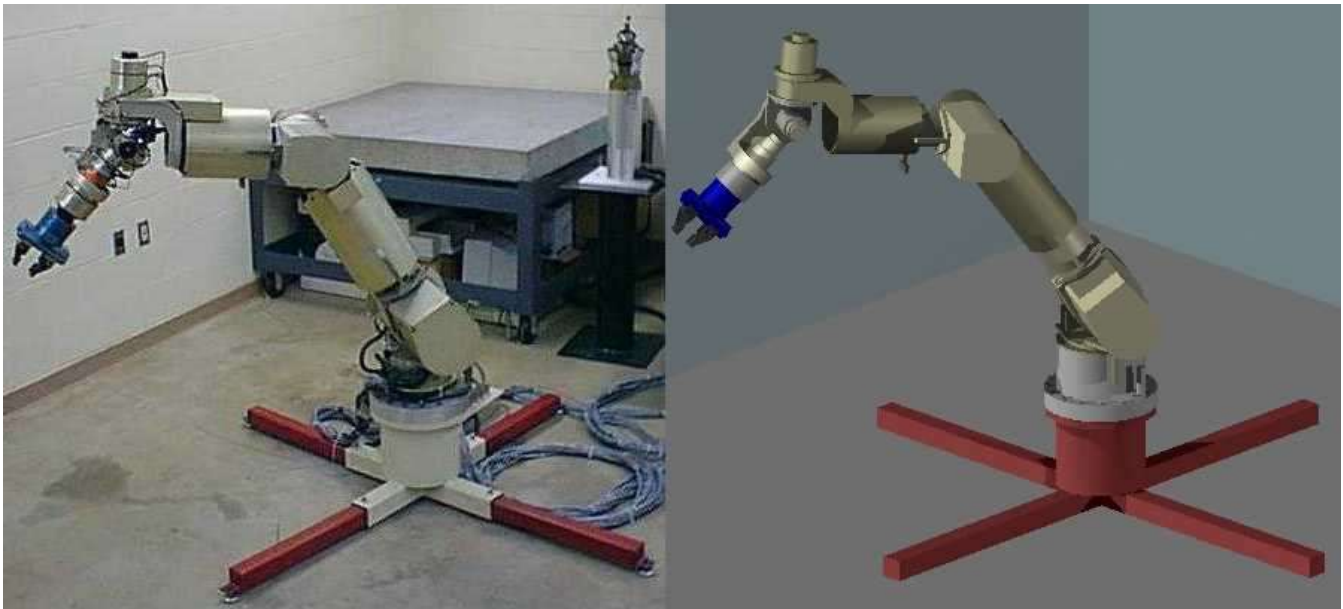
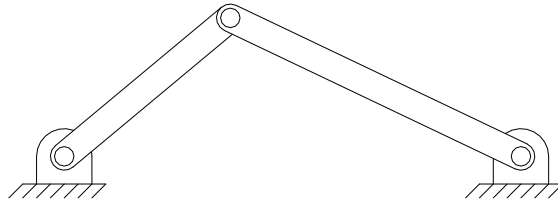**© 2023 Dr. Bob Productions**

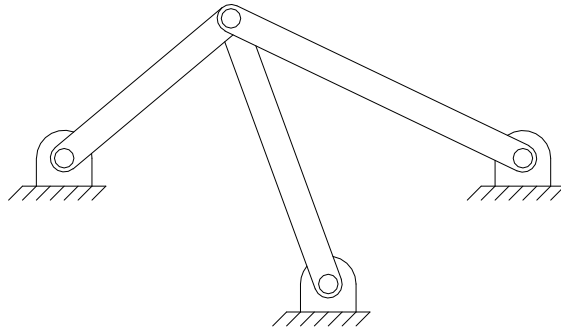**Hettich Hinge Watt I 6-bar Mechanism**

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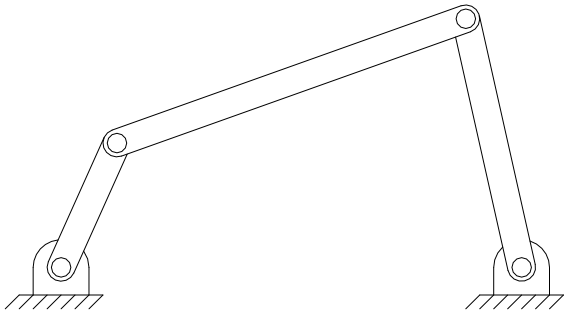**NASA 8-dof ARMII Robot**

Zero-dof (or less) Structures

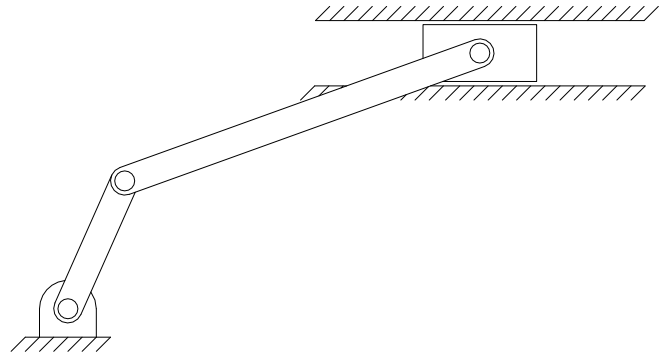**Statically Determinate Structure**
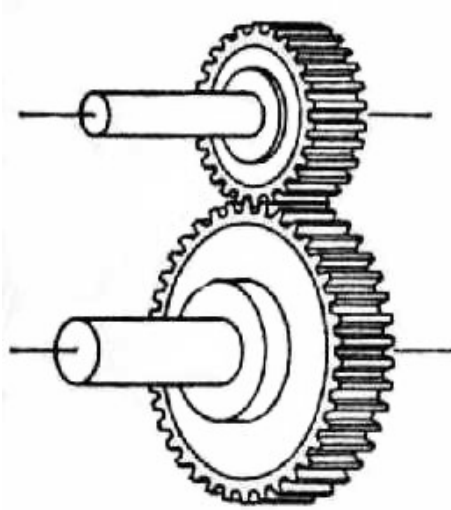

Statically Indeterminate Structure
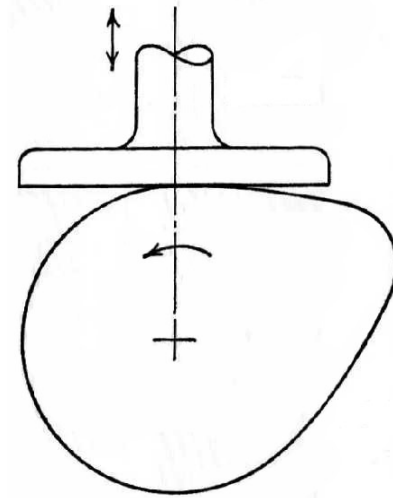
One-dof Mechanisms

4-Bar Mechanism

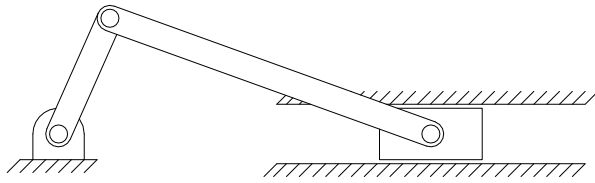**Offset Slider-Crank Mechanism**
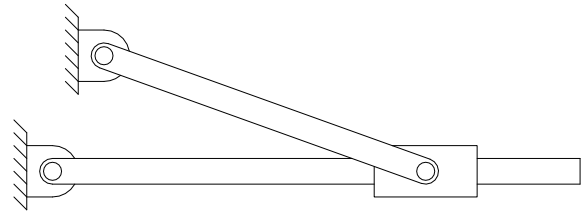
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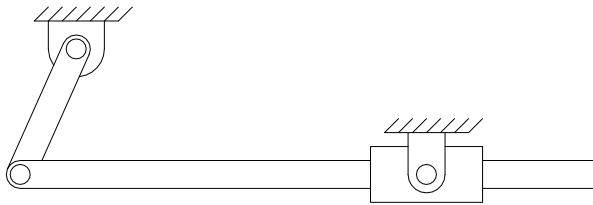
Cam-and-Follower Mechanism

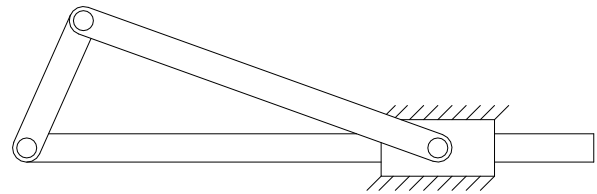## The Four Slider-Crank Mechanism Inversions

Slider-Crank Mechanism Inversion 1
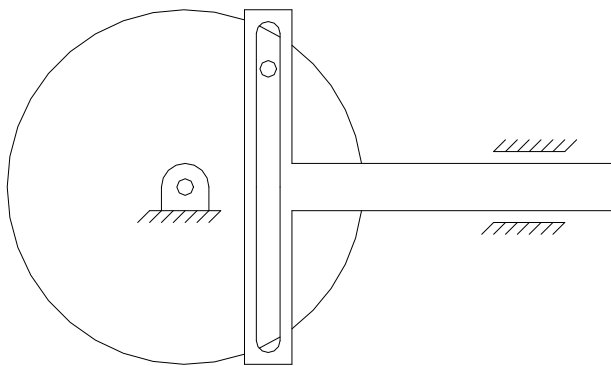

Slider-Crank Mechanism Inversion 2
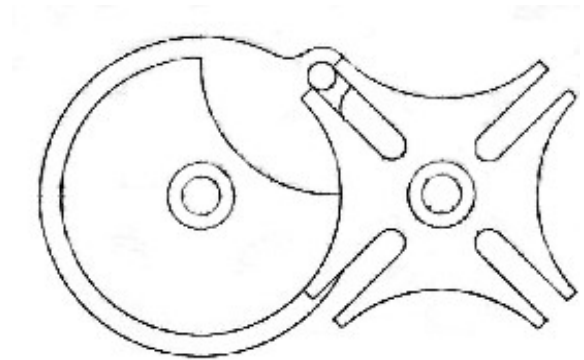

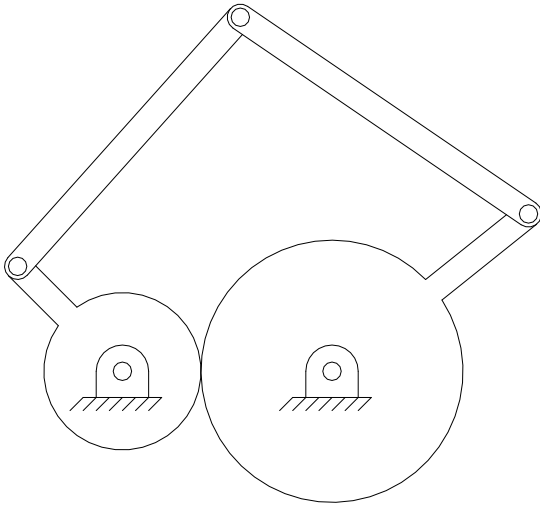**Slider-Crank Mechanism Inversion 3**

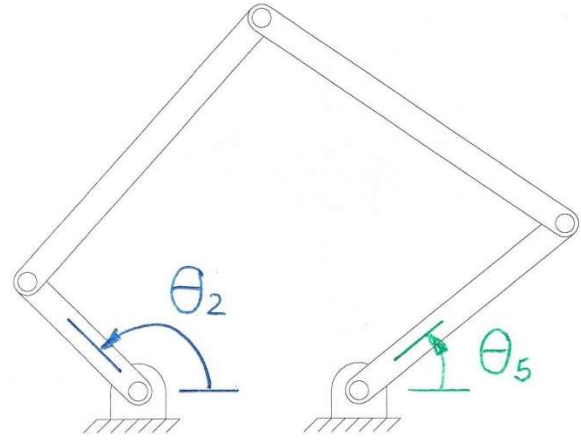**Slider-Crank Mechanism Inversion 4**

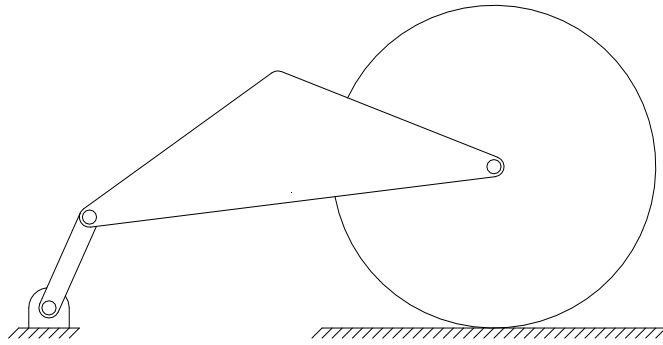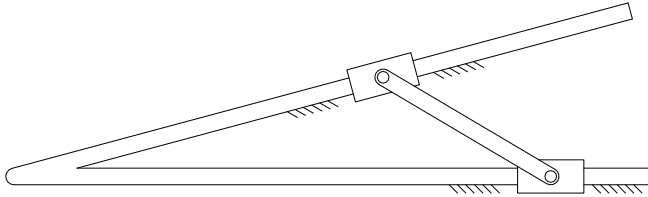## Two Mechanisms with Slotted-Pin Joints

