ME2201 Mini-Project Part(B)

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Question :-

For the mechanism shown in Figure 3, link 2 starts from rest at θ2 = 0 with a constant angular acceleration α2 = 1 − 5 rad/s2 . Write a Matlab program that plots the position, velocity and acceleration of slider (link 4) as well as the angular position, velocity and acceleration of link 6 as a function of input angle θ2. BA=10 in, CB=8 in, CA = DC=4 in, O2O6=8 in, O6D=6 in and O2A varies between 2-4 in.

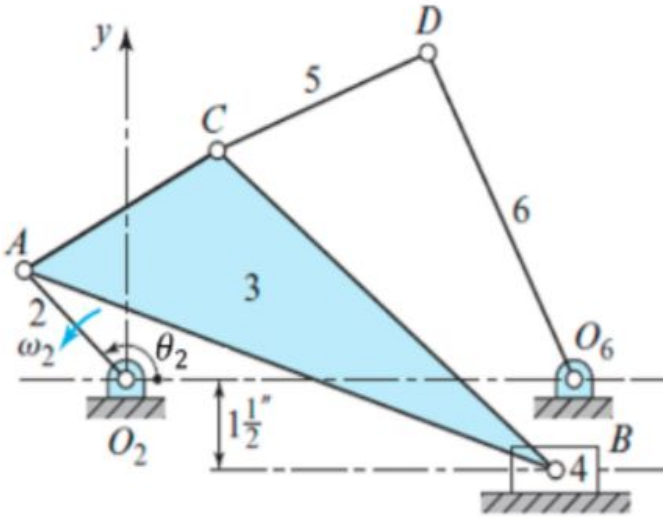


Figure 3:

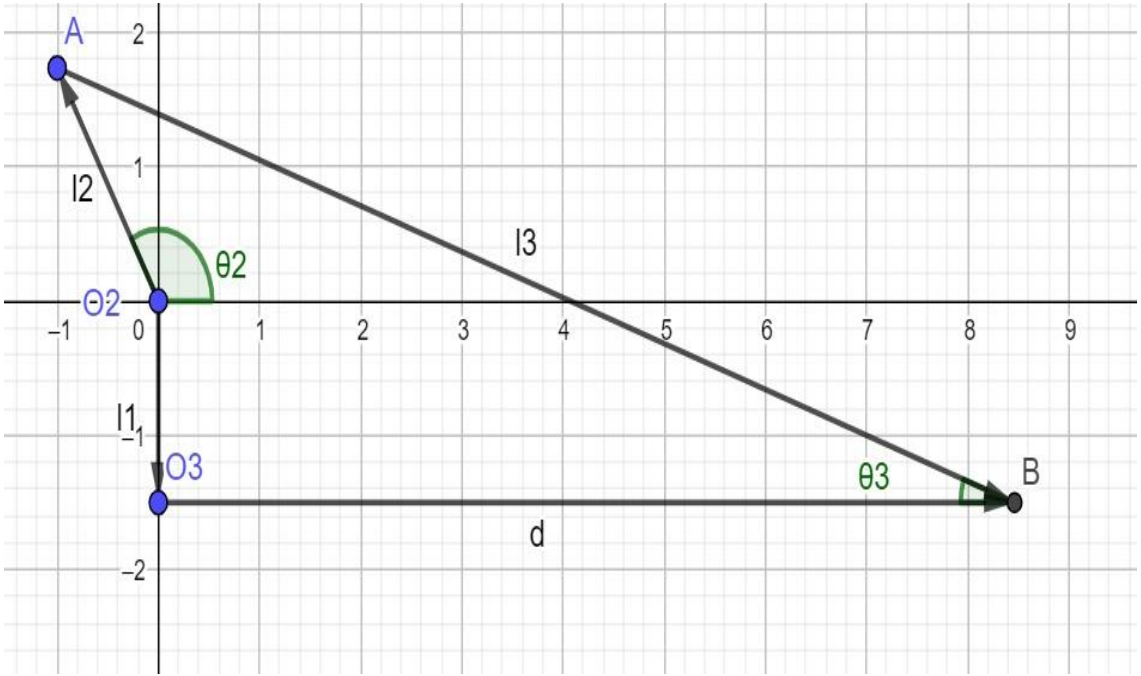
Loop 1 O2O3BA:

Loop 1: O2O3BA

Length of Link 3(AB) = 10 in

Length of Link 1(O3O2) = 1.5 in

Length of Link 2 (O2A) = 2-4 in



We can write the equation for the displacement as:

$$\begin{bmatrix} l_3 \sin\theta_3 & 1 \\ l_3 \cos\theta_3 & 0 \end{bmatrix} \begin{bmatrix} \Delta\theta_3 \\ \Delta d \end{bmatrix} = - \begin{bmatrix} d - l_3 \cos\theta_3 - l_2 \cos\theta_2 \\ l_3 \sin\theta_3 - l1 - l_2 \sin\theta_2 \end{bmatrix}$$

We write the velocity equation as:

$$\begin{bmatrix} l_3 \sin\theta_3 & 1 \\ l_3 \cos\theta_3 & 0 \end{bmatrix} \begin{bmatrix} \dot{\theta}_3 \\ V_s \end{bmatrix} = -\dot{\theta}_2 \begin{bmatrix} -l_2 \sin\theta_2 \\ l_2 \cos\theta_2 \end{bmatrix}$$

And the acceleration equation as:

$$\begin{bmatrix} l_3 \sin\theta_3 & 1 \\ l_3 \cos\theta_3 & 0 \end{bmatrix} \begin{bmatrix} \ddot{\theta}_3 \\ a_s \end{bmatrix} = -\dot{\theta}_2^2 \begin{bmatrix} l_2 \cos\theta_2 \\ l_2 \sin\theta_2 \end{bmatrix} - \ddot{\theta}_2 \begin{bmatrix} l_2 \sin\theta_2 \\ -l_2 \cos\theta_2 \end{bmatrix} + \dot{\theta}_3^2 \begin{bmatrix} -l_3 \cos\theta_3 \\ l_3 \sin\theta_3 \end{bmatrix}$$

Loop 2 O2ACDO6:

Loop 2: O2ACDO6

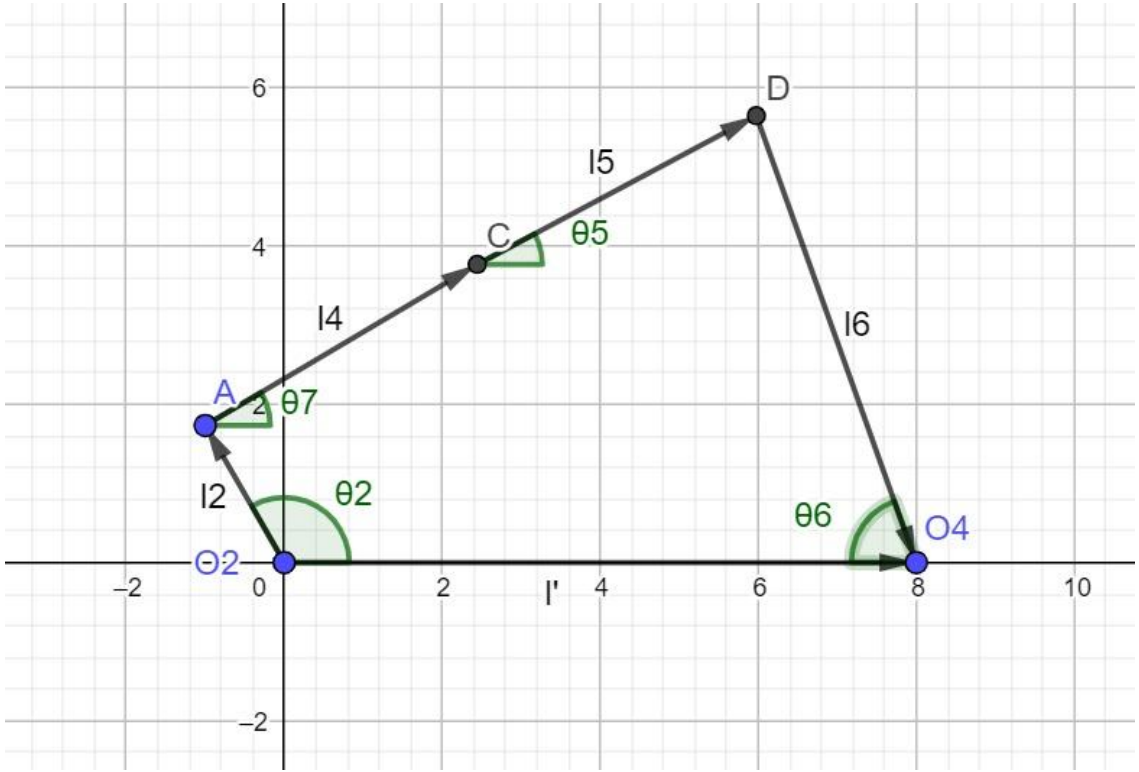
Length of Link 2 (O2A) = 2-4 inches

Length of Link 4 (AC) = 4 inches

Length of Link 5 (CD) = 4 inches

Length of Link 6 (DO6) = 6 inches

Length of Link O2O6 = 10 inches



$$\theta_7 = 49.45 - \theta_3$$

The displacement equation is:

$$\begin{bmatrix} -l_5 \sin\theta_5 & -l_6 \sin\theta_6 \\ l_5 \cos\theta_5 & -l_6 \cos\theta_6 \end{bmatrix} \begin{bmatrix} \Delta\theta_5 \\ \Delta\theta_6 \end{bmatrix} = - \begin{bmatrix} l_5 \cos\theta_5 + l_6 \cos\theta_6 + l_2 \cos\theta_2 + l_4 \cos(49.45 - \theta_3) - l' \\ l_5 \sin\theta_5 - l_6 \sin\theta_6 + l_2 \sin\theta_2 + l_4 \sin(49.45 - \theta_3) \end{bmatrix}$$

The velocity equation is:

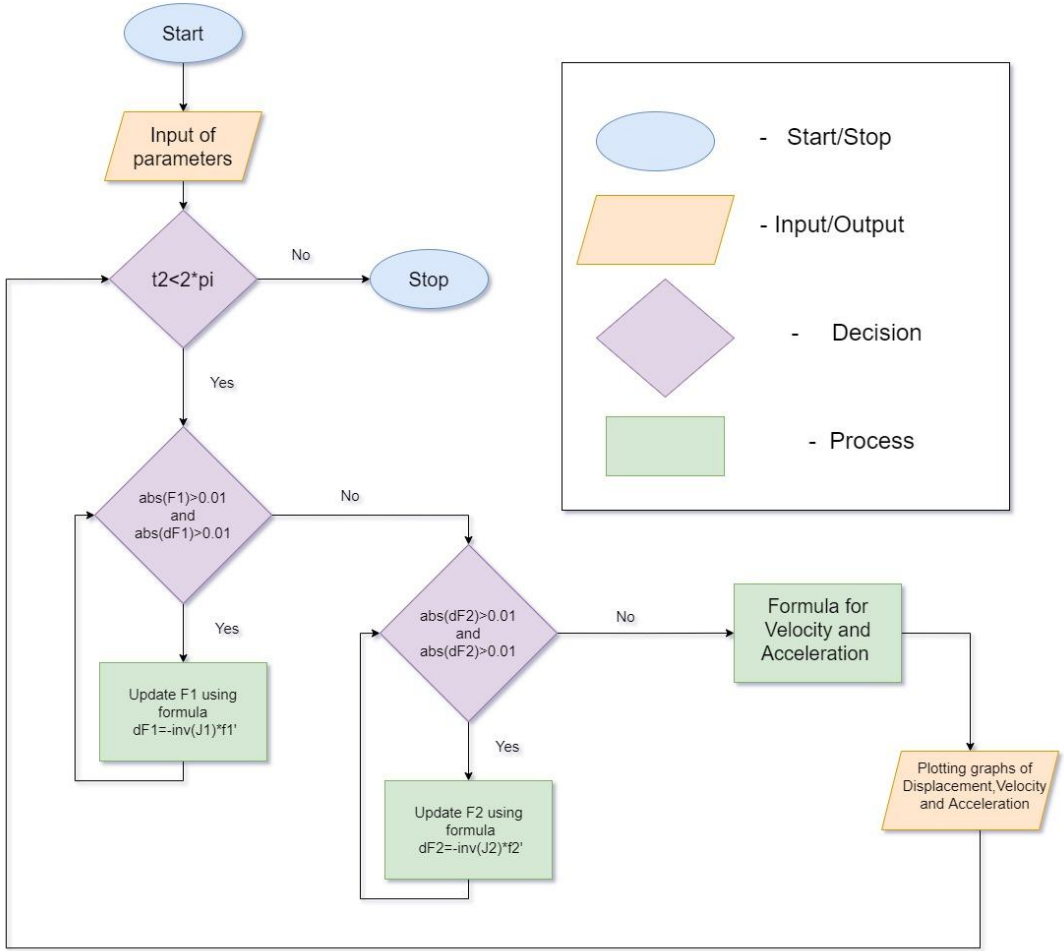
$$\begin{bmatrix} -l_5 \sin\theta_5 & -l_6 \sin\theta_6 \\ l_5 \cos\theta_5 & -l_6 \cos\theta_6 \end{bmatrix} \begin{bmatrix} \dot{\theta_5} \\ \dot{\theta_6} \end{bmatrix} = \dot{\theta_2} \begin{bmatrix} l_2 \sin\theta_2 \\ -l_2 \cos\theta_2 \end{bmatrix} + \dot{\theta_3} \begin{bmatrix} -l_4 \sin 49.45 - \theta_3 \\ l_4 \cos 49.45 - \theta_3 \end{bmatrix}$$

