EME 152 Discussion 6

November 3, 2021

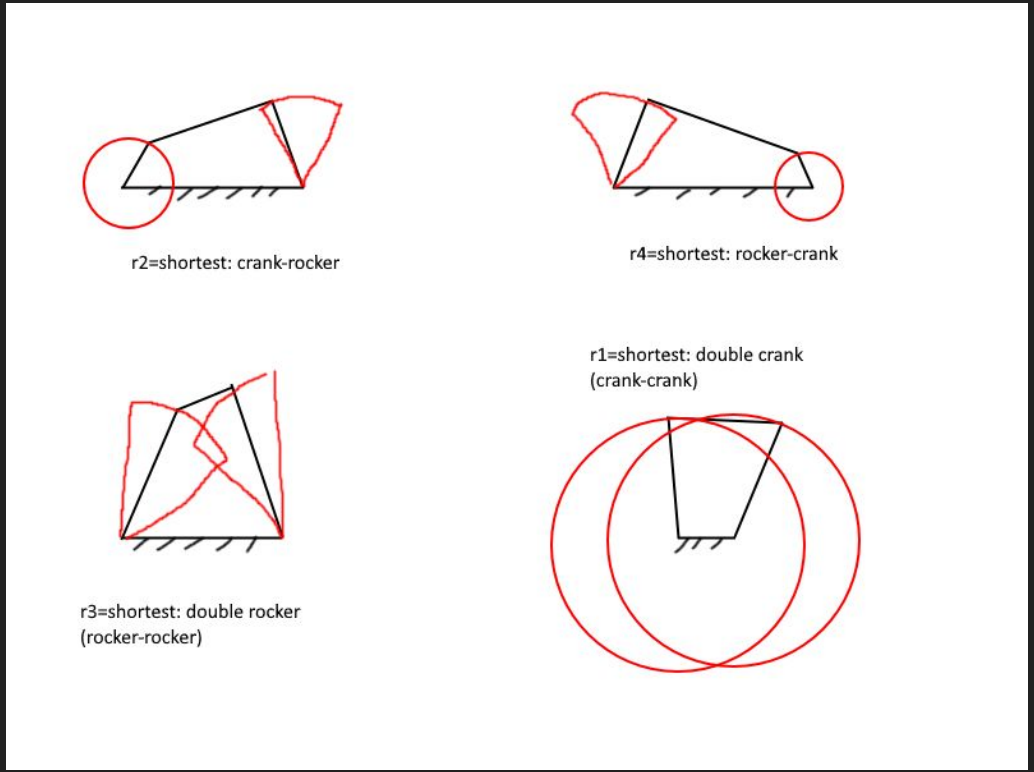
Agenda

- **Announcement**: homework 1-5 solutions are posted on Canvas + GitHub
  - Will be posted weekly for the rest of the quarter
- Fourbar naming convention
- Range of motion
- Positional analysis using the CFourbar class
- Loop closure equation

Fourbar Naming Convention

- r_1 = ground link
- r_2 = input link
- r_3 = floating link
- r_4 = output link

Fourbar Naming Convention (Grashof)



Fourbar Naming Convention (Non-Grashof)