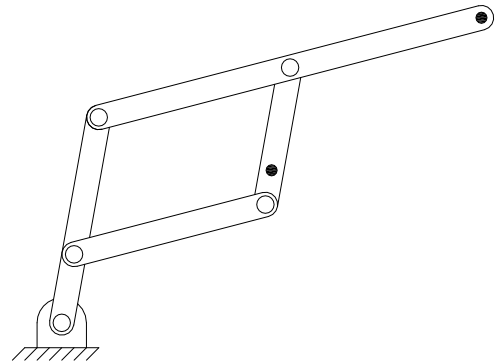**Scotch-Yoke Mechanism**

Geneva Wheel Mechanism

Geared 5-Bar Mechanism vs. 5-Bar Robot

Geared 5-Bar Mechanism
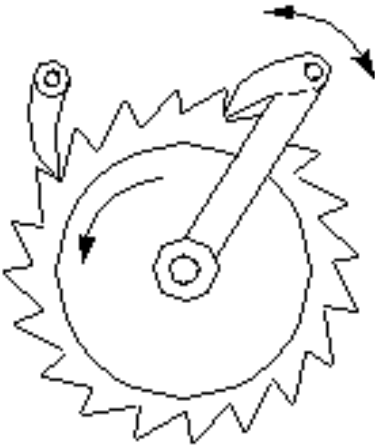
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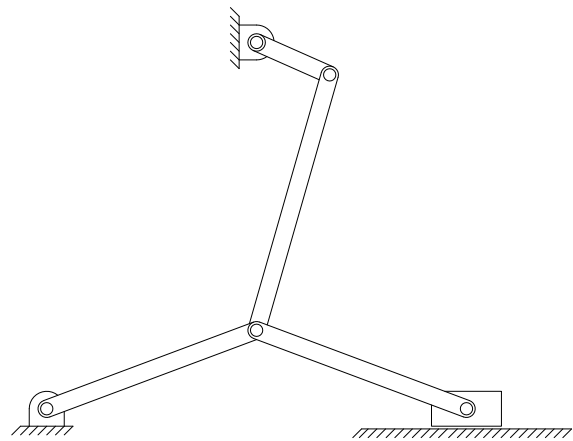
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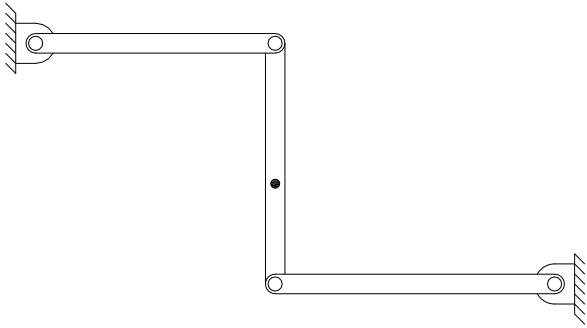
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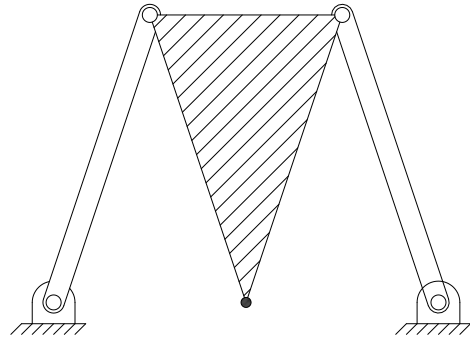
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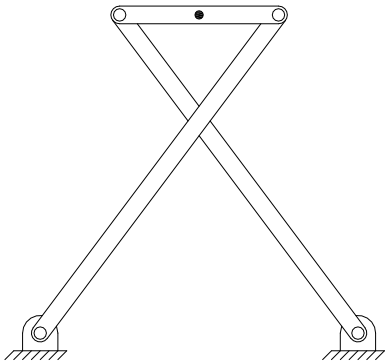**Ratchet Mechanism**

Toggle Mechanism
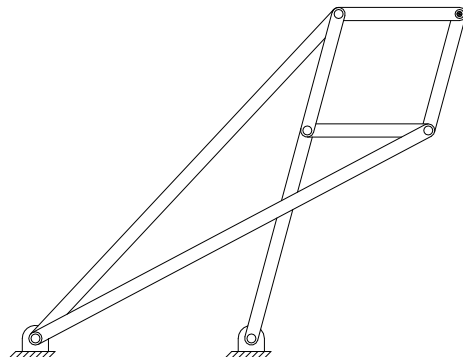
Five Straight-Line Mechanisms

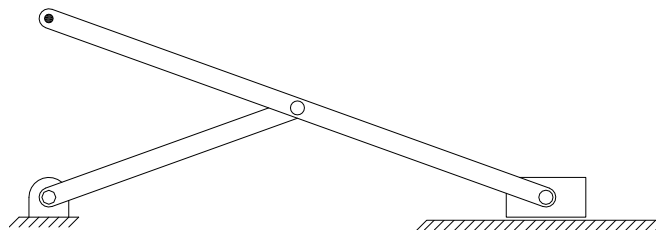**Watt Straight-Line Mechanism
(approximate)**

**Roberts Straight-Line Mechanism
(approximate)**
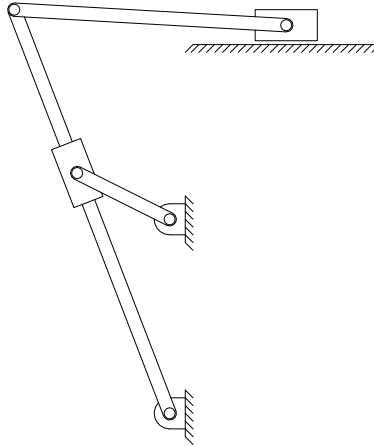

**Chebyshev Straight-Line Mechanism
(approximate)**

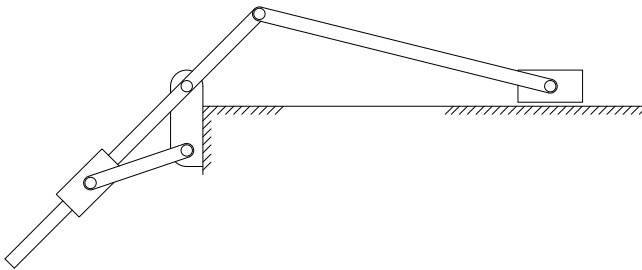**Peaucellier Straight-Line Mechanism
(exact)**

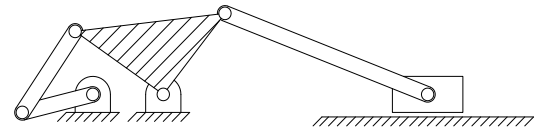**Scott-Russell Straight-Line Mechanism
(exact)**
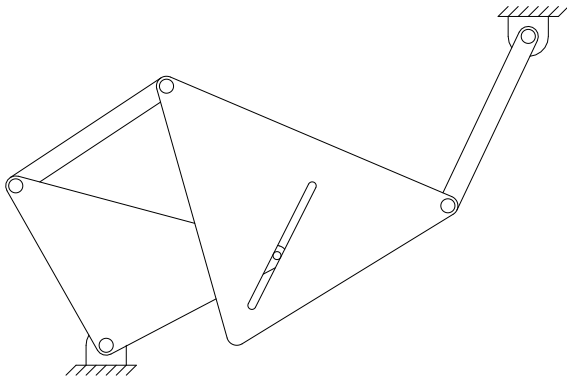
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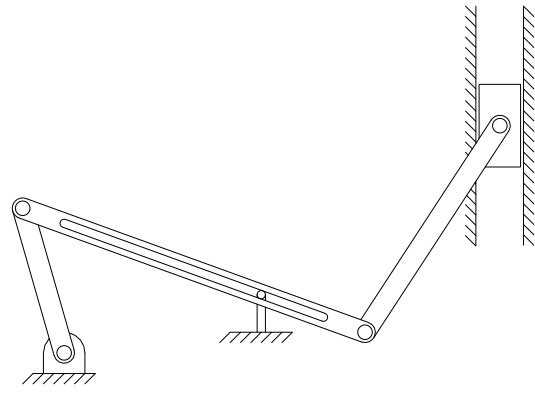

Crank-Shaper Quick-Return Mechanism

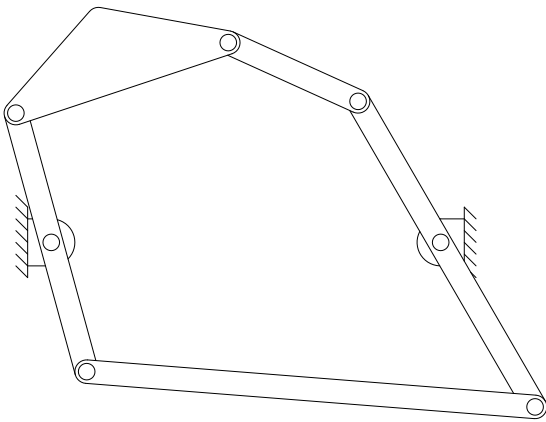**Whitworth Quick-Return Mechanism**
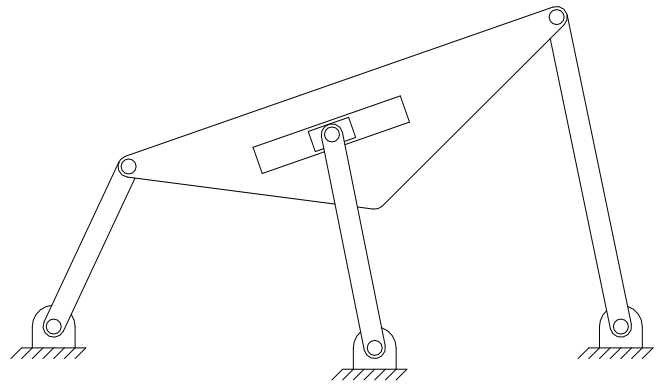
Drag-Link Quick-Return Mechanism
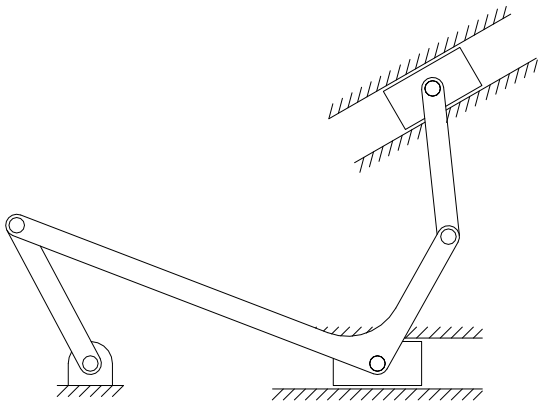
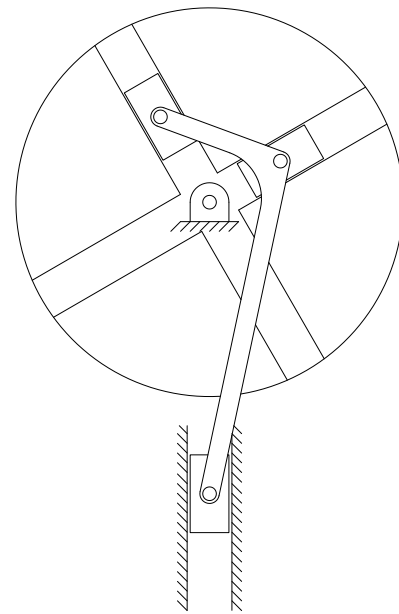**5-bar Slotted Mechanism**