The acceleration equation is:

$$\begin{bmatrix} -l_5 \sin\theta_5 & -l_6 \sin\theta_6 \\ l_5 \cos\theta_5 & -l_6 \cos\theta_6 \end{bmatrix} \begin{bmatrix} \ddot{\theta_5} \\ \ddot{\theta_6} \end{bmatrix} = \dot{\theta_2^2} \begin{bmatrix} l_2 \cos\theta_2 \\ l_2 \sin\theta_2 \end{bmatrix} + \ddot{\theta_2} \begin{bmatrix} l_2 \sin\theta_2 \\ -l_2 \cos\theta_2 \end{bmatrix} + \dot{\theta_3^2} \begin{bmatrix} l_4 \cos(49.45 - \theta_3) \\ l_4 \sin(49.45 - \theta_3) \end{bmatrix}$$

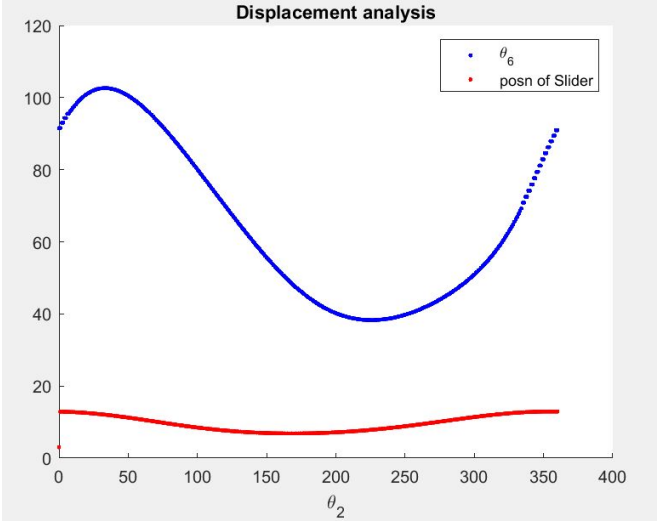
$$+\ddot{\theta_3} \begin{bmatrix} -l_4 \sin(49.45 - \theta_3) \\ l_4 \cos(49.45 - \theta_3) \end{bmatrix} + \dot{\theta_5^2} \begin{bmatrix} l_5 \cos\theta_5 \\ l_5 \sin\theta_5 \end{bmatrix} + \dot{\theta_6^2} \begin{bmatrix} l_6 \cos\theta_6 \\ -l_6 \sin\theta_6 \end{bmatrix}$$