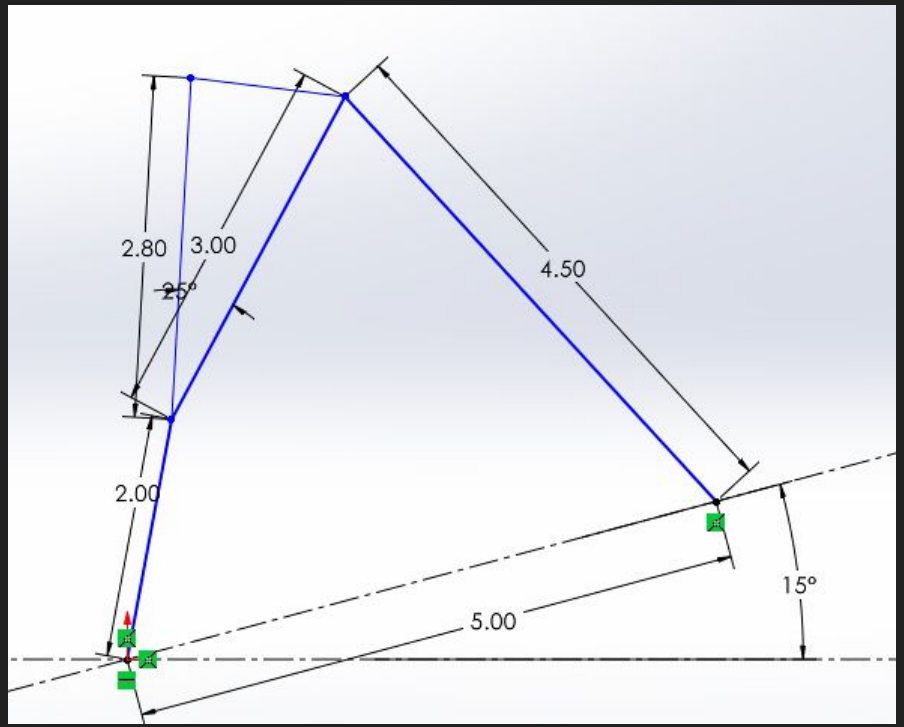
- Non-Grashof mechanisms are called “triple rocker” mechanisms
- $r_1+r_2<r_3+r_4$ and $r_1+r_4<r_2+r_3$: inward/inward
- $r_1+r_2>=r_3+r_4$ and $r_1+r_4<r_2+r_3$: outward/inward
- $r_1+r_2<r_3+r_4$ and $r_1+r_4>=r_2+r_3$: inward/outward
- $r_1+r_2>=r_3+r_4$ and $r_1+r_4>=r_2+r_3$: outward/outward

4 Bar Linkage Simulation

dynref.engr.illinois.edu/aml.html

Range of Motion

Calculate the range of motion for the output link (r_4) of this mechanism from homework 5.



Range of Motion

First, determine whether or not it is a Grashof linkage.

2.0 + 5.0 < 3.0 + 4.5

Grashof Linkage: $r_s + r_l < r_p + r_q$

Range of Motion

$$\cos(\theta''_{2,max}) = \frac{r_1^2 + r_2^2 - (r_3 + r_4)^2}{2r_1 r_2}$$

$$\cos(\theta''_{2,min}) = \frac{r_1^2 + r_2^2 - (r_3 - r_4)^2}{2r_1 r_2}$$

$$\Delta\theta_2 = |\theta_{2,max} - \theta_{2,min}|$$

Range of Motion

$$\theta_{2min} = \arccos\left(\frac{r_1^2 + r_4^2 - (r_2 - r_3)^2}{2r_1 r_4}\right) \cdot \frac{180}{\pi}$$

$$\theta_{2min} = 10.4753138432$$

$$\theta_{2max} = \arccos\left(\frac{r_1^2 + r_4^2 - (r_2 + r_3)^2}{2r_1 r_4}\right) \cdot \frac{180}{\pi}$$

$$\theta_{2max} = 63.2563160496$$

$$\left|\theta_{2max} - \theta_{2min}\right|$$

$$= 52.7810022064$$

$r_1 = 5$

−10 10

$r_2 = 2$

−10 10

$r_3 = 3$

−10 10

$r_4 = 4.5$

−10 10

CFourbar Class

- C:\Ch\toolkit\include\fourbar.h
  - Header file
- C:\Ch\toolkit\lib\mechanism\CFourbar.chf
  - Function file
- #include <fourbar.h>

CFourbar Class

```
CFourbar fourbar; // initialization

fourbar.uscUnit(false); // set US/SI units

fourbar.setLinks(r1, r2, r3, r4, theta1); // set lengths

fourbar.setCouplerPoint(rp, beta); // set coupler point
```

CFourbar Class

Calculate the range of motion with this function:

- The parameters to this function are its outputs. They should each be an array of double with length 2 for the 2 branches.

