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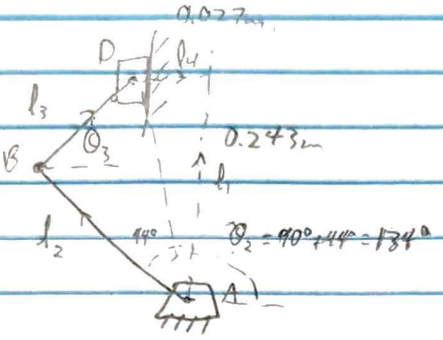
HW3

problem 1 a)



Initial position isn't possible, assuming l_1 is wrong.

$l_2 = 0.105m$ $\quad \theta_2 = 136°$

$l_3 = 0.172m$ $\quad \theta_3 = 73.6°$

$l_1 = 0.243m$ $\quad l_{arm} = 0.301m$

$l_4 = 0.027m$

$$\bar{R}_2 + \bar{R}_3 - \bar{R}_1 + \bar{R}_4 = 0$$

Re: $l_2 \cdot \cos(136) + l_3 \cdot \cos\theta_3 + l_4 = 0$, $\quad \theta_3 = \cos^{-1}\left(\frac{-l_4 - l_2\cos\theta_2}{l_3}\right) = 74.51°$

Im: $l_1 = l_2 \cdot \sin(136) + l_3 \cdot \sin\theta_3 = 0.243m$

$$\frac{d}{dt}\left(\bar{R}_2 + \bar{R}_3 - \bar{R}_1 + \bar{R}_4\right) = 0$$

solve for $\dot{l}$ in terms of ω_2,

$$l_2 j\omega_2 e^{j\theta_2} + j l_3 \omega_3 e^{j\theta_3} - \dot{l}_1 j = 0$$

$$-l_2\omega_2\sin\theta_2 - l_3\omega_3\sin\theta_3 = 0, \quad \omega_3 = -\frac{\omega_2 l_2 \sin\theta_2}{l_3\sin\theta_3}$$

$$-\dot{l}_1 j + l_2 \cdot j\omega_2 \cdot \cos\theta_2 + l_3 \cdot j \cdot \omega_3 \cos\theta_3 = 0$$

$$\dot{l}_1 = l_2 \cdot \omega_2 \cdot \cos\theta_2 + l_3 \cdot -\frac{\omega_2 l_2 \sin\theta_2}{l_3 \sin\theta_3} \cdot \cos\theta_3$$

$$\dot{l}_1 = l_2 \cdot \omega_2 \cdot \cos\theta_2 - \omega_2 l_2 \cdot \frac{\sin\theta_2 \cdot \cos\theta_3}{\sin\theta_3}$$

mechanical advantage $= \frac{F_{out}}{F_{in}}$

$F_{in} \cdot l_{arm} \cdot \omega_2 = F_{out} \cdot \dot{l}_1$

$\frac{l_{arm} \cdot \omega_2}{\dot{l}} \quad \frac{F_{out}}{F_{in}}$

$$\text{mechanical advantage} = \left| \frac{l_{arm}}{l_2 \cdot \cos\theta_2 - l_2 \cdot \frac{\sin\theta_2 \cdot \frac{-l_4 - l_2\cos\theta_2}{l_3}}{\sin\left(\cos^{-1}\left(\frac{-l_4 - l_2\cos\theta_2}{l_3}\right)\right)}} \right|$$