Flowchart Explaining the MATLAB Code



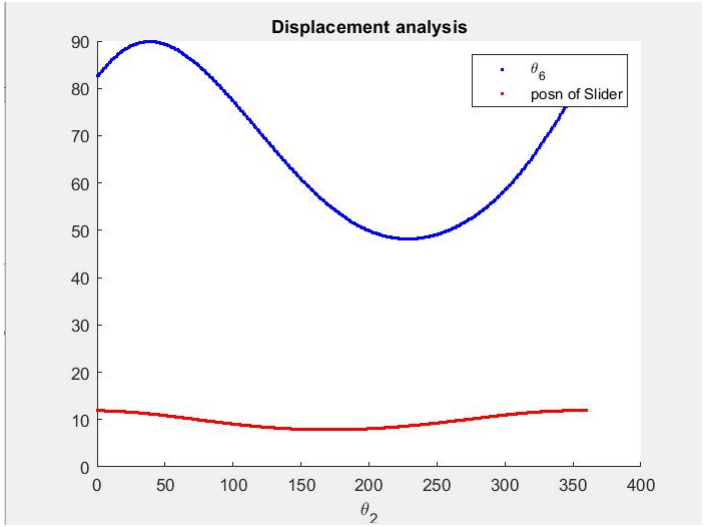
Displacement Analysis

α2 = 1 rad/sec^2

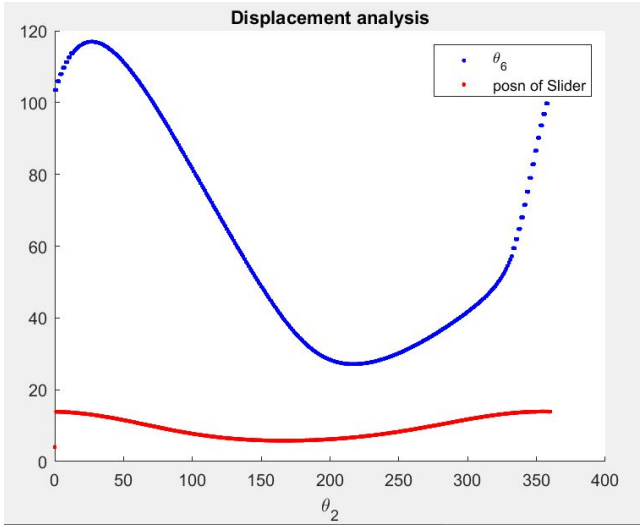


O2A = 3 inches

O2A = 2 inches

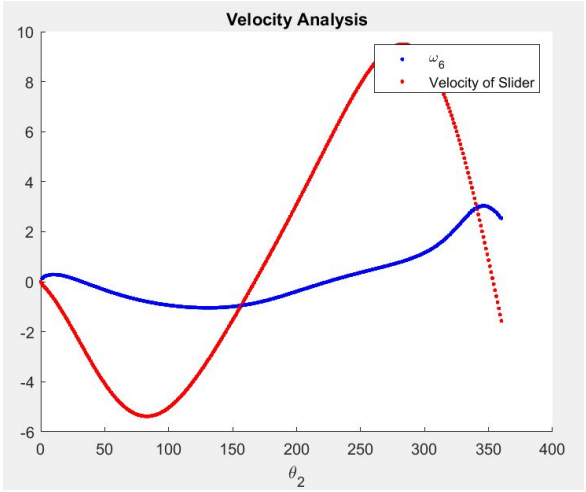


