ME 222: Kinematics of Machines and Mechanisms

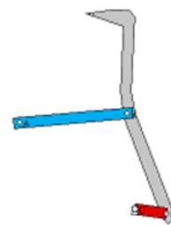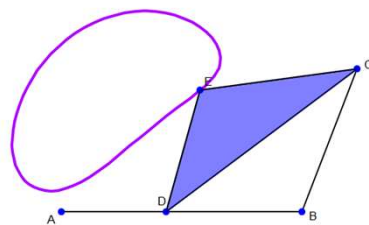## [L13] Path Generation 1

Overview

- Path generation
- Coupler Curve
- Cognates
- Parallel motion

Path Generation

- *The control of a **point** in the plane such that it follows some prescribed path*

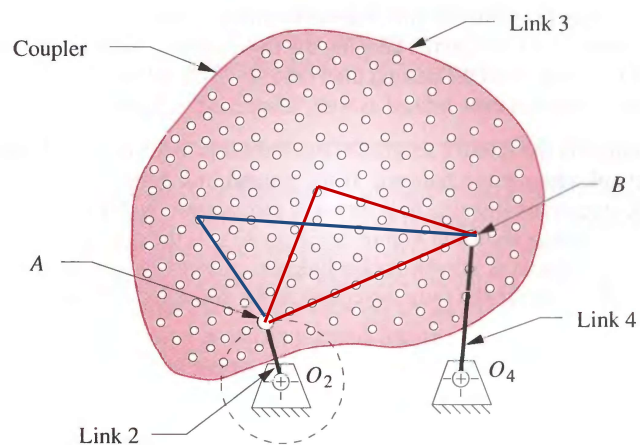# Coupler curve

- Coupler: most interesting link of four bar

Coupler curve

- A slider-crank can generate curve with max order m=4.

- four-bar mechanism can generate curve with max order m=6.

- n-link revolute jointed can have maximum order

$$m = 2 \ 3^{(n/2-1)}$$

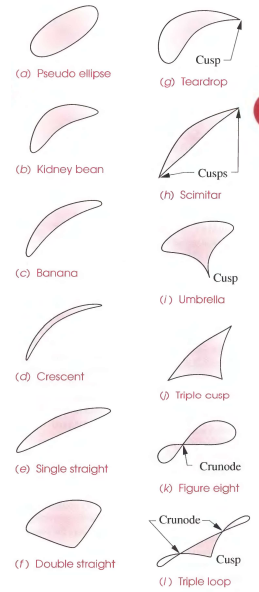# Coupler curve

Coupler curves

FOURBAR COUPLER CURVES can be crudely categorized as
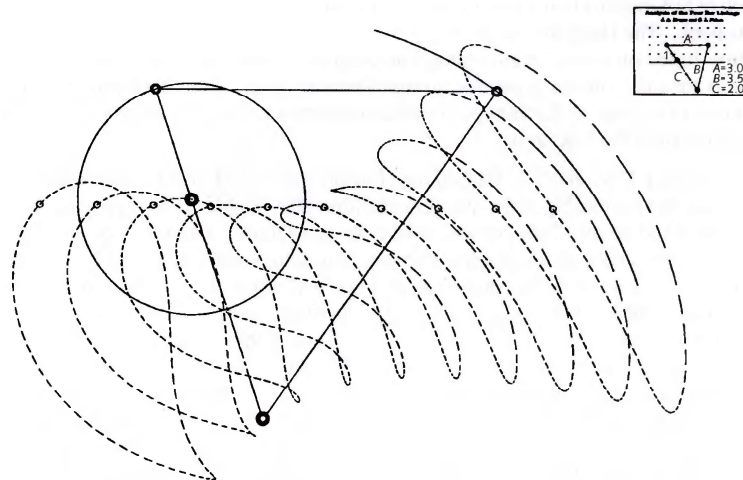
- Cusp
- Crunode