5-bar Slotted Slider Mechanism

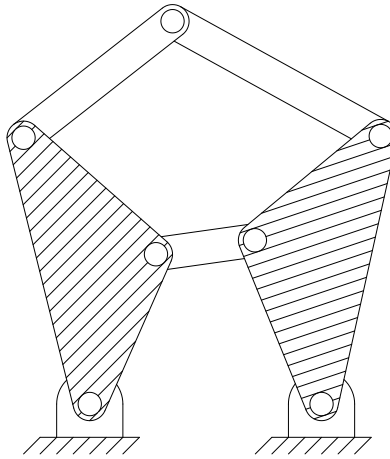**6-bar Mechanism**

6-bar Single-Slider Mechanism

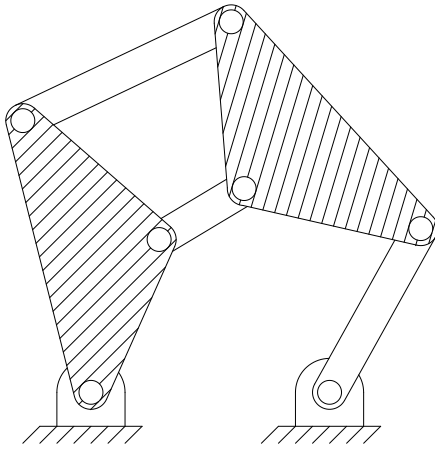**6-bar Crank Dual-Slider Mechanism**

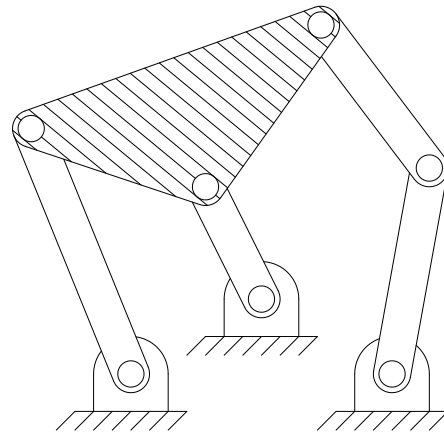**6-bar Crank Triple-Slider Mechanism**

The Five Classical 6-Bar Mechanisms
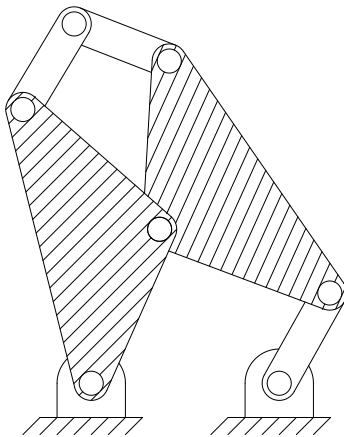

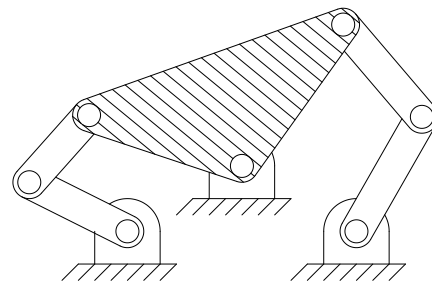**Stephenson I 6-Bar Mechanism**

Stephenson II 6-Bar Mechanism

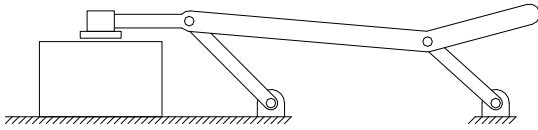

Stephenson III 6-Bar Mechanism
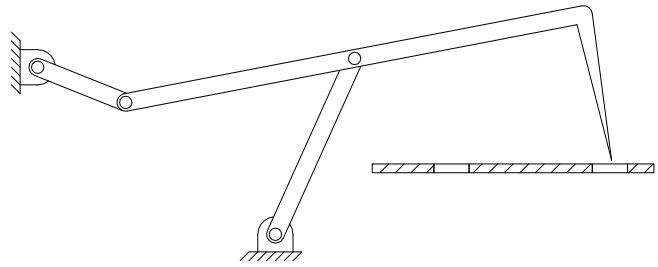

Watt I 6-Bar Mechanism
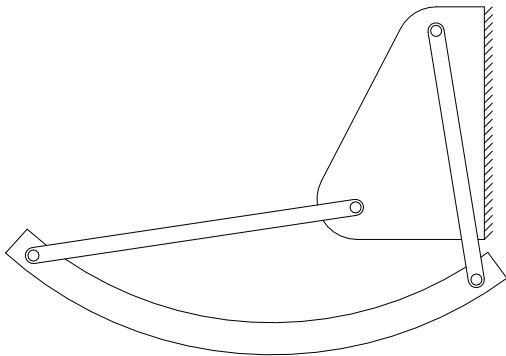

Watt II 6-Bar Mechanism
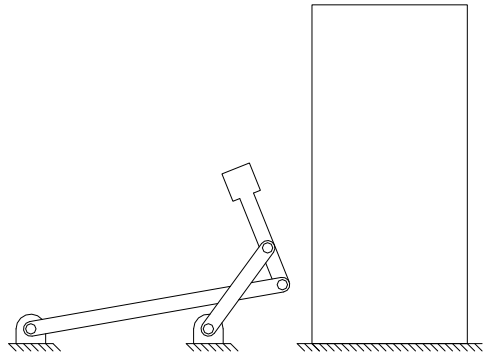
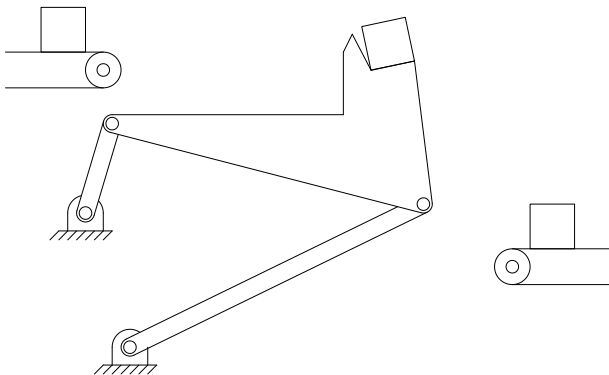# Some Real-World 4-Bar Mechanisms

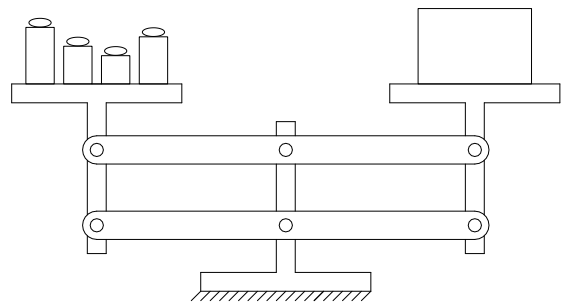**4-Bar Clamp Mechanism**

4-Bar Film-Advance Mechanism

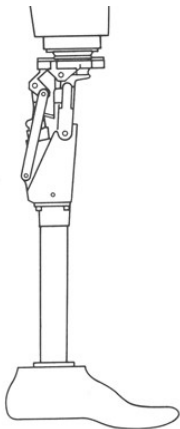**4-Bar Aircraft Carry-on Bin Mechanism**
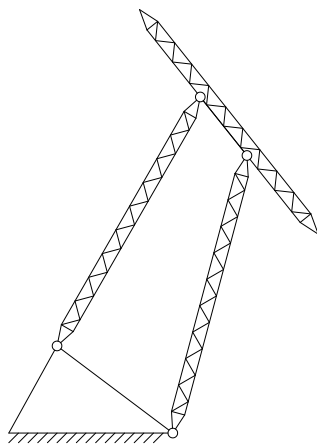
4-Bar Bass Drum Pedal Mechanism

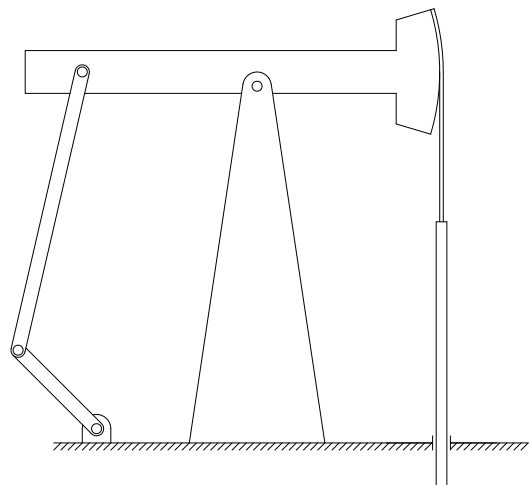**4-Bar Conveyor Transfer Mechanism**

Dual 4-bar Balance Scale Mechanism
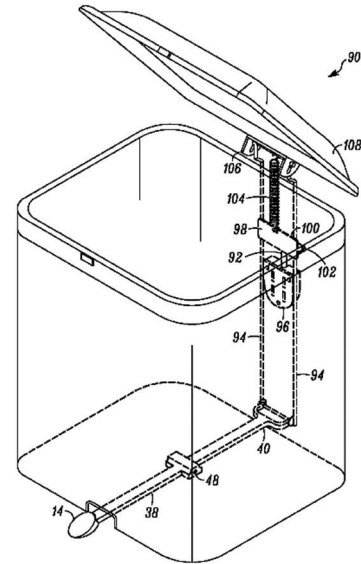
4-Bar Knee Prosthesis

4-Bar Crane

4-bar Horsehead Pump

Some Real-World 4-Bar Mechanisms (cont.)
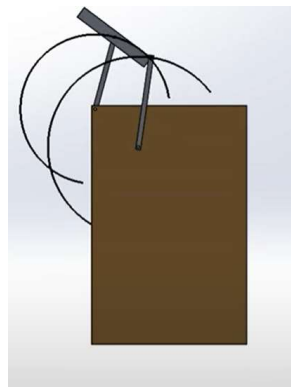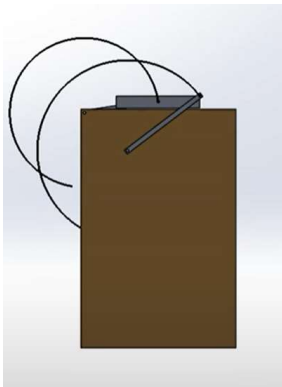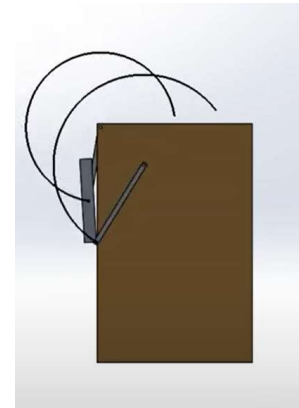

How does an Oscillating Fan work

US08136688-20120320-D00000.png

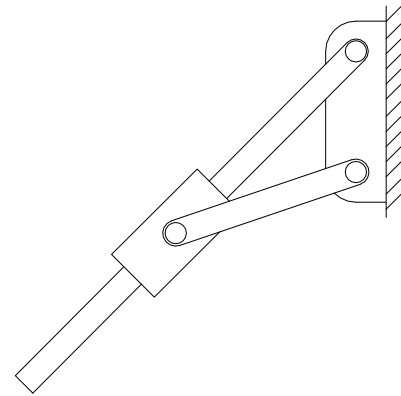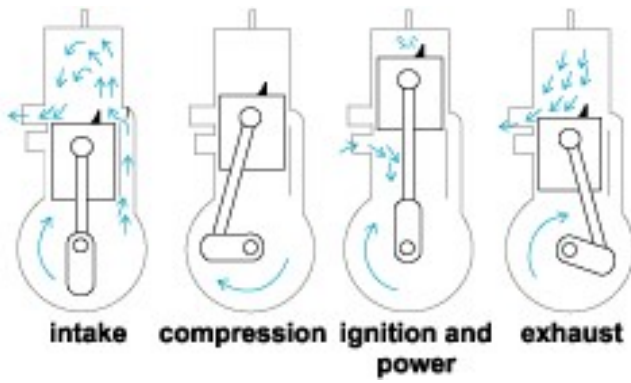**4-Bar Oscillating Fan Mechanism**　　　　　**4-Bar Trashcan Mechanism**

www.youtube.com/watch?v=_re0o4S4mw4

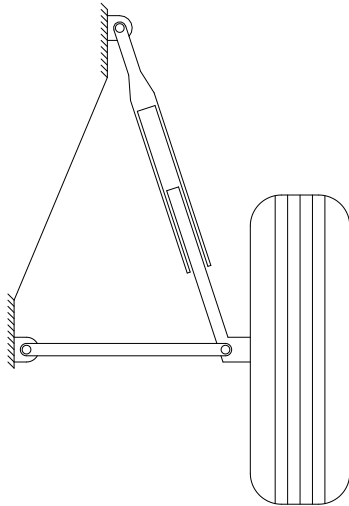**Another 4-Bar Trashcan Mechanism**

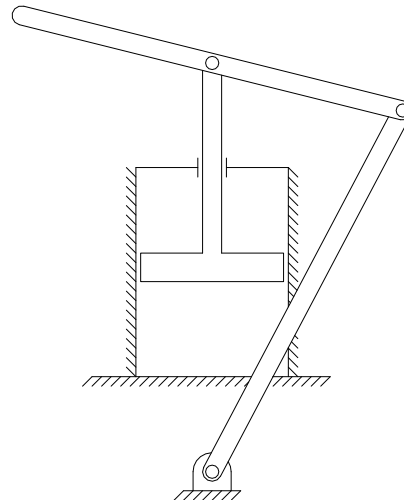## Some Real-World Slider-Crank Mechanisms, all 4 inversions

4-Stroke Internal Combustion Engine Mechanism
S-C Inversion 1

Whitworth Mechanism
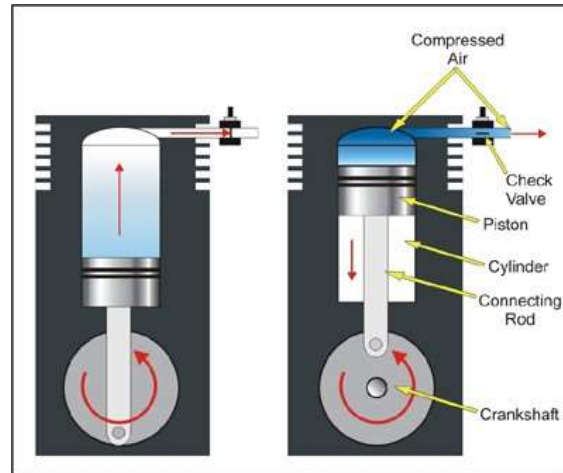**S-C Inversion 2**

MacPherson Strut Mechanism
S-C Inversion 3

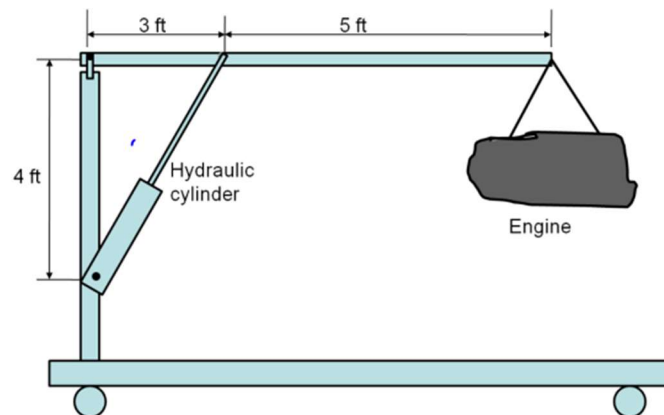**Pump Mechanism**
S-C Inversion 4

Some Real-World Slider-Crank Mechanisms (cont.)

Air Compressor Mechanism
S-C Inversion 1

media/ca4/ca45002e-e065-4da3-b020-47b24b372ede/phpmz23oG.png

Engine Hoist Mechanism
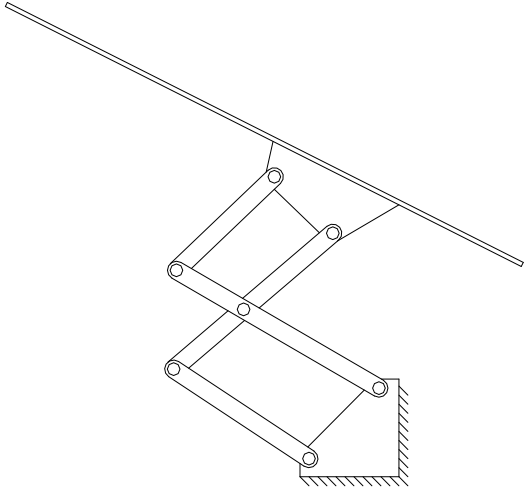**S-C Inversion 3**