O2A = 4 inches



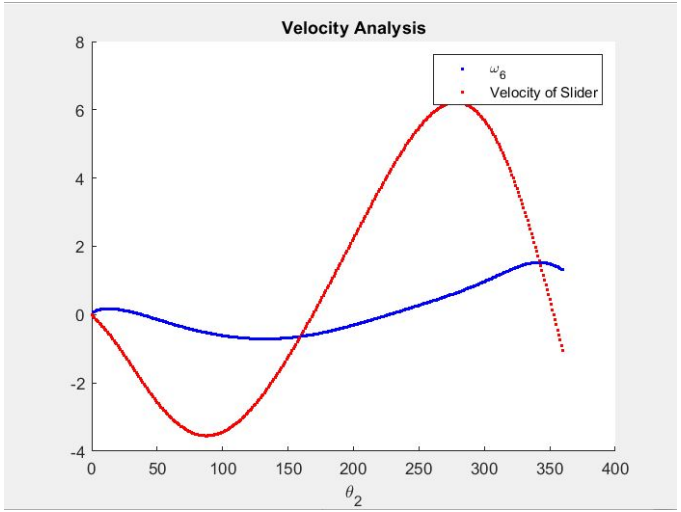
Velocity Analysis

α2 = 1 rad/sec^2

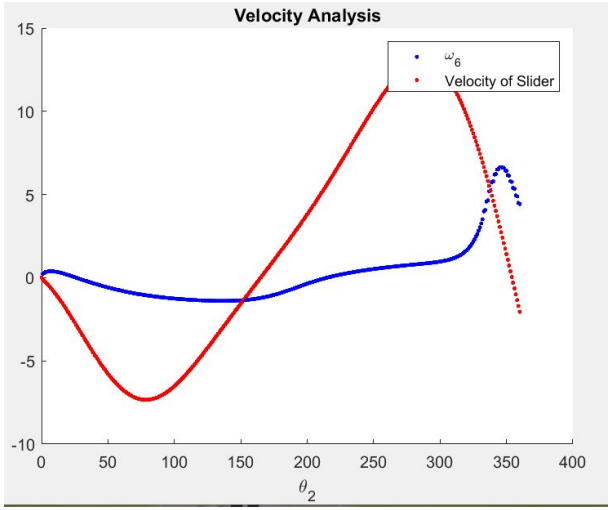


O2A = 3 inches

O2A = 2 inches

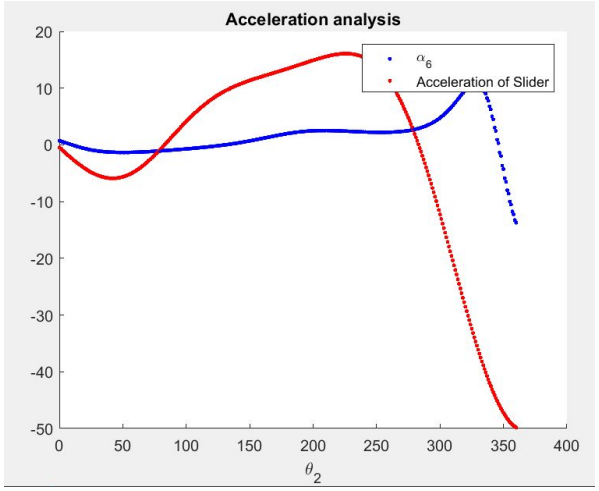


O2A= 4 inches



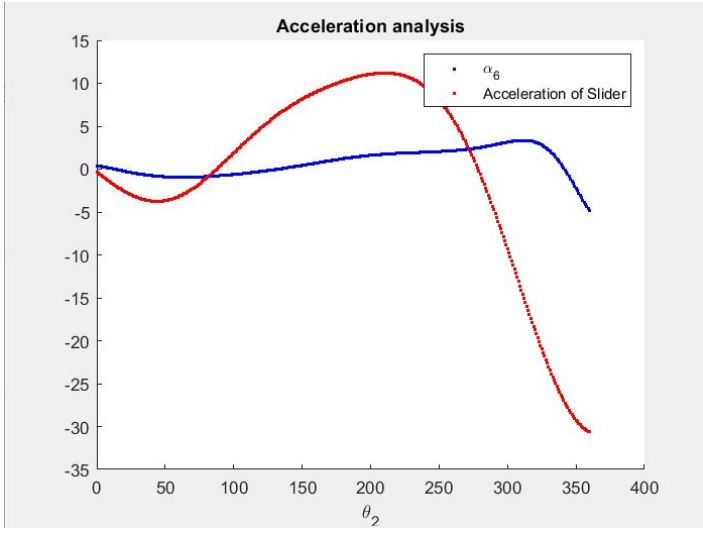