(a) Pseudo ellipse
(b) Kidney bean
(c) Banana
(d) Crescent
(e) Single straight
(f) Double straight
(g) Teardrop — Cusp
(h) Scimitar — Cusps
(i) Umbrella — Cusp
(j) Triple cusp
(k) Figure eight — Crunode
(l) Triple loop — Crunode, Cusp

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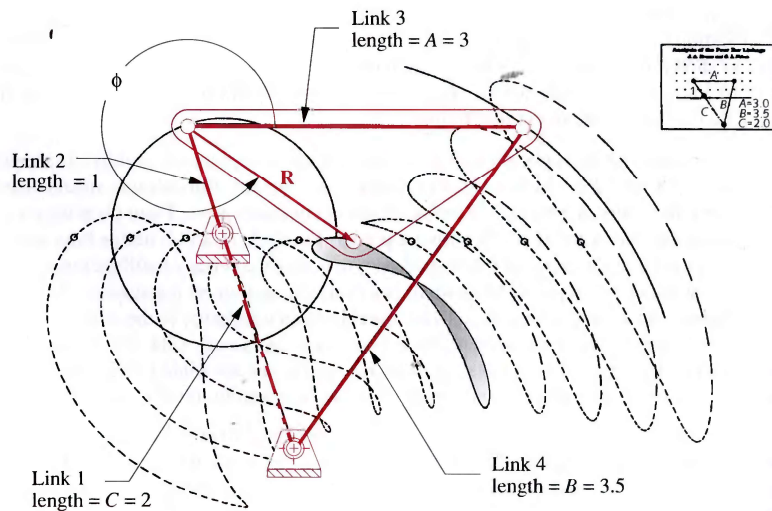# *Hrones and Nelson* (H&N) atlas

- Atlas of fourbar coupler curves (7000)

A=3.0
B=3.5
C=2.0

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Hrones and Nelson (H&N) atlas

Hrones, J. A., and G. L. Nelson. (1951). *Analysis of the Fourbar Linkage.* MIT Technology Press:Cambridge, MA.
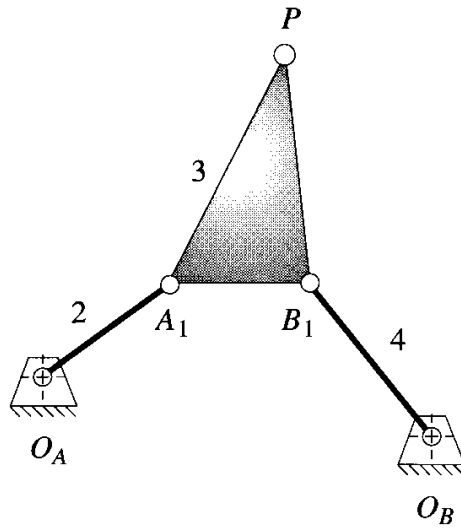
Cognates

- Good solution that satisfies path generation constraints but inappropriate fixed pivots

- **Cognate** can be helpful in such situations.

- **Cognate** : A *linkage, of different geometry, which generates the same coupler curve.*

- **Roberts-Chebyschev Theorem:** *Three different planar, pin-jointed fourbar linkages will trace identical coupler curves.*
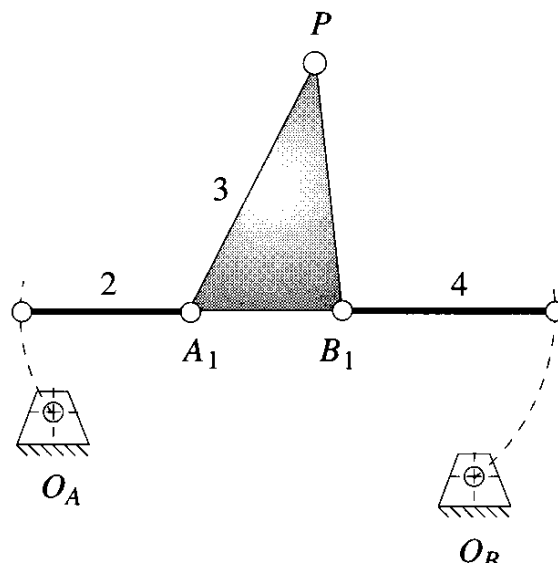
Cayley Diagram