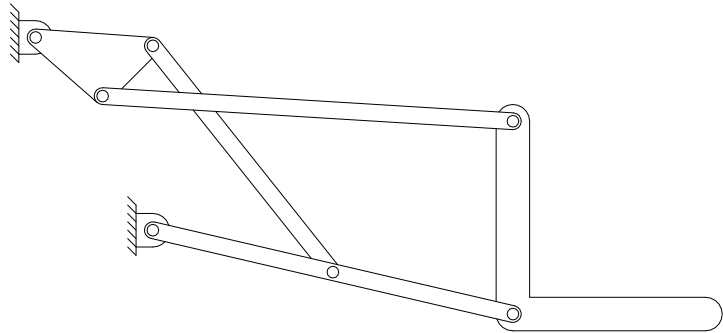## Real-World Geared 5-Bar Mechanism
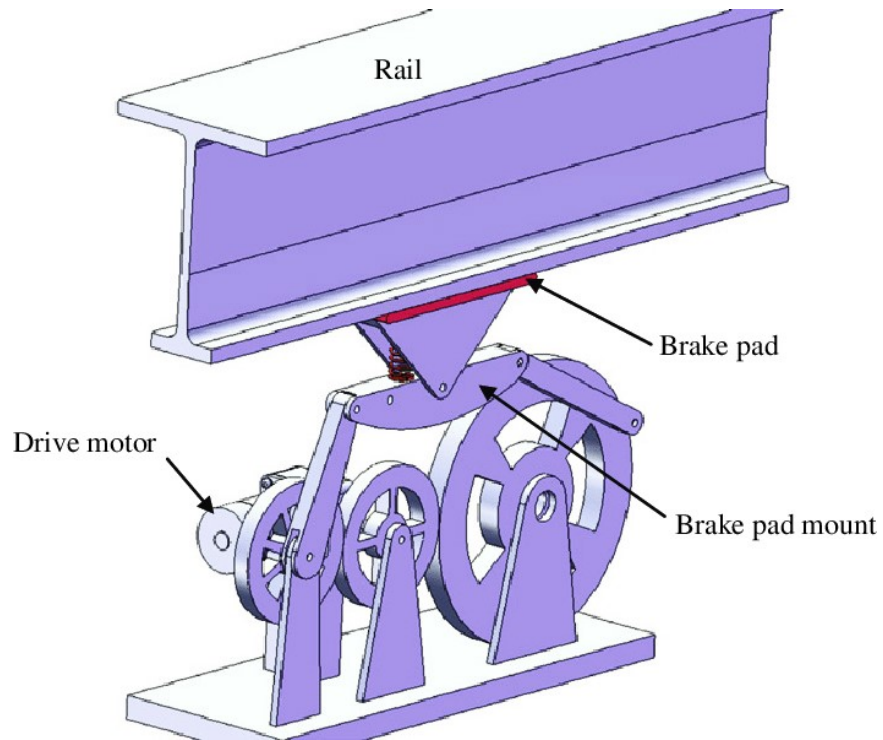
geared five-bar mechanism - Bing images
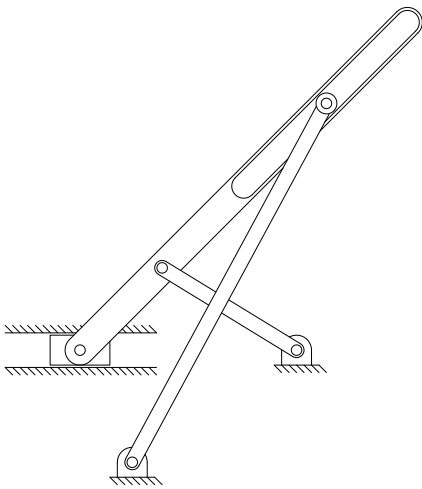
Overhead Traveler Braking Geared 5-Bar Mechanism
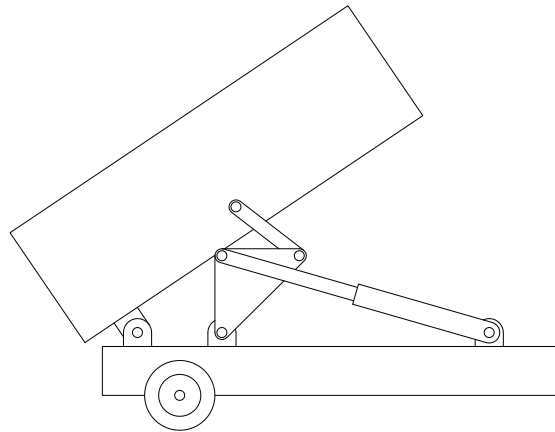
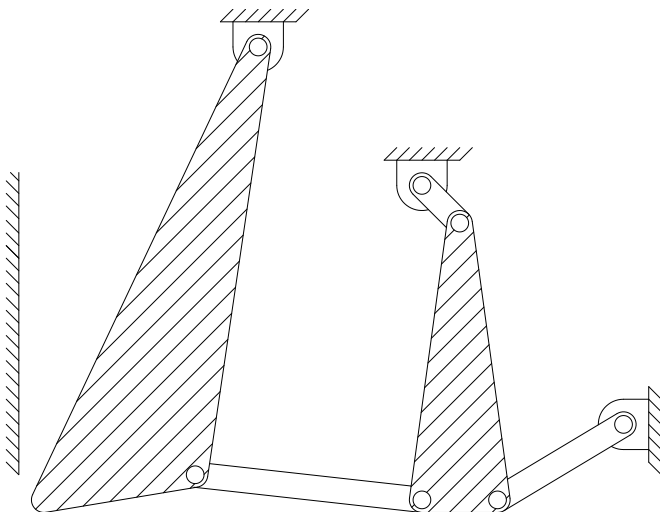## Some Real-World 6-Bar Mechanisms

6-bar Car Hood Mechanism
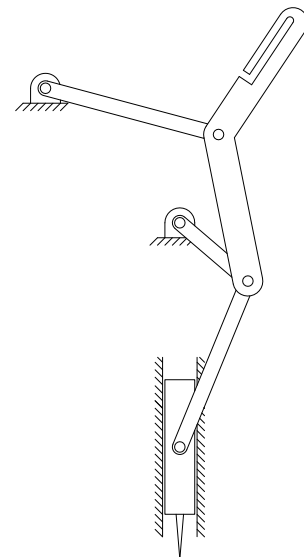
6-bar Lift Mechanism

6-bar Window Mechanism

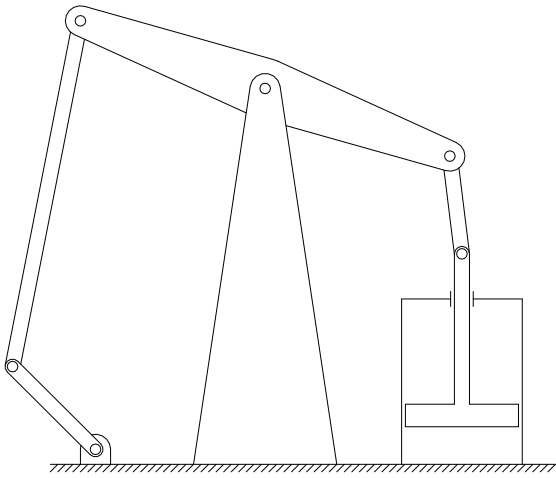**6-bar Dump Truck Mechanism**
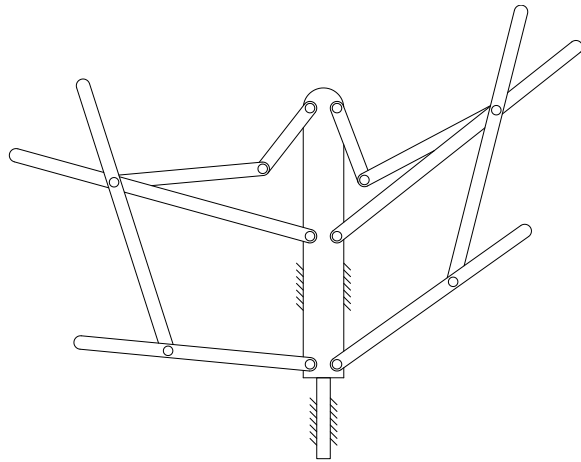
6-bar Rock Crusher Mechanism
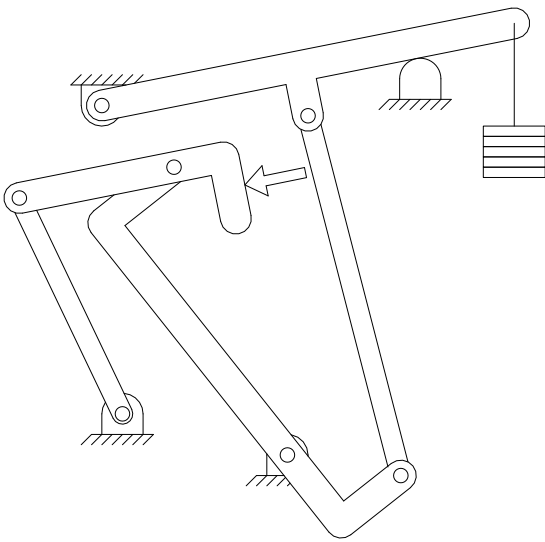
6-bar Sewing Machine Mechanism

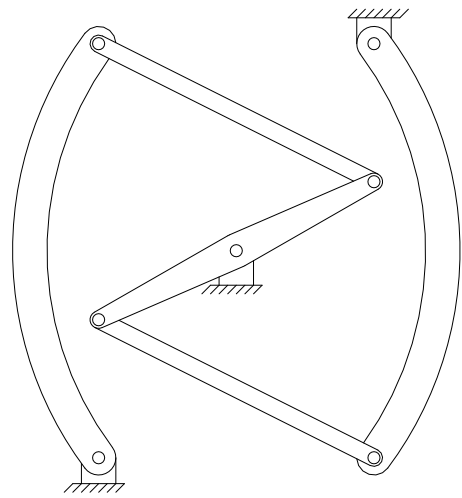# Some Real-World 6-Bar Mechanisms (cont.)

6-bar Watt Steam Engine Mechanism

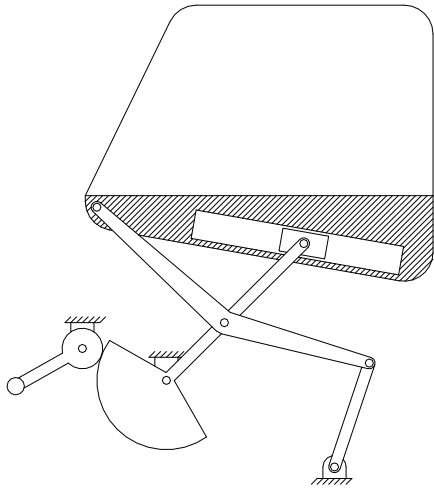**Dual 6-bar Mechanism Collapsible Music Stand**

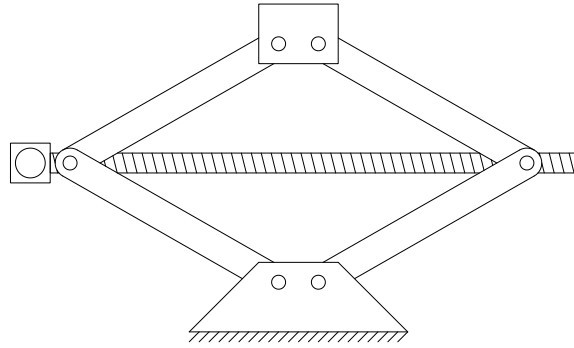**6-bar Leg Press Mechanism**

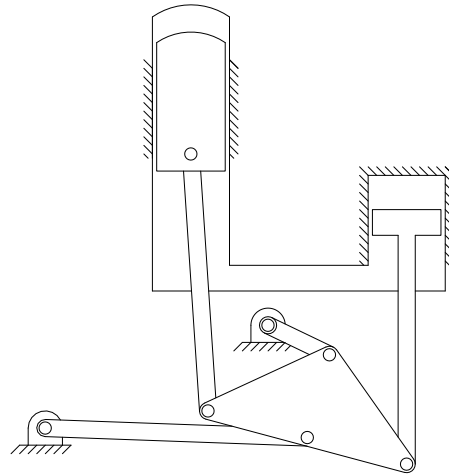**6-bar Drum Brake Mechanism**

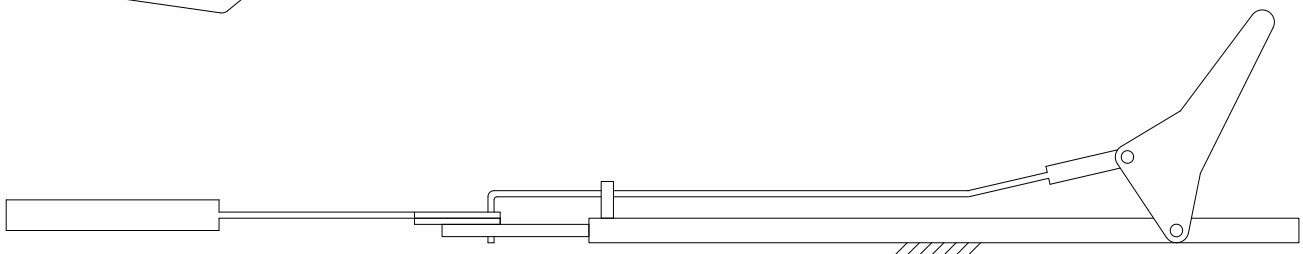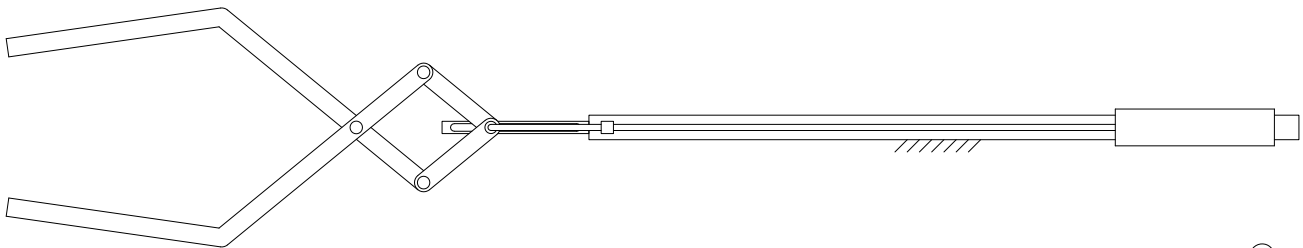## Some Real-World 7-Bar Mechanisms