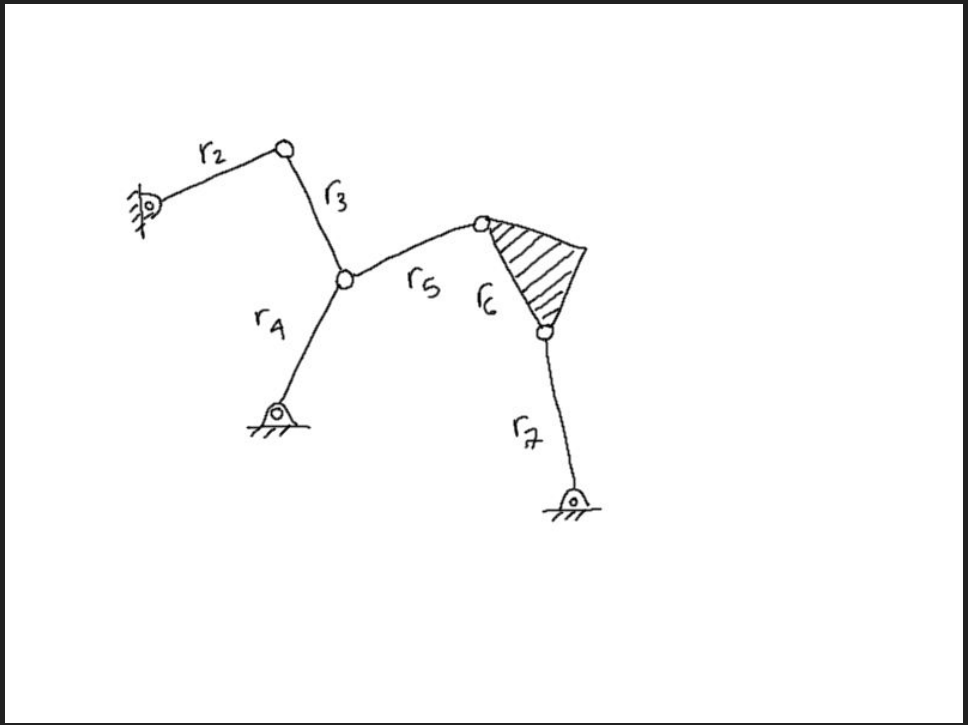
```
fourbar.getJointLimits(theta2min, theta2max, theta4min, theta4max);
```

CFourbar Class

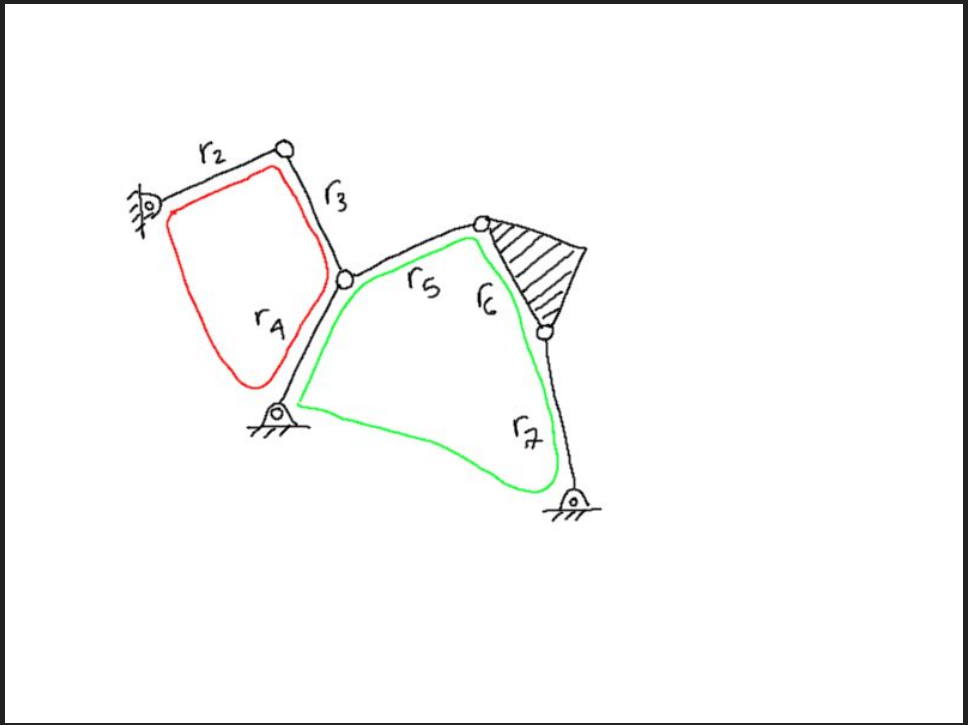
Plot transmission angle gamma vs. input angle (theta 2) using this function:

```
fourbar.plotTransAngles(&plot, branch_num);
```

