Graphical Linkage Synthesis

Lecture 4
Design of Crank-Rocker

Today’s Agenda

- Graphical determination Limit Positions
- Time ratio
- Transmission angle
- A standard design problem
Synthesis

Definition:

1. Putting together
2. Creating something new

You cannot analyze anything until it has been synthesized into existence
Dimensional Synthesis

- Determines the proper link lengths of a mechanism to perform the required task. (i.e. Grashof’s Criterion)
- Can be done either graphically or analytically.
- One method can be used to check the other.
Design Considerations

- Do we know the required type of input/output motion?
- How will the mechanism be powered?
- How do we determine the efficiency of the mechanism?
Some examples of possible input/output motion.

- Slider-crank \((\text{rotate} - \text{translate})\)
- Crank-rocker \((\text{rotate} - \text{rock})\)
- Double-rocker \((\text{rock} - \text{rock})\)
Non Grashof fourbar linkage has its limit positions when the crank and the coupler links are colinear. These limits positions are called **toggle positions**.
A Grashof fourbar linkage will assume two stationary positions when the crank (link 2) and the coupler (link 3) are either extended colinear or overlapping colinear. These stationary positions defined the limit motion of the driven rocker (link 4).
Time ratio

The timing of the crank-rocker can be assessed using the two stationary positions.

\[
\text{Time ratio} = \frac{\text{Time it takes to complete forward motion}}{\text{Time it takes to complete return motion}}
\]

OR

\[
\text{Time ratio} = \frac{\text{Crank angle to complete forward motion}}{\text{Crank angle to complete return motion}}
\]
**Time ratio and return mechanisms**

**Even return crank-rocker**

- For a given constant input speed, It takes the *same time* to complete the forward and the return motion, therefore: \[ \text{Time ratio} = 1 \]

- The two stationary positions of the crank line up with each other, and the *angles* swept between these stationary positions are equal.
Quick-return crank-rocker

- For a given constant input speed, the Time it takes to complete the forward motion is more than the time it takes to complete the return motion, therefore:

  \[ \text{Time ratio} > 1 \]

- The two stationary positions of the crank do not line up with each other, and the angles swept between the stationary positions are not equal.
Quick-return crank-rocker

\[ \alpha + \beta = 360^\circ \]

Time ratio: \[ T_R = \frac{\alpha}{\beta} \]

\[ \delta = |180^\circ - \alpha| = |\beta - 180^\circ| \]

Or the time ratio is:

\[ T_R = \frac{(180^\circ + \delta)}{(180^\circ - \delta)} \]

These angular values and relationships will be used to synthesize the linkage.