7-bar Car Window Mechanism
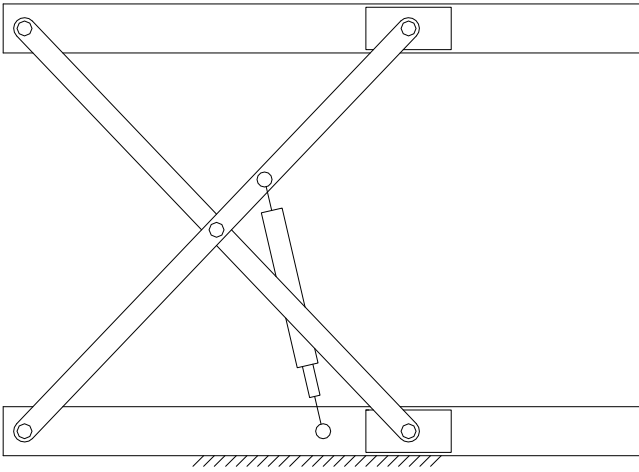

7-bar Car Jack Mechanism
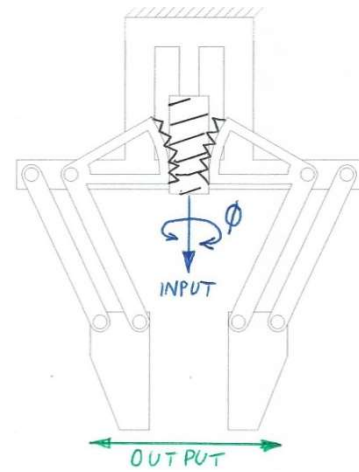

7-bar Ross Stirling Engine Mechanism
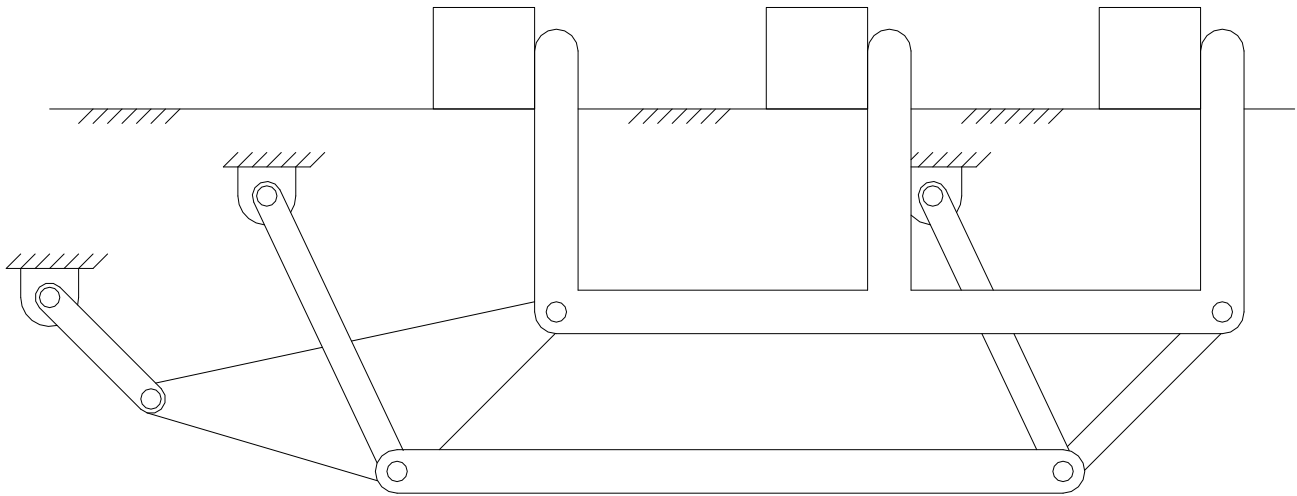

7-bar Grabber/Extender Compound Mechanism

Some Real-World 8-Bar Mechanisms

8-bar Scissor-Lift Mechanism
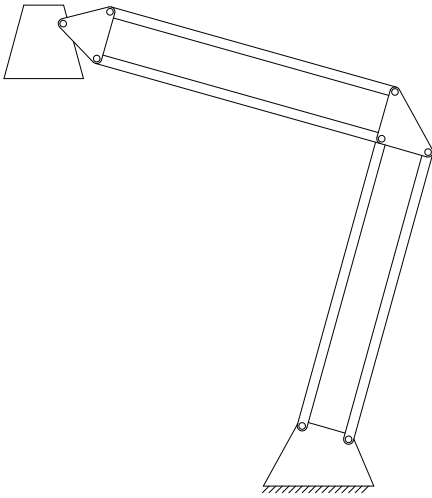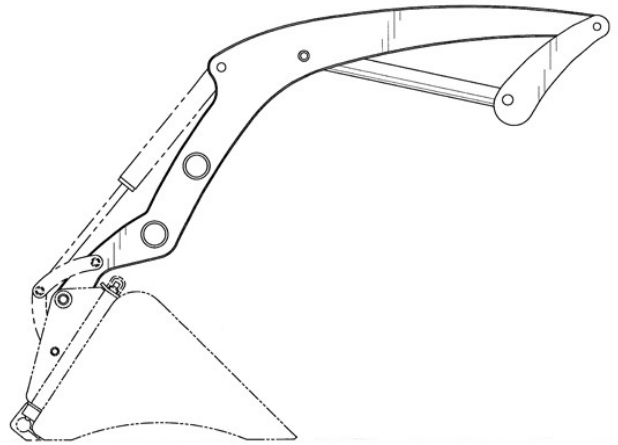
8-bar Robot Gripper Mechanism

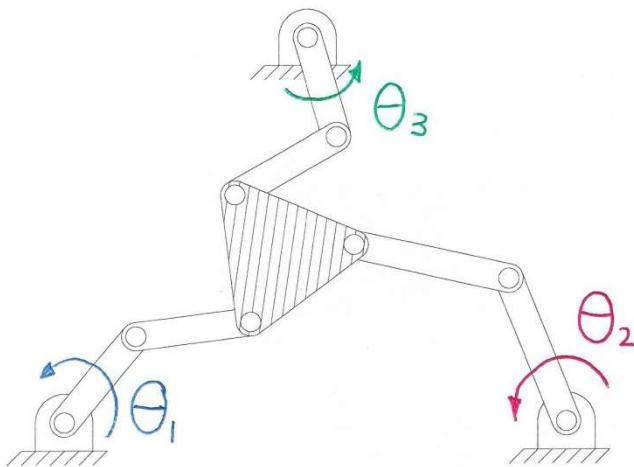**8-Bar Straight-Line Transfer Mechanism**
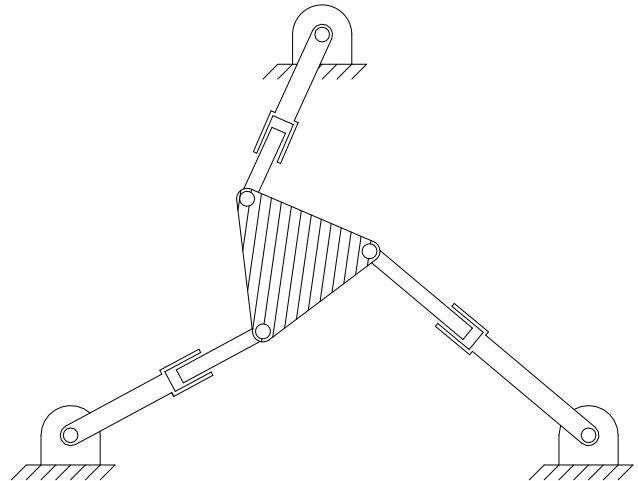
Multi-dof Robots

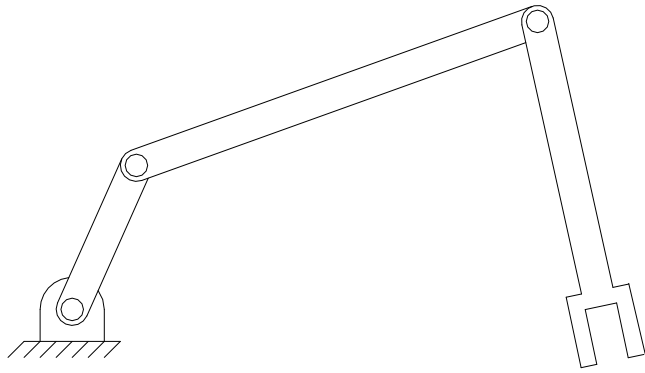**3-dof 8-bar Desk Lamp Robot**

2-dof 9-bar Front-End Loader Robot
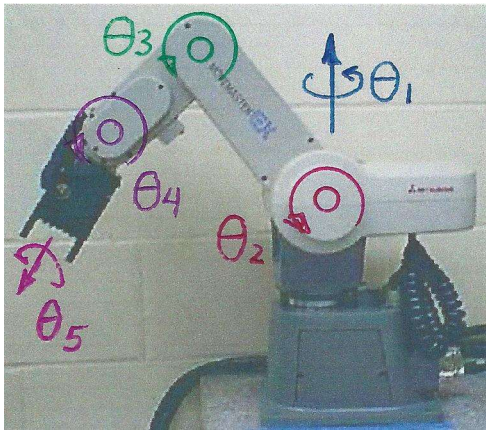

3-dof 3-RRR Parallel Robot

3-dof 3-RPR Parallel Robot

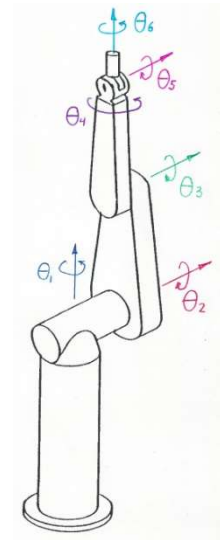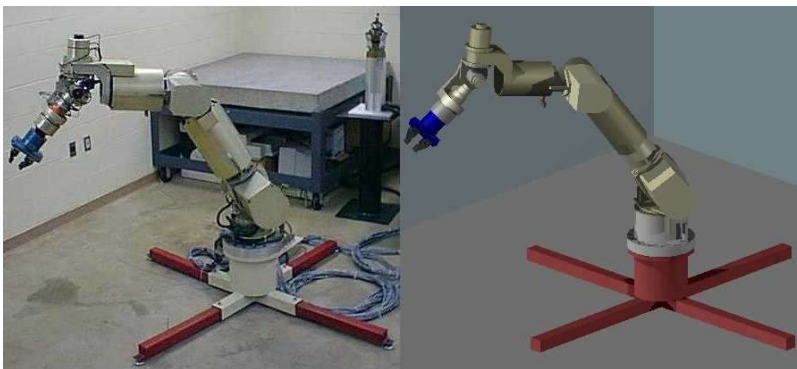**Planar 3-dof Robot**

Adept 4-dof SCARA Robot

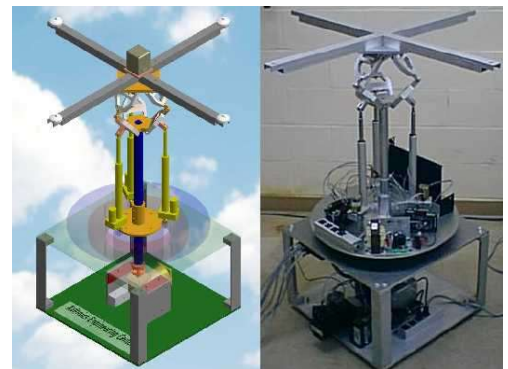**Mitsubishi 5-dof Robot**

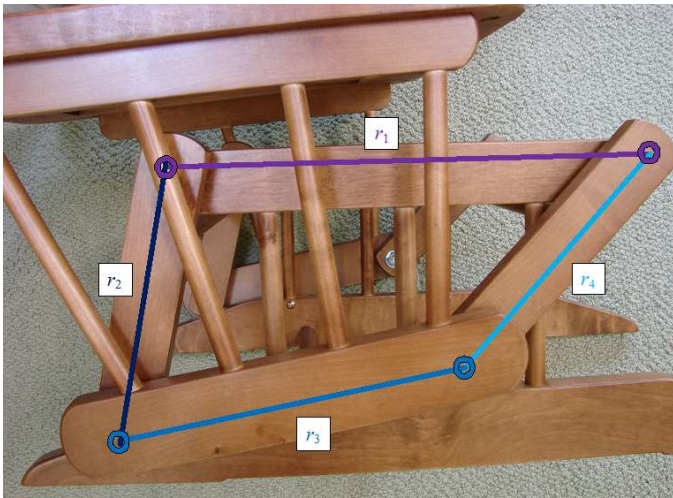**PUMA 6-dof Robot**

NASA 8-dof ARMII Robot

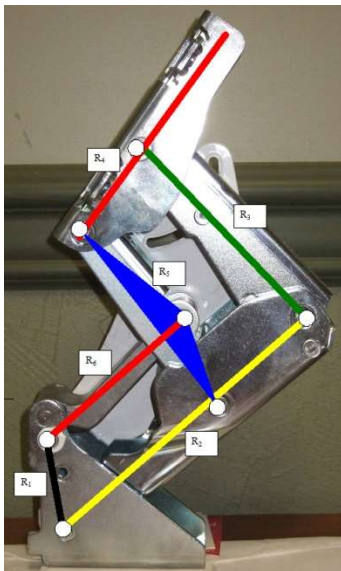**3-dof Carpal Wrist Robot**

Real-World Mechanisms / Kinematic Diagrams

4-bar Glider-Rocker Mechanism

Bicycle/Human Leg 4-bar Mechanism (lock ankle)
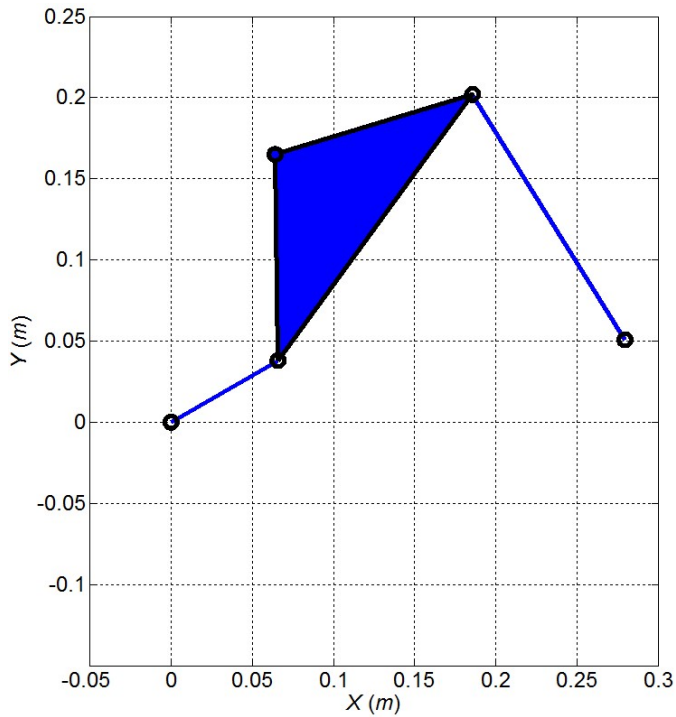

Hettich Hinge Watt I 6-bar Mechanism

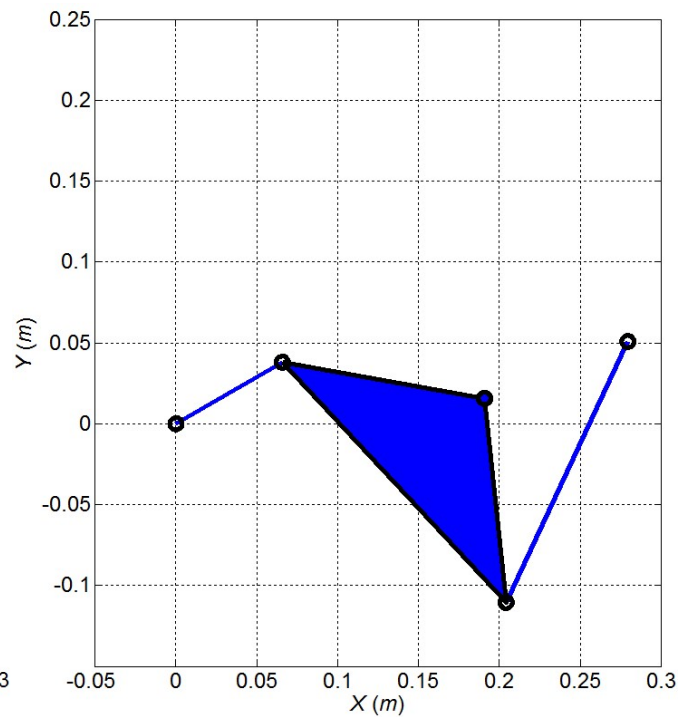**Mountain Bike Rear Suspension Mechanism**

MATLAB Simulation/Animation Gallery

All of the following MATLAB graphics/animations were created by Dr. Bob at Ohio University. These are presented according to the Ohio University course they support.