Cayley Diagram

Cayley Diagram
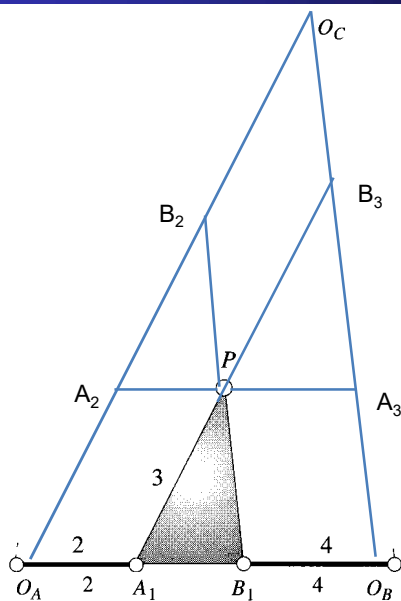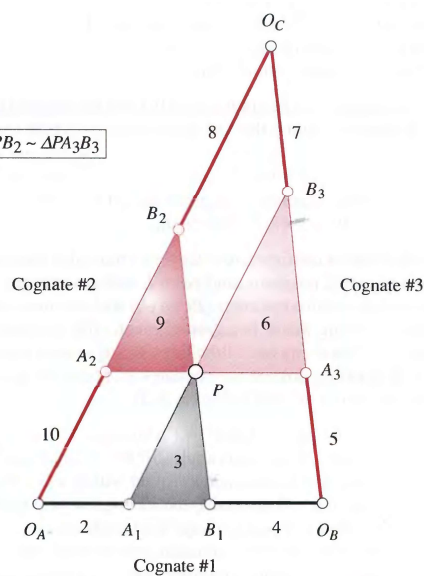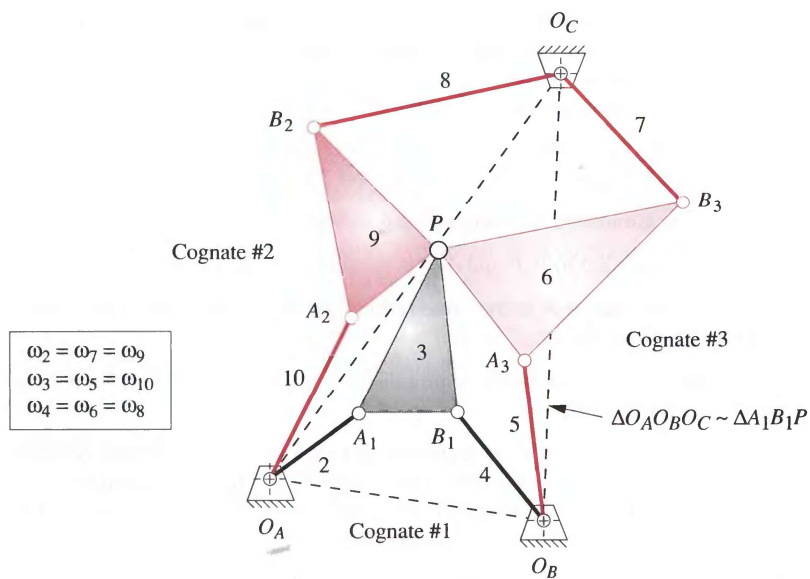
Cayley Diagram