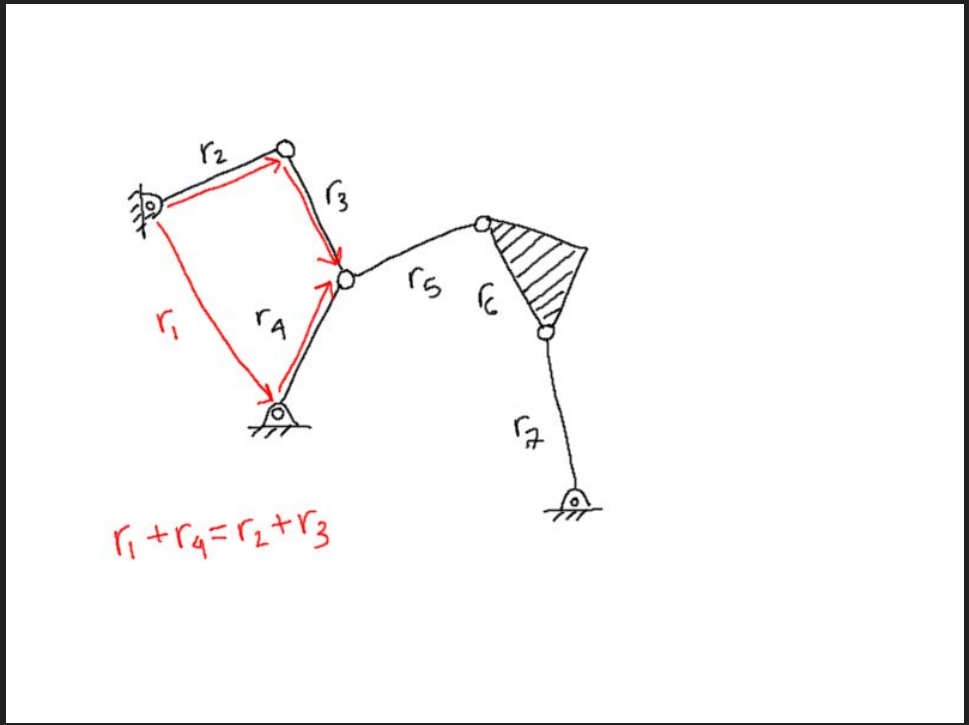
Loop Closure Equation



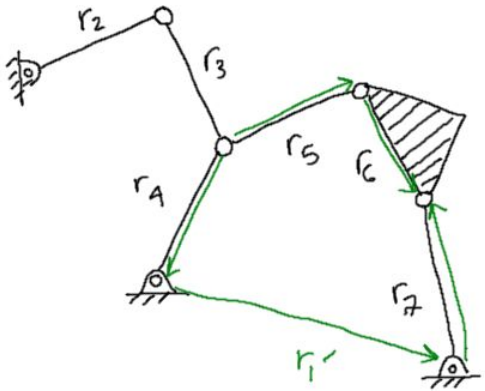
Loop Closure Equation



Loop Closure Equation