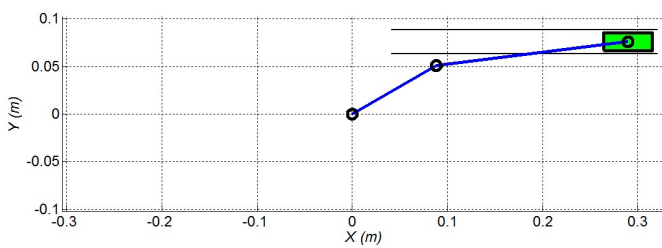## ME 3011 Kinematics & Dynamics of Machines and Introduction to Vibrations
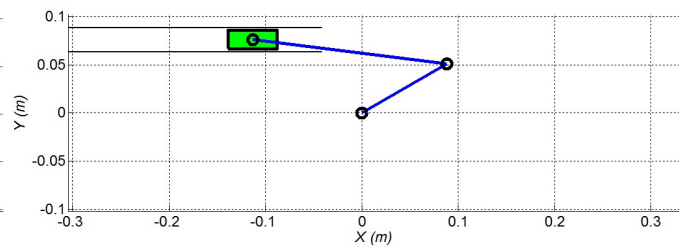
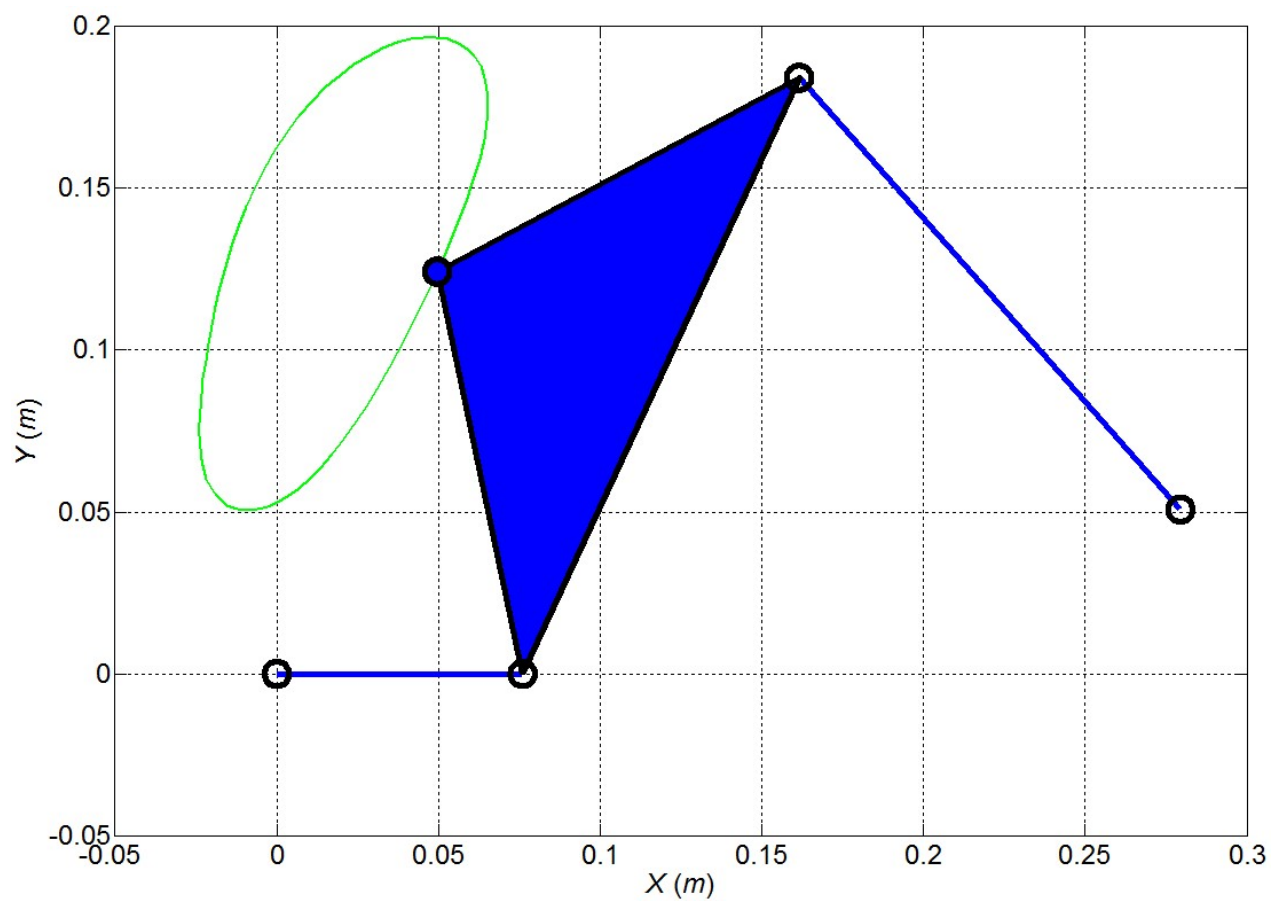**Open Branch**   **Crossed Branch**

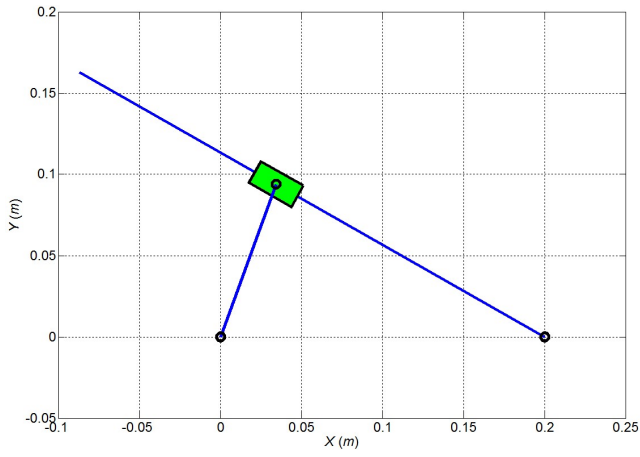**Four-Bar Mechanism**
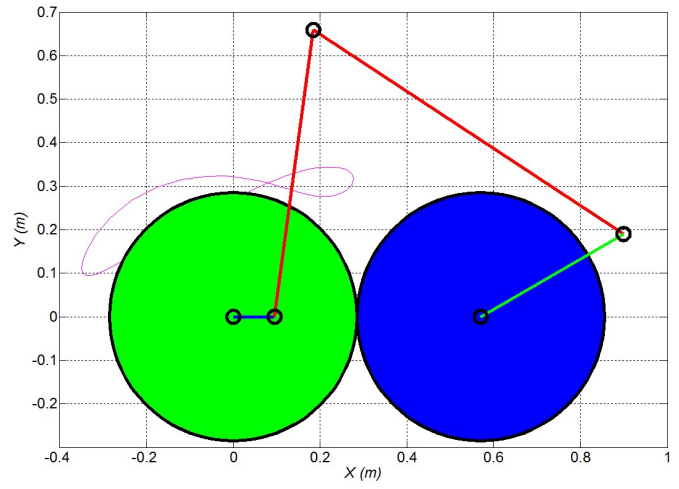
Right Branch   **Left Branch**
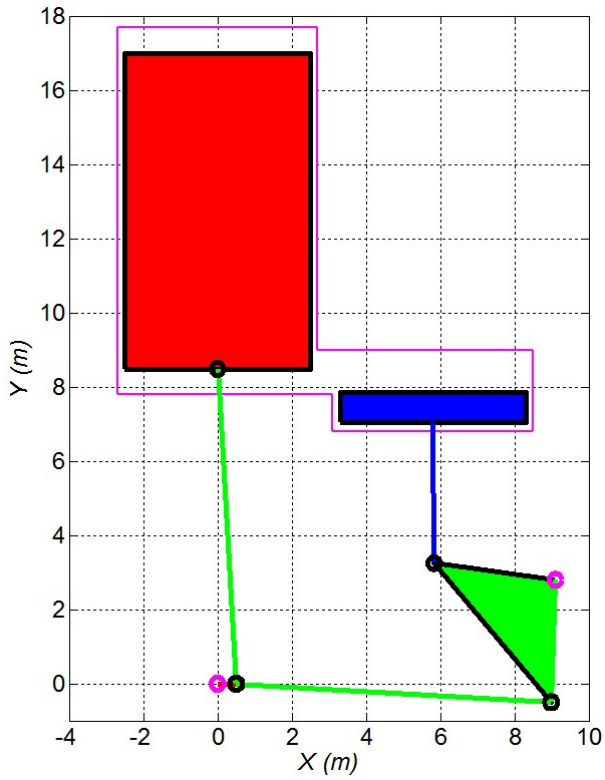
Slider-Crank Mechanism

Four-Bar Mechanism Coupler Curve
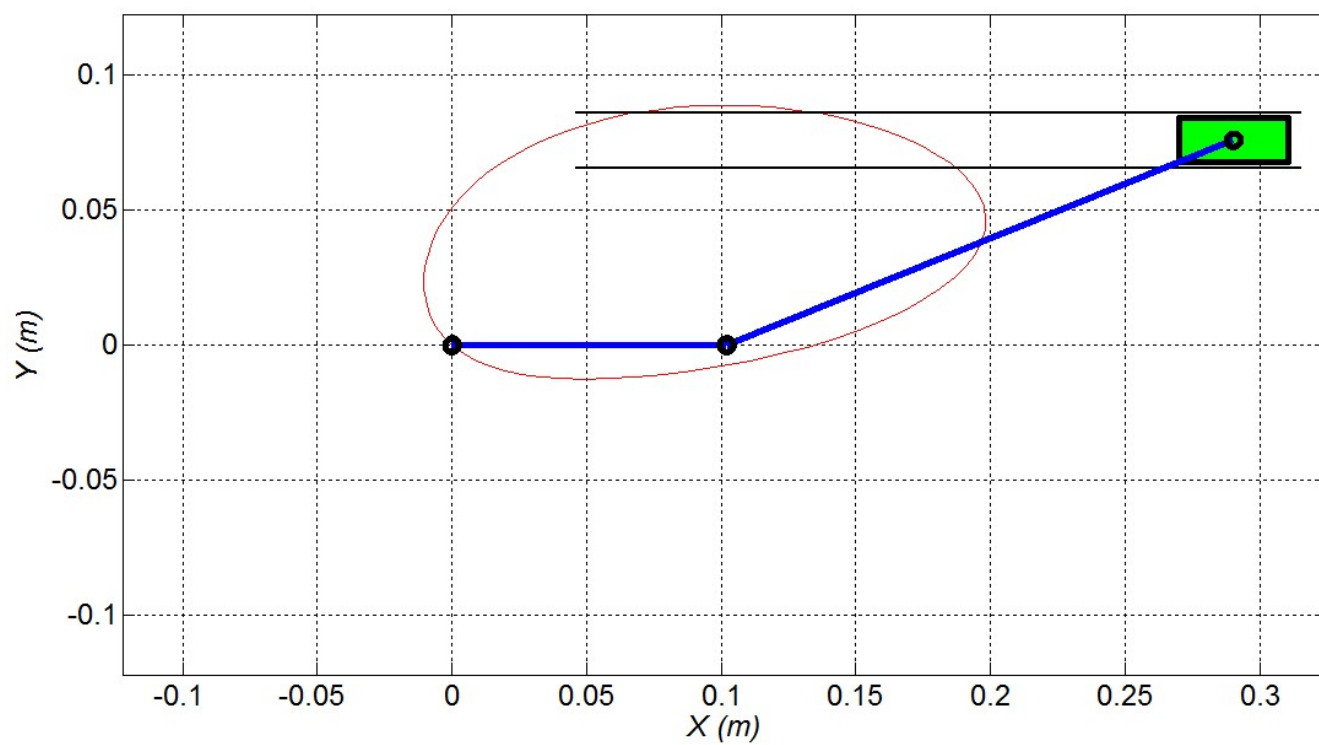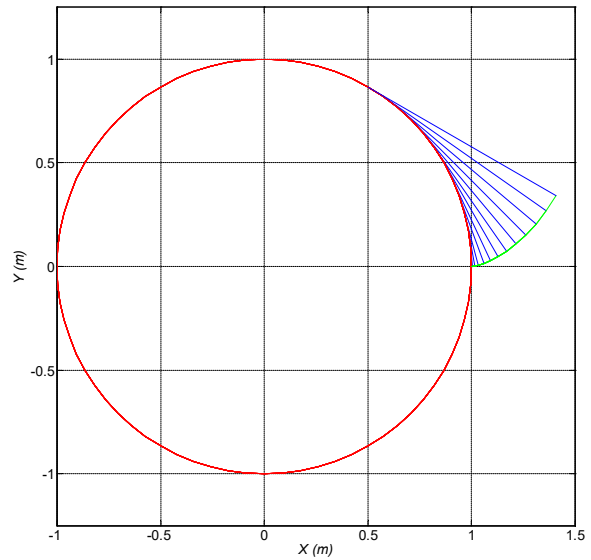
Slider-Crank Mechanism Coupler Curve