$$\Delta A_1B_1P \sim \Delta A_2PB_2 \sim \Delta PA_3B_3$$
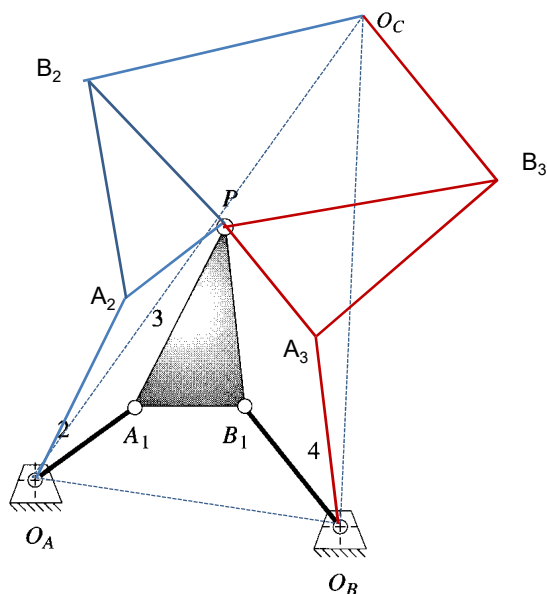

Cognate #2

Cognate #3

Cognate #1

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Roberts Diagram

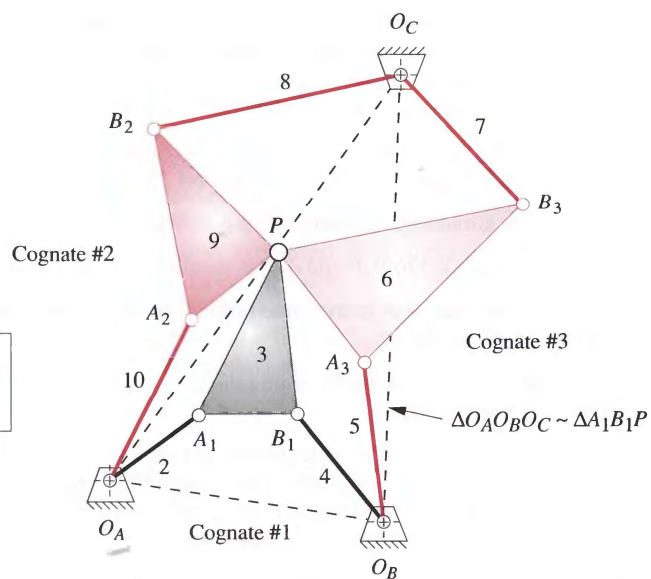# 3-Cognates
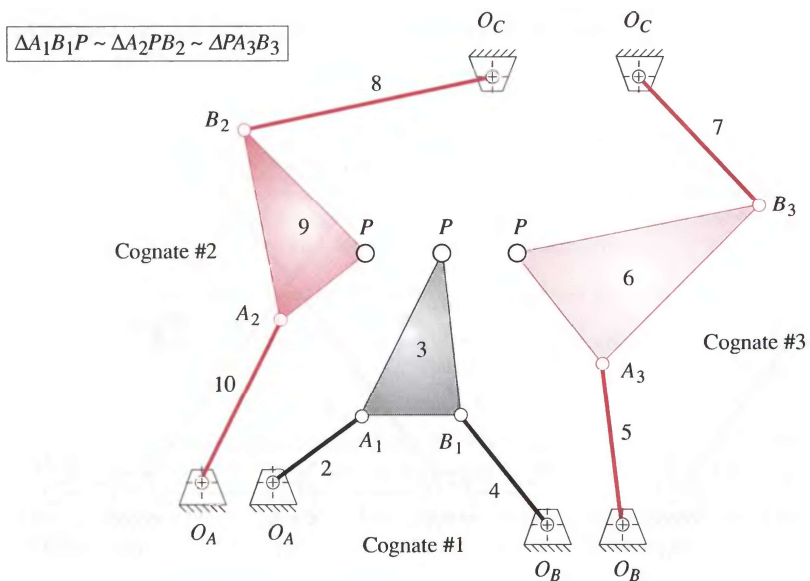
Robert's Diagram