Acceleration Analysis

α2 = 1 rad/sec^2

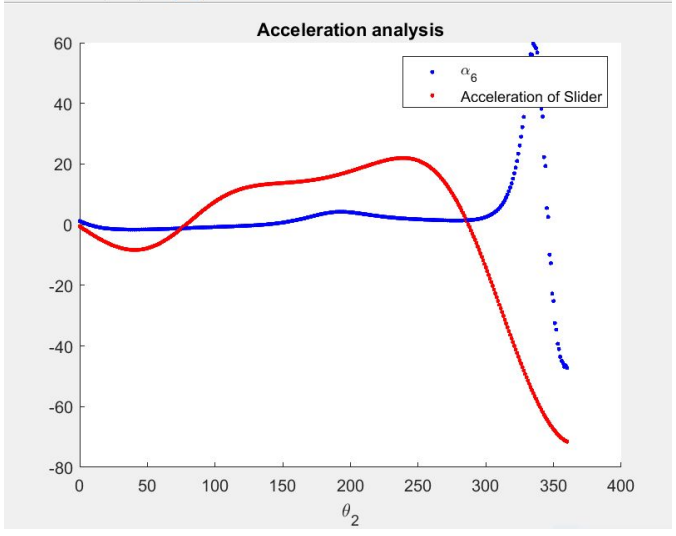


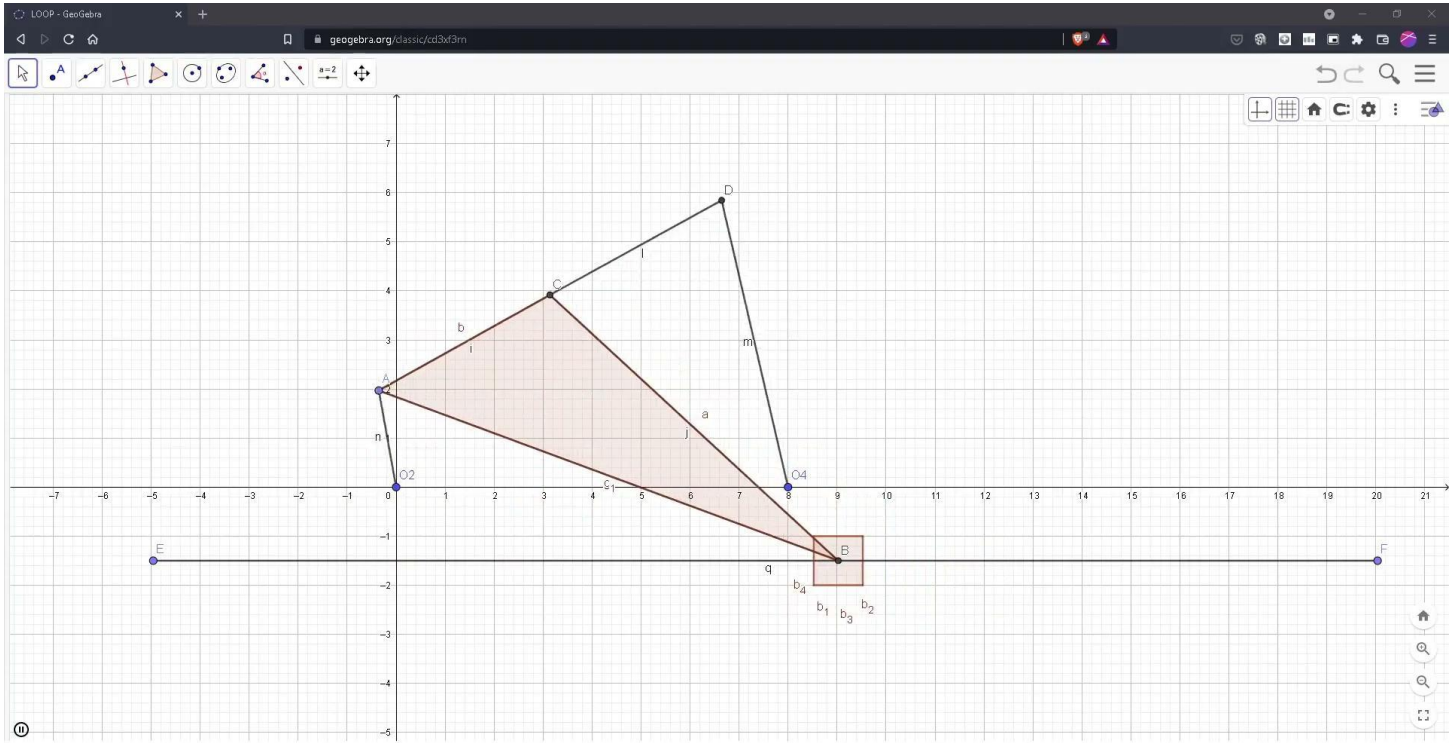
O2A= 3 inches

O2A = 2 inches



O2A= 4 inches

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