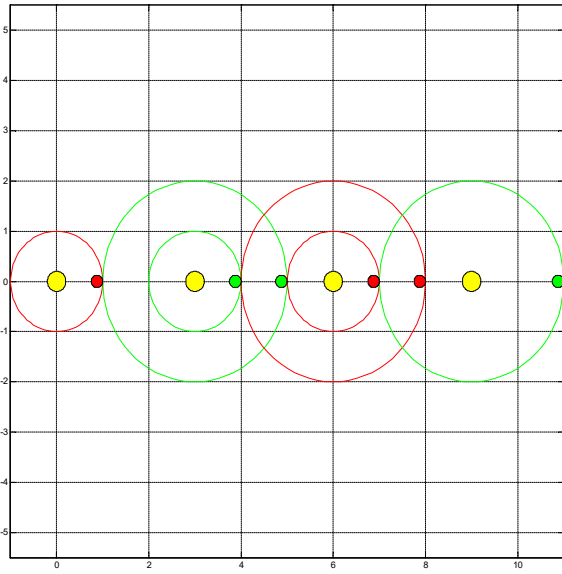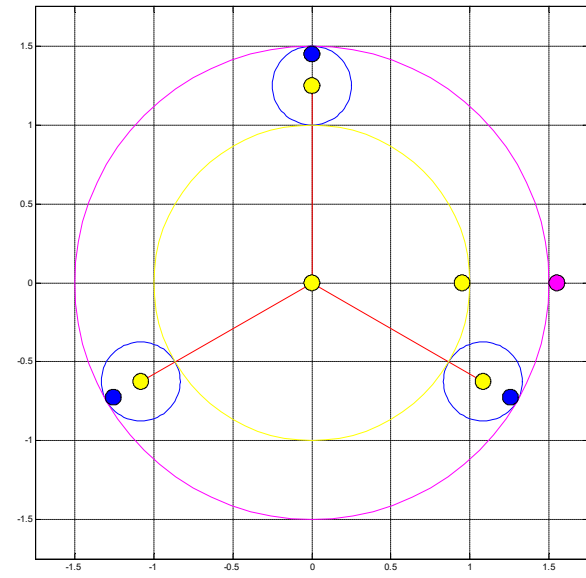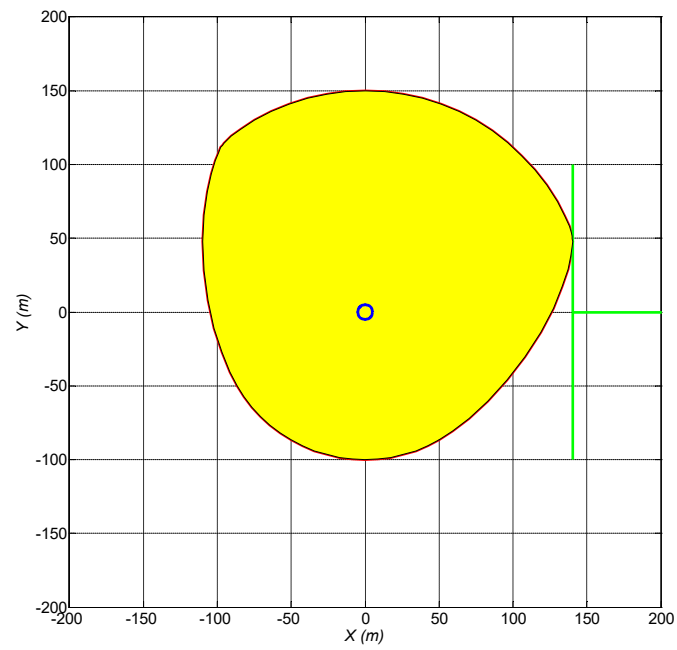**Slider-Crank Mechanism, Inversion 2**
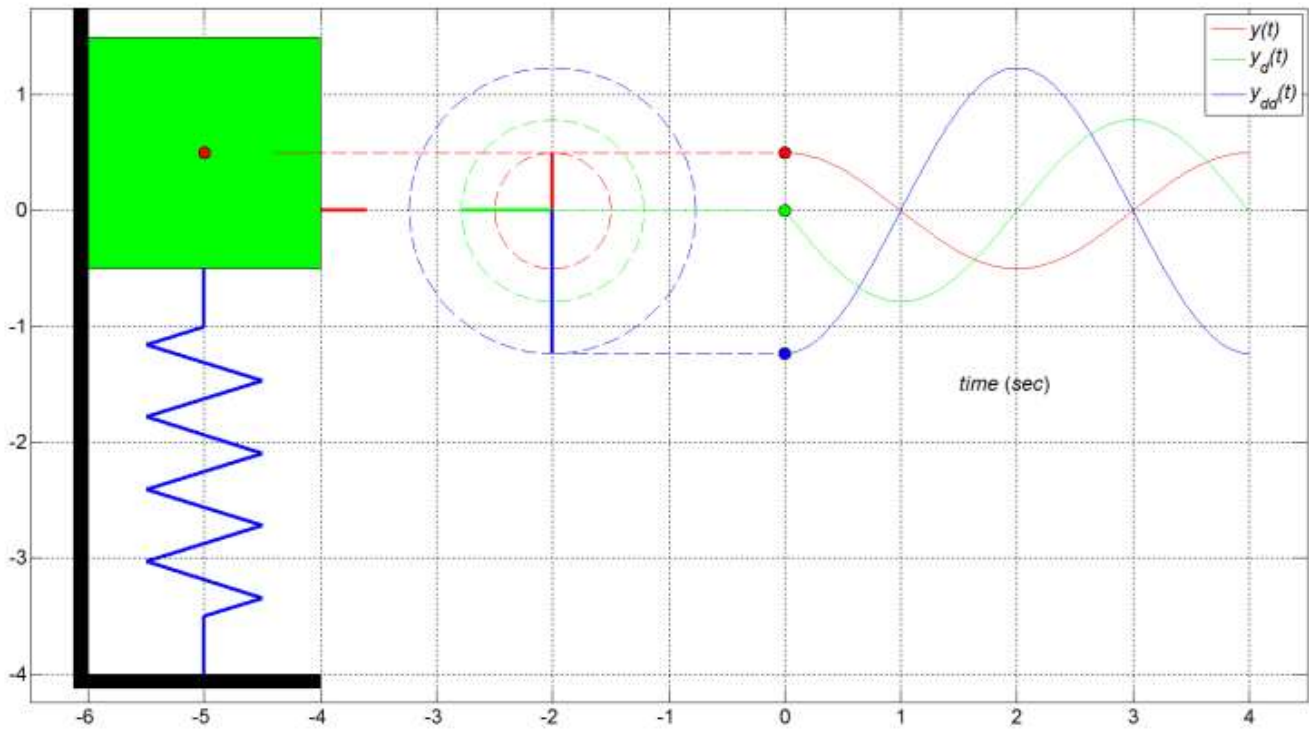

Geared Five-Bar Mechanism

Ross-Yoke Stirling Engine Mechanism

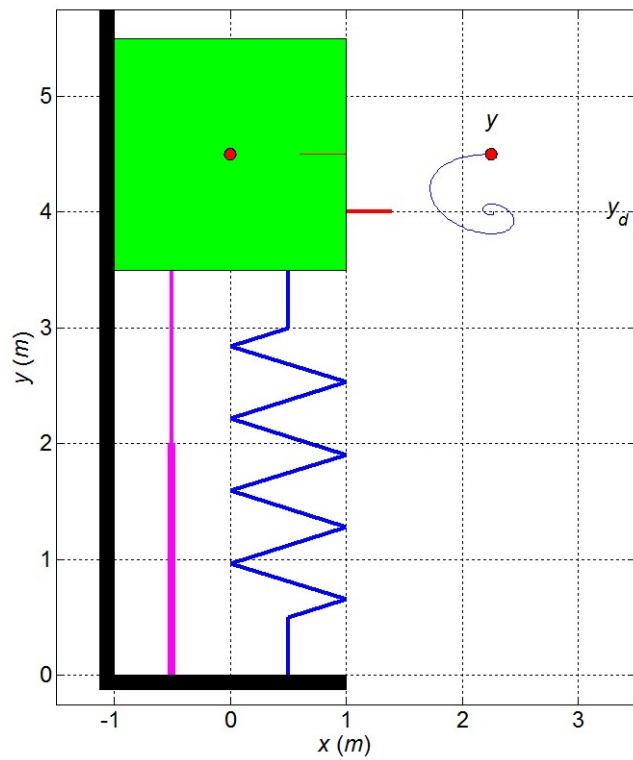**Involute Gear Tooth Construction**

Gearbox Simulation

Planetary Gear Train Simulation
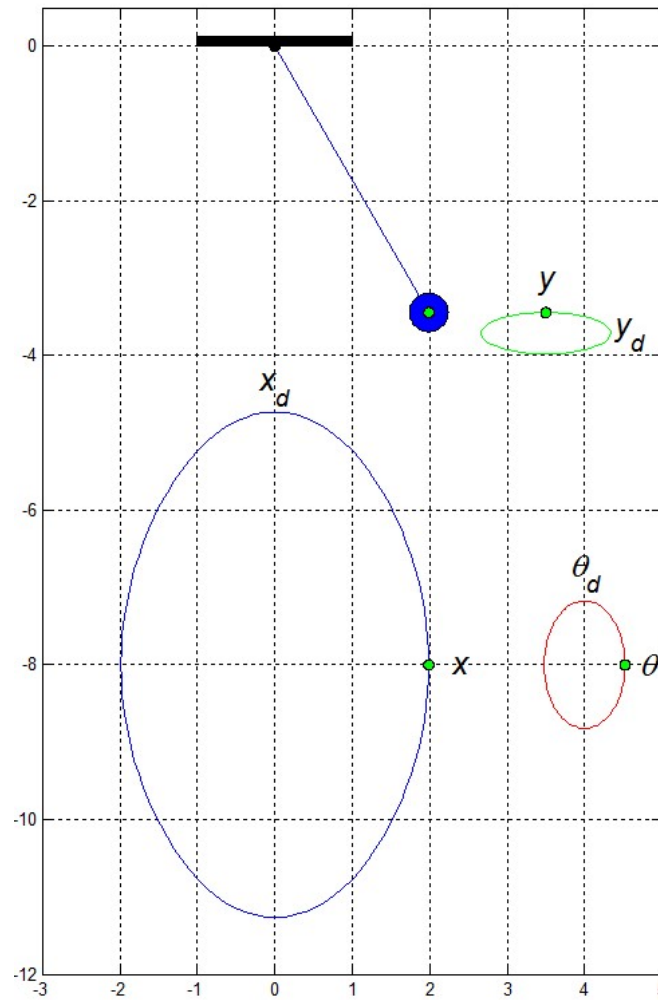

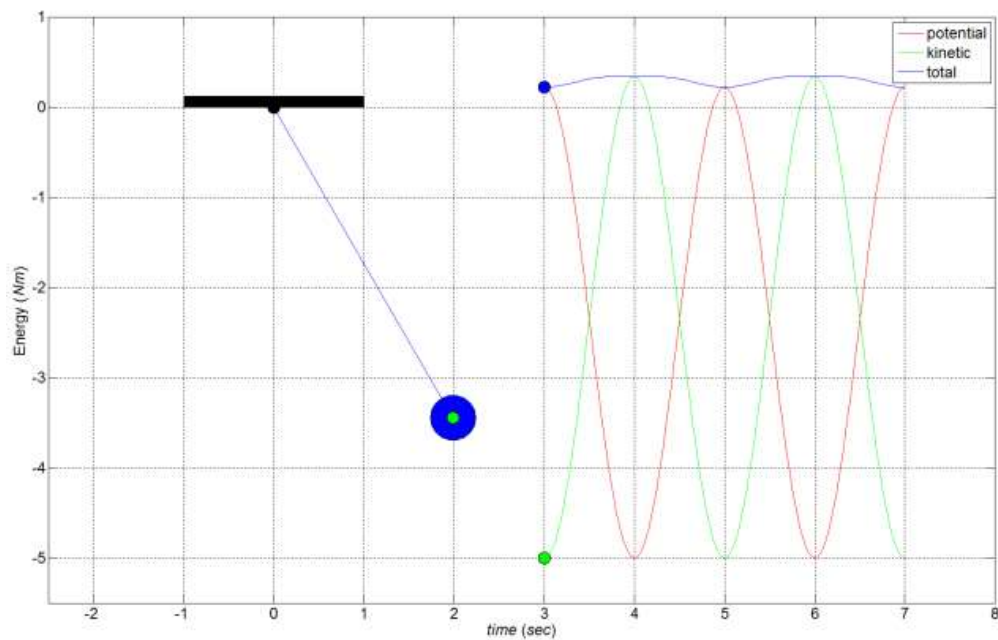**Cam/Follower Animation**

Mechanical Vibrations

1-dof m-k Vibrational System, Undamped Simple Harmonic Motion, Rotating Phasors

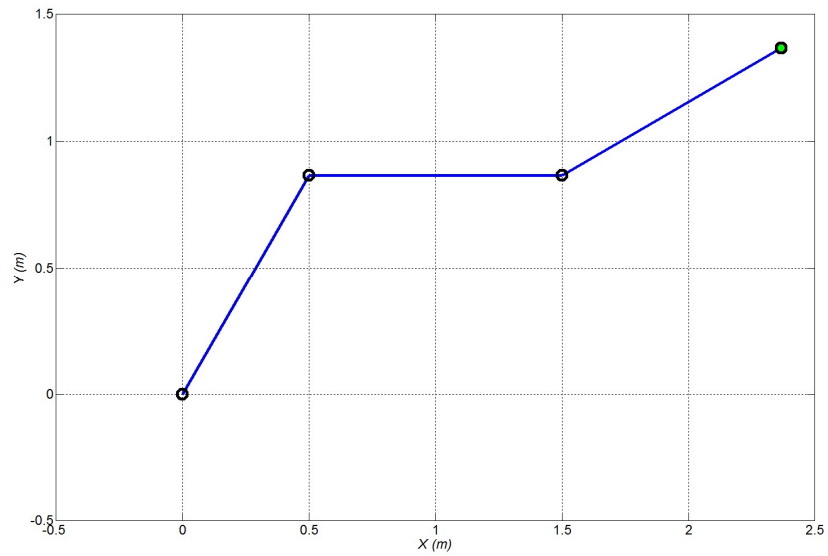**1-dof m-k Vibrational System, Underdamped Response with Phase Plot**