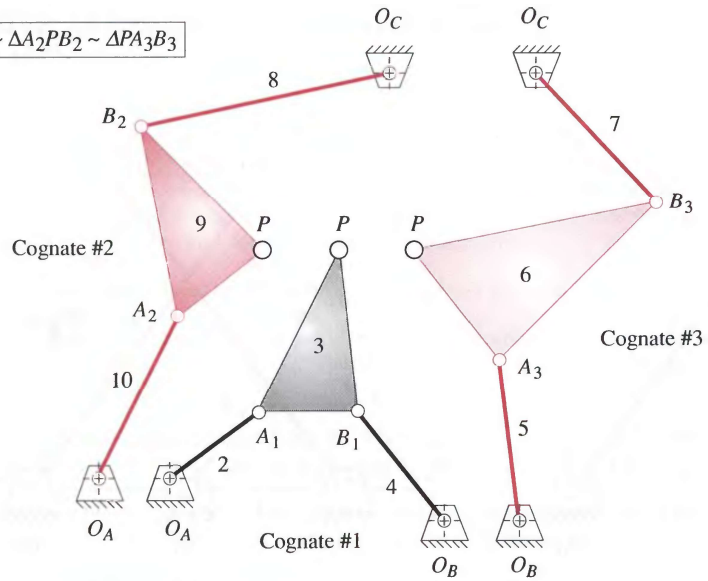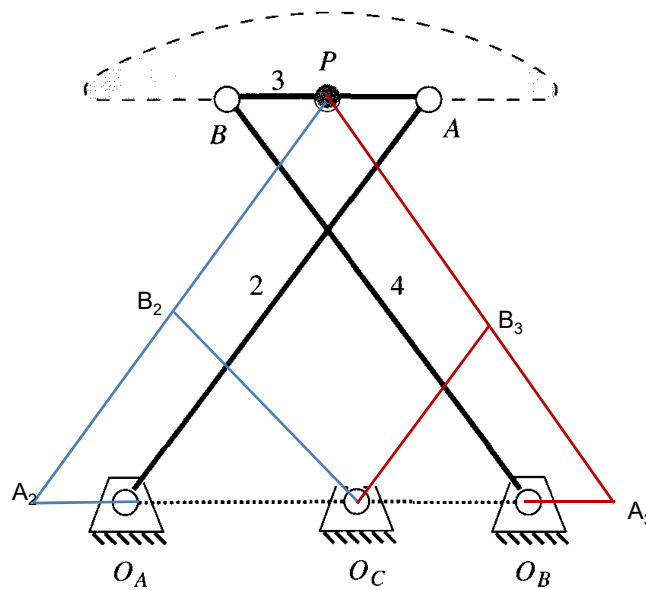# Robert's Diagram

$\omega_2 = \omega_7 = \omega_9$
$\omega_3 = \omega_5 = \omega_{10}$
$\omega_4 = \omega_6 = \omega_8$