mechanical advantage$(134°) = 3.21$

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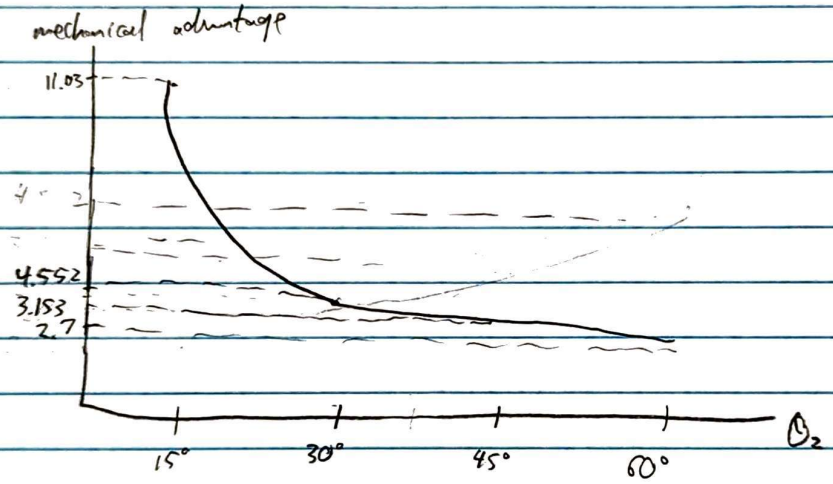
problem 1 b) From part a, mechanical advantage(θ_2) $= \left| \frac{l_{arm}}{l_2 \cdot \cos\theta_2 - l_2 \cdot \sin\theta_2 \cdot \frac{-l_4 - l_2\cos\theta_2}{l_3}}{\sin\left(\cos^{-1}\left(\frac{-l_4 - l_2\cos\theta_2}{l_3}\right)\right)} \right|$

graphing from $\theta_2 = 105°$ to $\theta_2 = 150°$ (I defined θ_2 as 90 + angle given, I used complementary angle for cleanliness)

From desmos:



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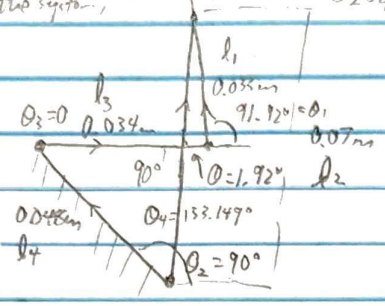
problem 2: Using excel to determine the possible angles at moment of contact, given O_2O_4 doesn't fully define the system, an angle for O_2O_4 is required, assumed angle is 133.149°.



$$\frac{d}{dt}\left(\bar{R}_4+\bar{R}_3+\bar{R}_1-\bar{R}_2\right)=0$$

$$l_3 j\omega_3 e^{j\theta_3}+l_1 j\omega_1 e^{j\theta_1}-l_2 j\omega_2 e^{j\theta_2}=0$$

Re: $-l_3\omega_3\sin\theta_3-l_1\omega_1\sin\theta_1+l_2\omega_2\sin\theta_2=0$, $0-0.03498\omega_1+0.07\omega_2=0$, $\omega_1=2.001\omega_2$

Im: $l_3\omega_3\cos\theta_3+l_1\omega_1\cos\theta_1-l_2\omega_2\cos\theta_2=0$, $0.034\omega_3-0.002346\omega_2=0$

$\omega_3=0.069\omega_2$

$P_{in}=F_{in}\cdot 0.138m\cdot\omega_2$

$P_{out}=F_{out}\cdot\omega_3\cdot 0.082m$ $\quad P_{in}=P_{out}$

$$\text{mechanical advantage}=\frac{F_{out}}{F_{in}}=\frac{0.138m\cdot\omega_2}{0.082m\cdot 0.069\omega_2}=24.4$$