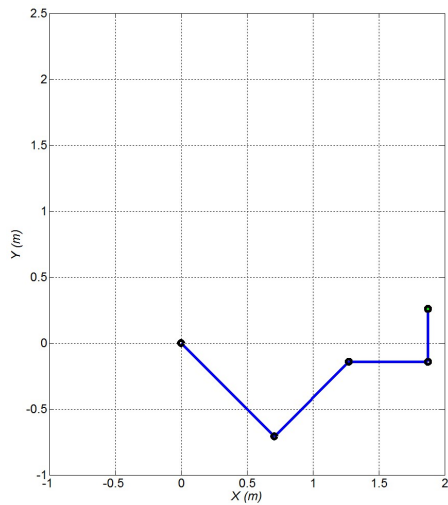**1-dof Pendulum Vibrational System, Simple Harmonic Motion with Phase Plots**

1-dof Pendulum Vibrational System, Simple Harmonic Motion with Energy Plot
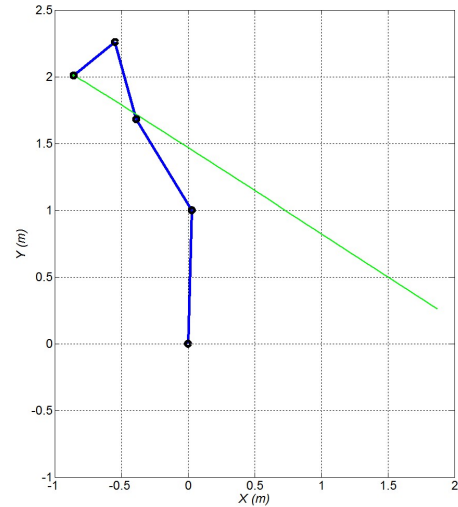
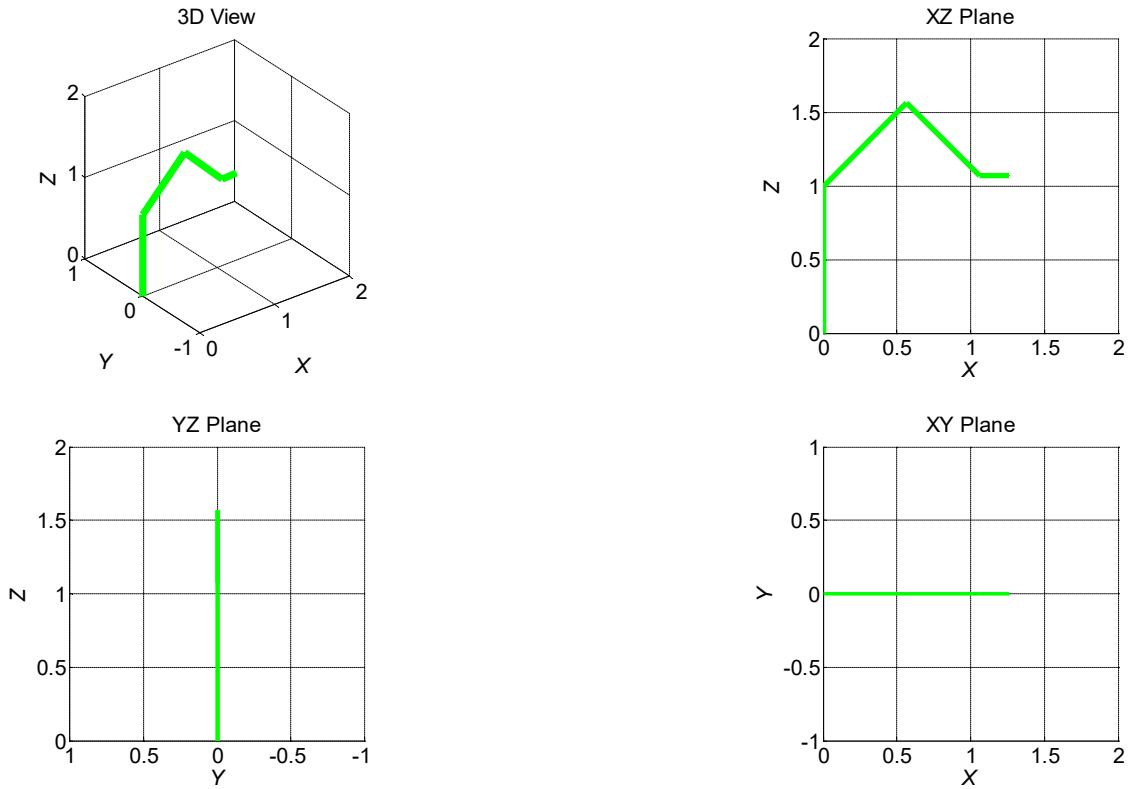**ME 4290/5290 Mechanics of Robotic Manipulators**

Planar 3R robot snapshot
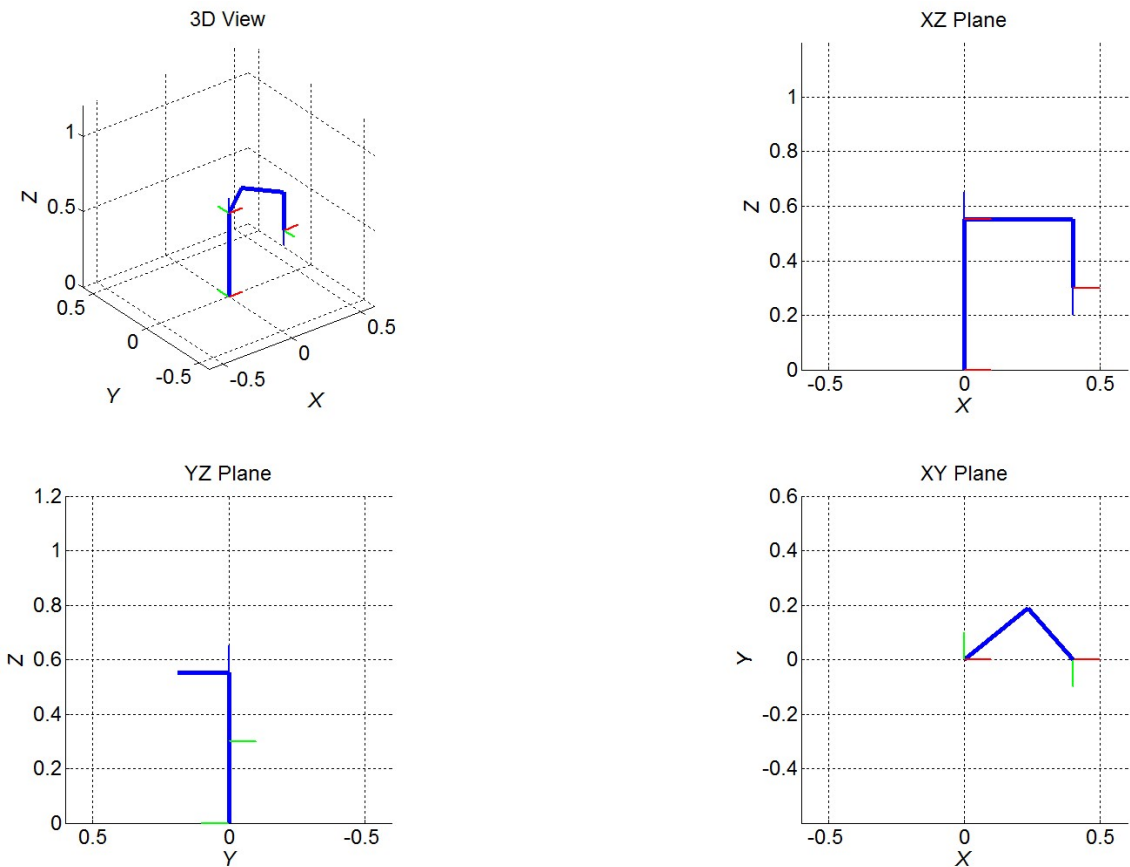

Initial Robot Pose

Final Robot Pose

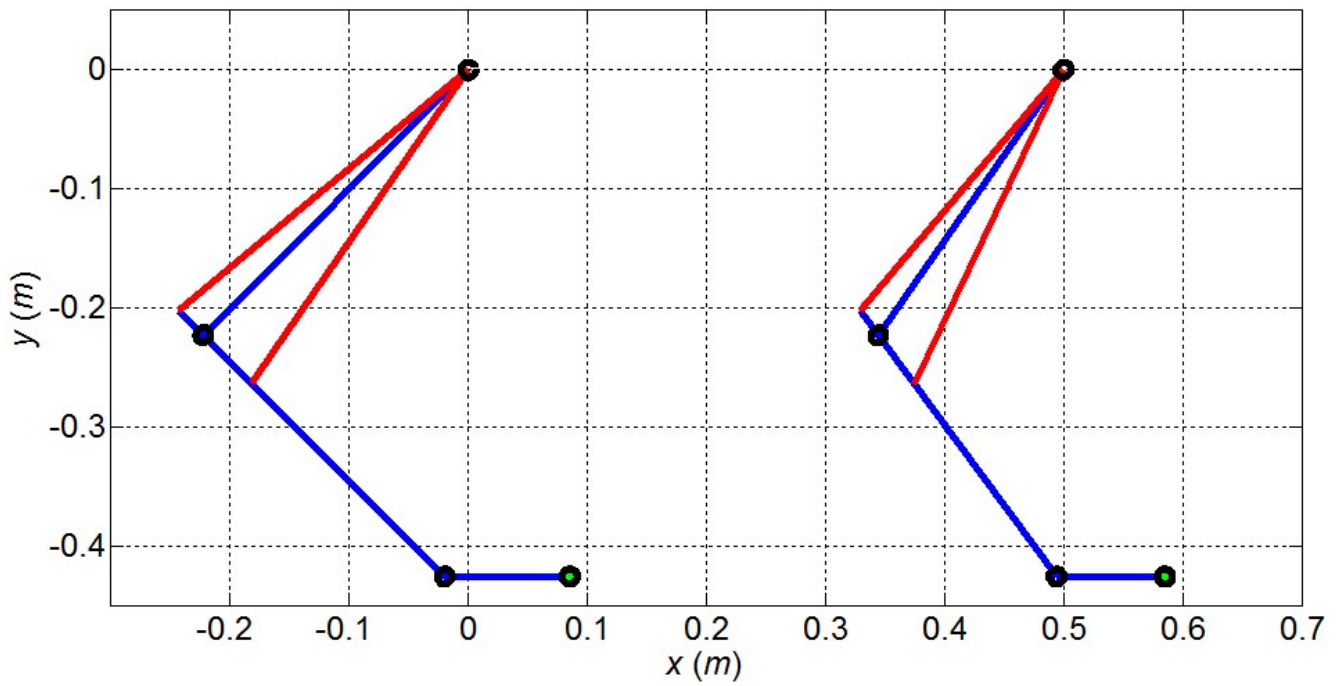**Planar 4R Kinematically-Redundant Robot Resolved-Rate Control Simulation**

Spatial 4R Kinematically-Redundant Robot Resolved-Rate Control Simulation
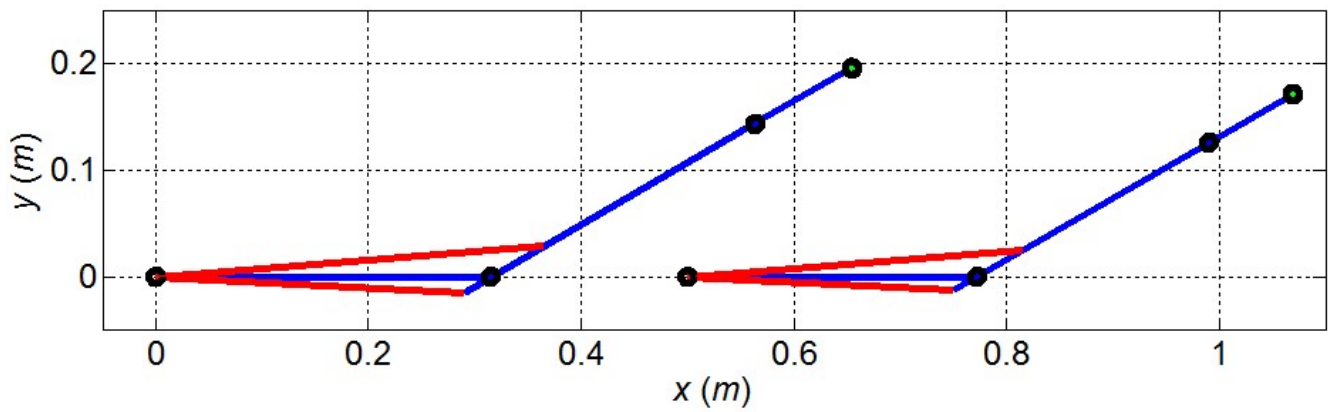

Adept 550 4-dof SCARA Robot MATLAB Simulation/Animation

ME 4670 / BME 5670 Biomechanics of Human Motion

Inverse Pose Kinematics Snapshot
(male left, female right)

Human Elbow/Biceps/Triceps Dynamic Simulation (male left, female right)