$\Delta O_A O_B O_C \sim \Delta A_1 B_1 P$

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3-Cognates

$\Delta A_1 B_1 P \sim \Delta A_2 P B_2 \sim \Delta P A_3 B_3$

Cognate #2

Cognate #3

Cognate #1

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Coupler point on link-3

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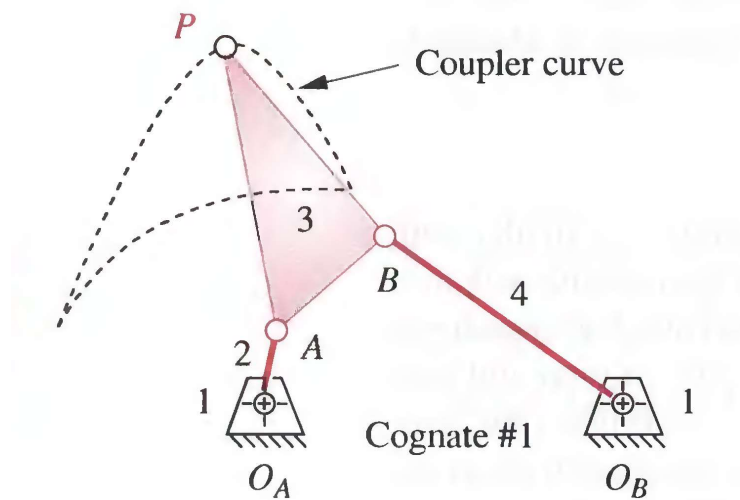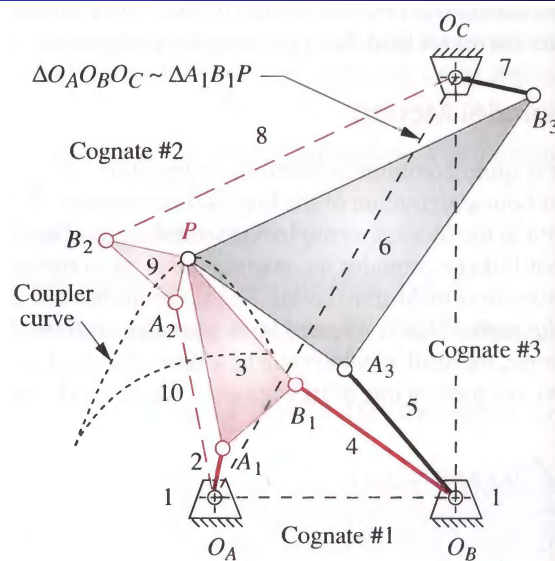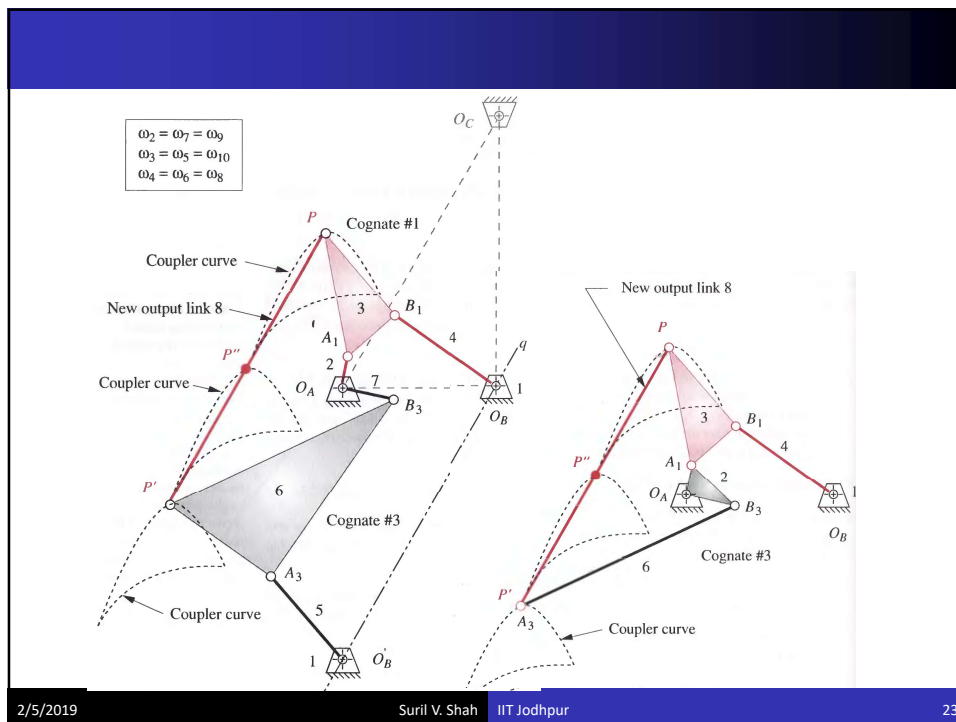
Parallel motion

Thank you
Next Class: Parallel motion