mechanical advantage = 24.4, if θ of link O_2O_4 is 133.149°

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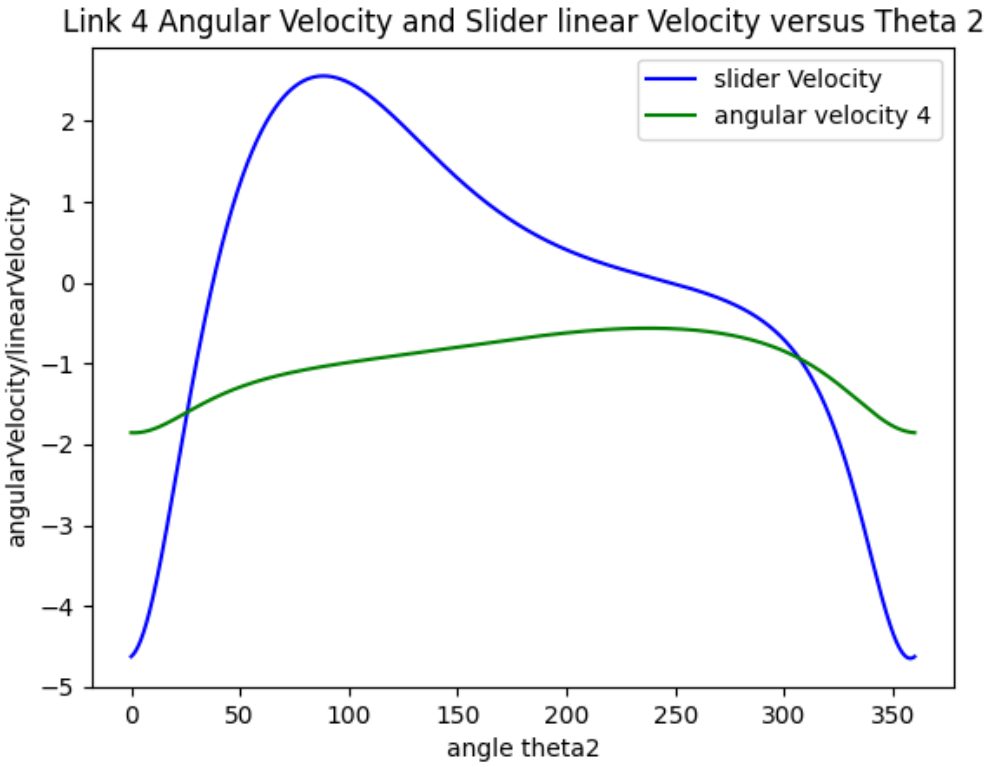
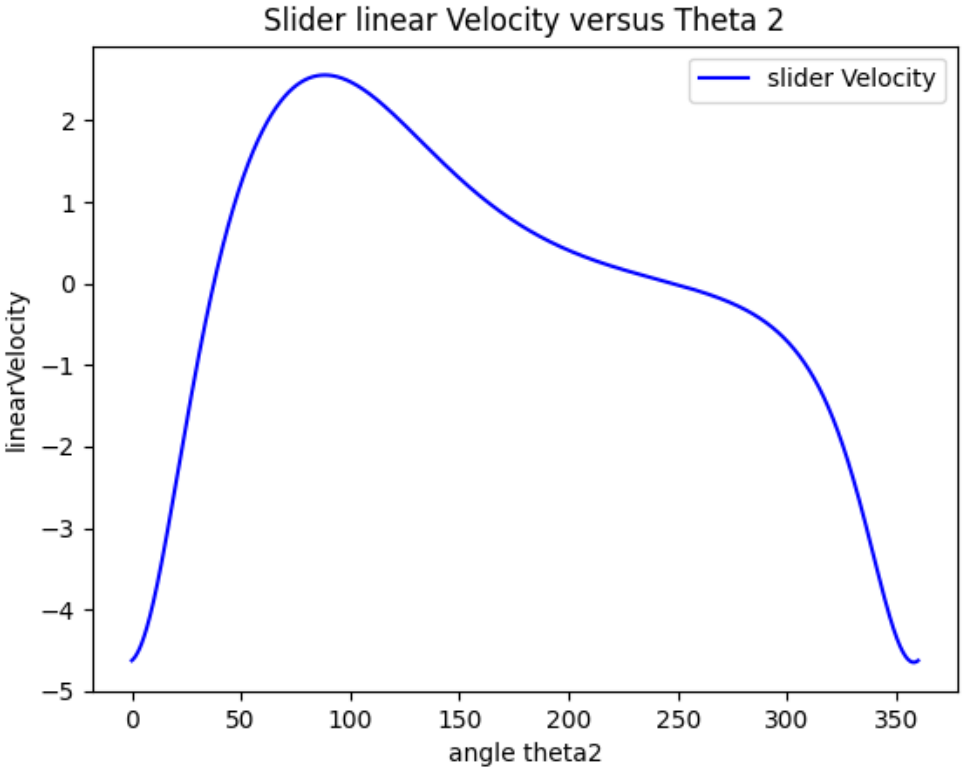
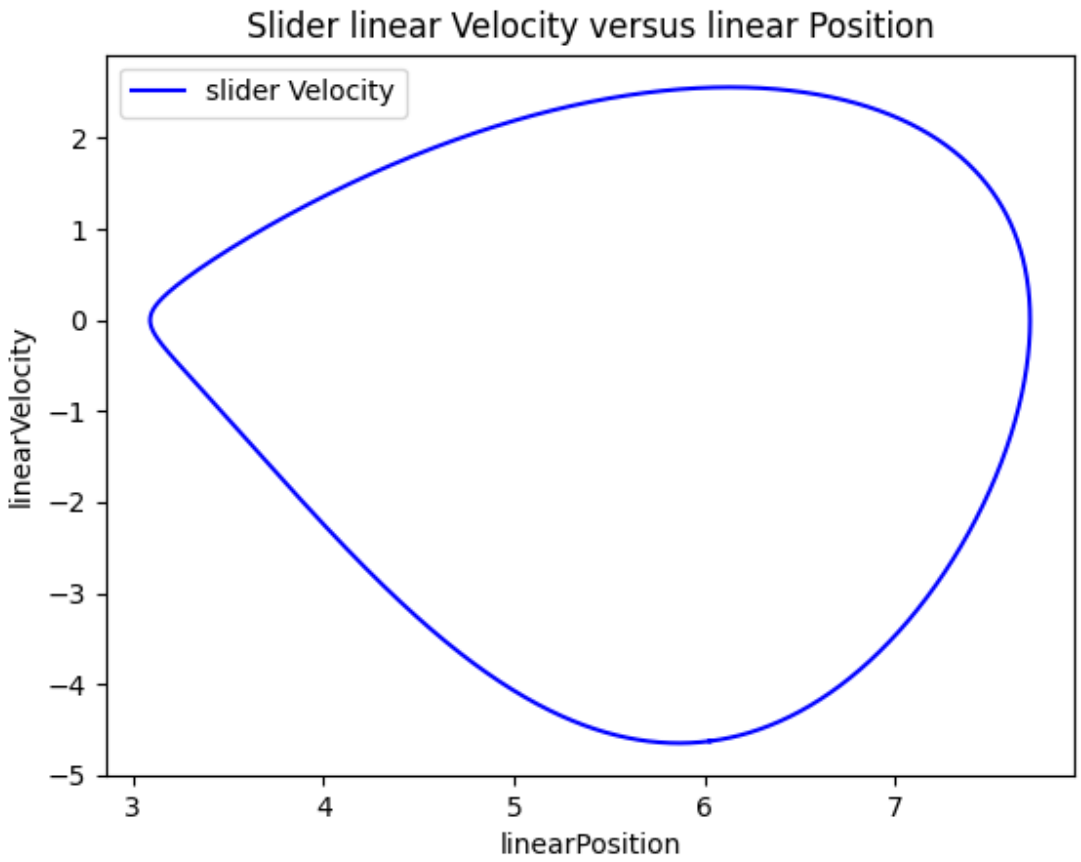
problem 3: percent deviation over 240° to 270°: -202.76%

percent deviation over 190° to 315°, -386.29%

graphs are attached.


Link 4 Angular Velocity and Slider linear Velocity versus Theta 2
slider Velocity
angular velocity 4
angularVelocity/linearVelocity
angle theta2
2
1
0
−1
−2
−3
−4
−5
0
50
100
150
200
250
300
350


Slider linear Velocity versus Theta 2
slider Velocity
linearVelocity
angle theta2
2
1
0
−1
−2
−3
−4
−5
0
50
100
150
200
250
300
350


Slider linear Velocity versus linear Position
slider Velocity
linearVelocity
linearPosition
2
1
0
−1
−2
−3
−4
−5
3
4
5
6
7