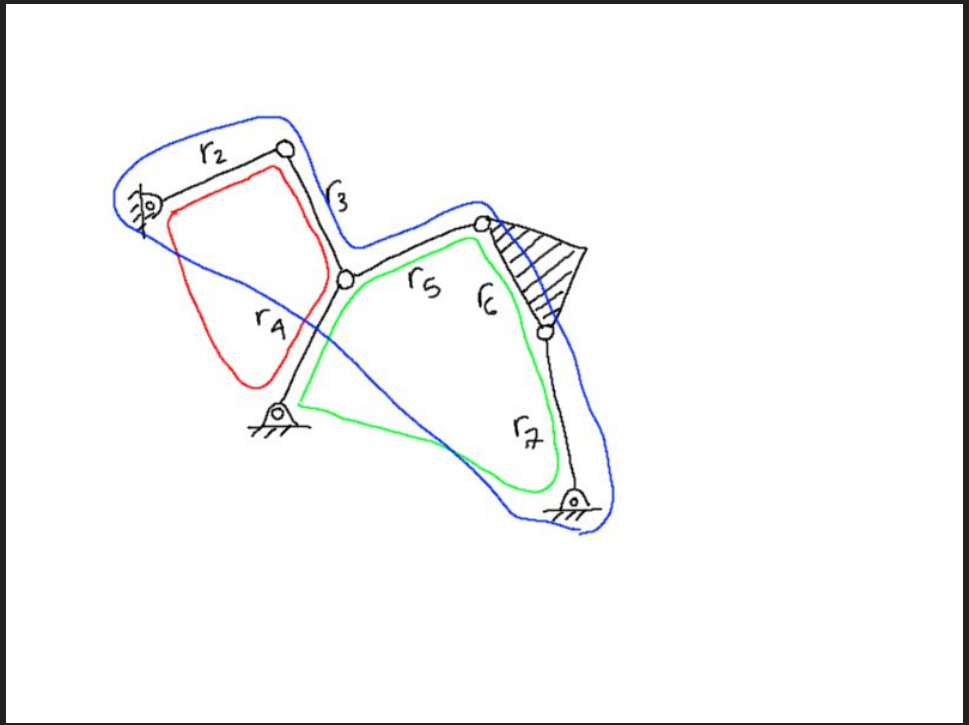
Loop Closure Equation



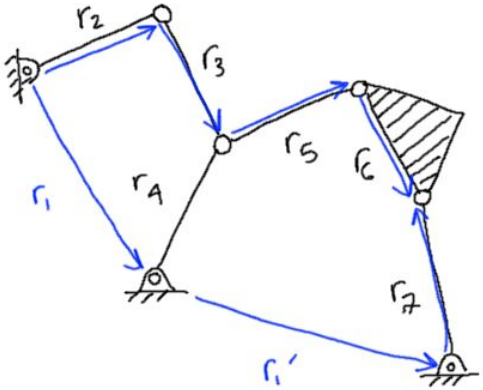
$$r_4 + r_1' + r_7 = r_5 + r_6$$

2(x2) equations, 5 unknowns?

Loop Closure Equation



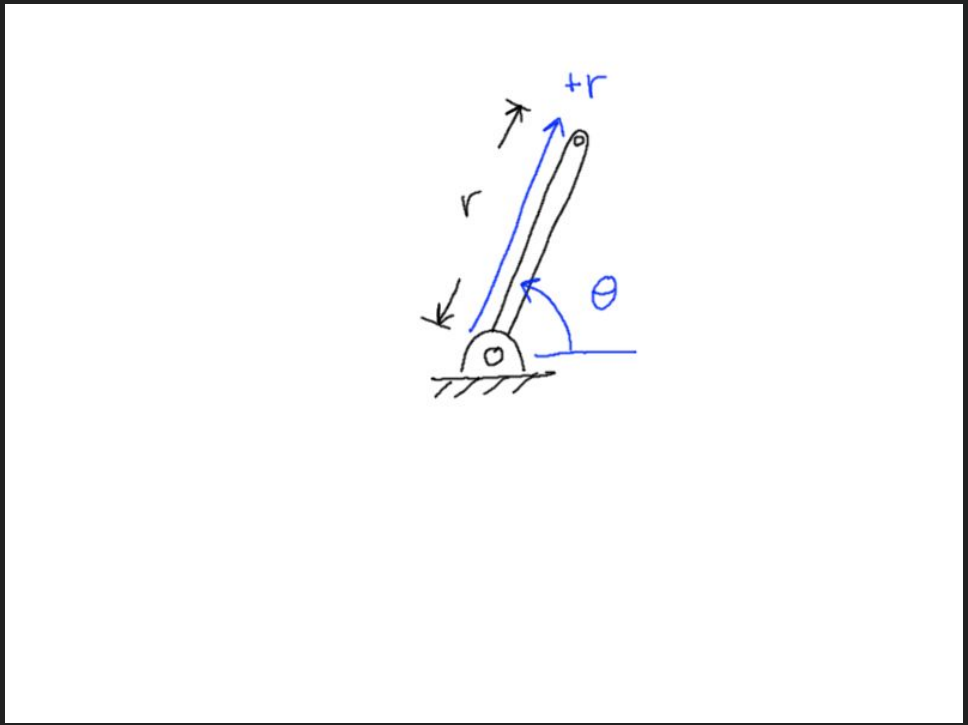
Loop Closure Equation



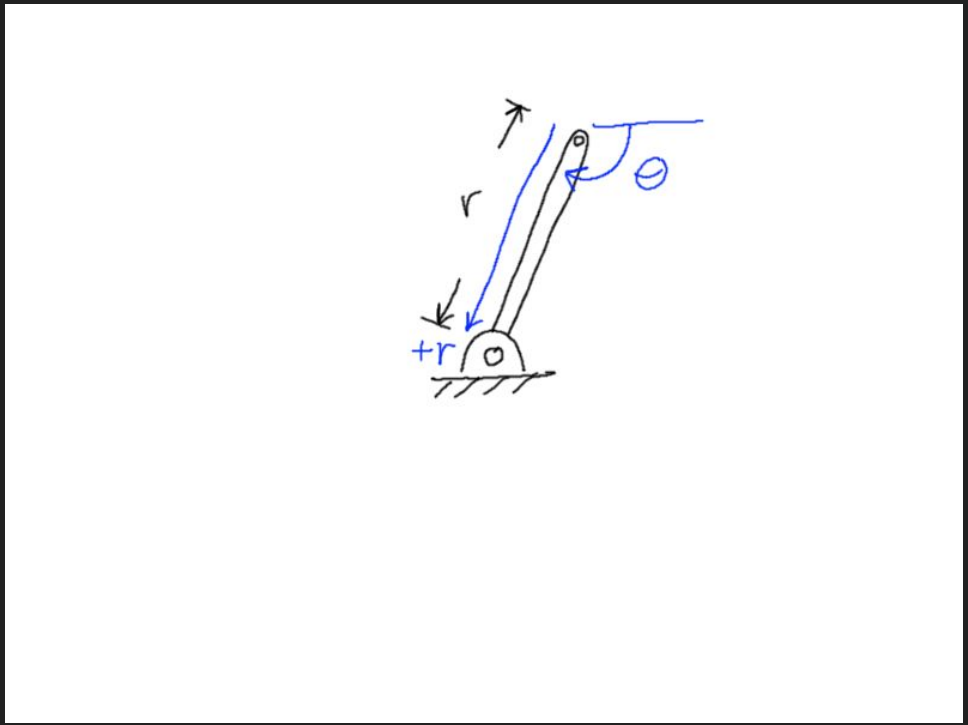
$$r_2 + r_3 + r_5 + r_6 = r_1 + r_1' + r_7$$

3(x2) equations, 5 unknowns

Loop Closure Equation



Loop Closure Equation



Thank you!

Questions?