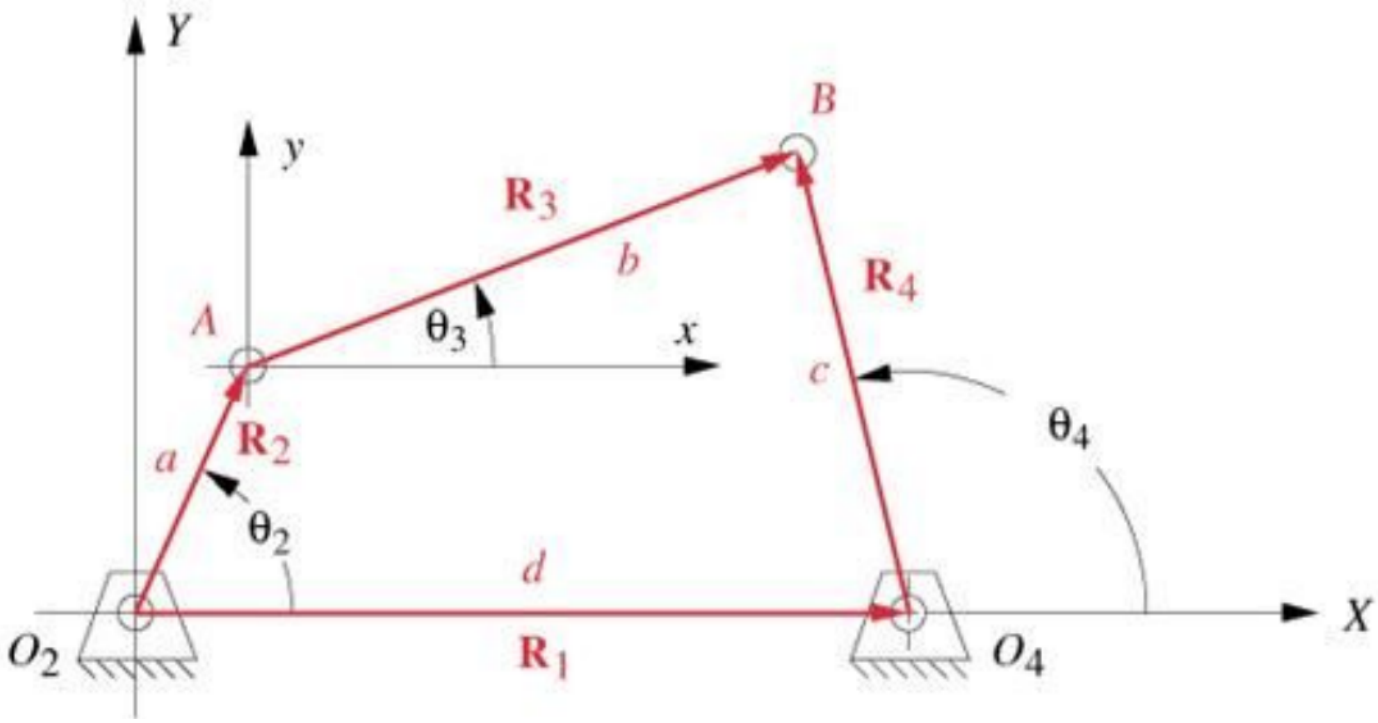
Assignment 2 Report

15110049
ME322 Synthesis and Analysis of Mechanisms

January 29, 2018

1 Equations determining relationship between desired input and outputs for the Mechanism



Using the Loop Closure Vector Equation for the above Vector diagram, we get θ_3 and θ_4 which are the outputs pertaining to positional analysis of mechanisms.
The equations for the same are as follows:

$$\theta_{4(1,2)} = 2arctan(\frac{-B \pm \sqrt{B^2 - 4AC}}{2A})$$
where
$$A = cos(\theta_2) - K_1 - K_2 cos(\theta_2) + K_3$$
$$B = -2sin(\theta_2)$$
$$C = K_1 - (K_2 + 1)cos(\theta_2) + K_3$$

$$\theta_{3(1,2)} = 2arctan(\frac{-E \pm \sqrt{E^2 - 4DF}}{2D})$$

where

$$D = cos(\theta_2) - K_1 + K_4 cos(\theta_2) + K_5$$

$$E = -2sin(\theta_2)$$

$$F = K_1 + (K_4 - 1)cos(\theta_2) + K_5$$

In the above Equations:

$$K_1 = \frac{d}{a}$$

$$K_2 = \frac{d}{c}$$

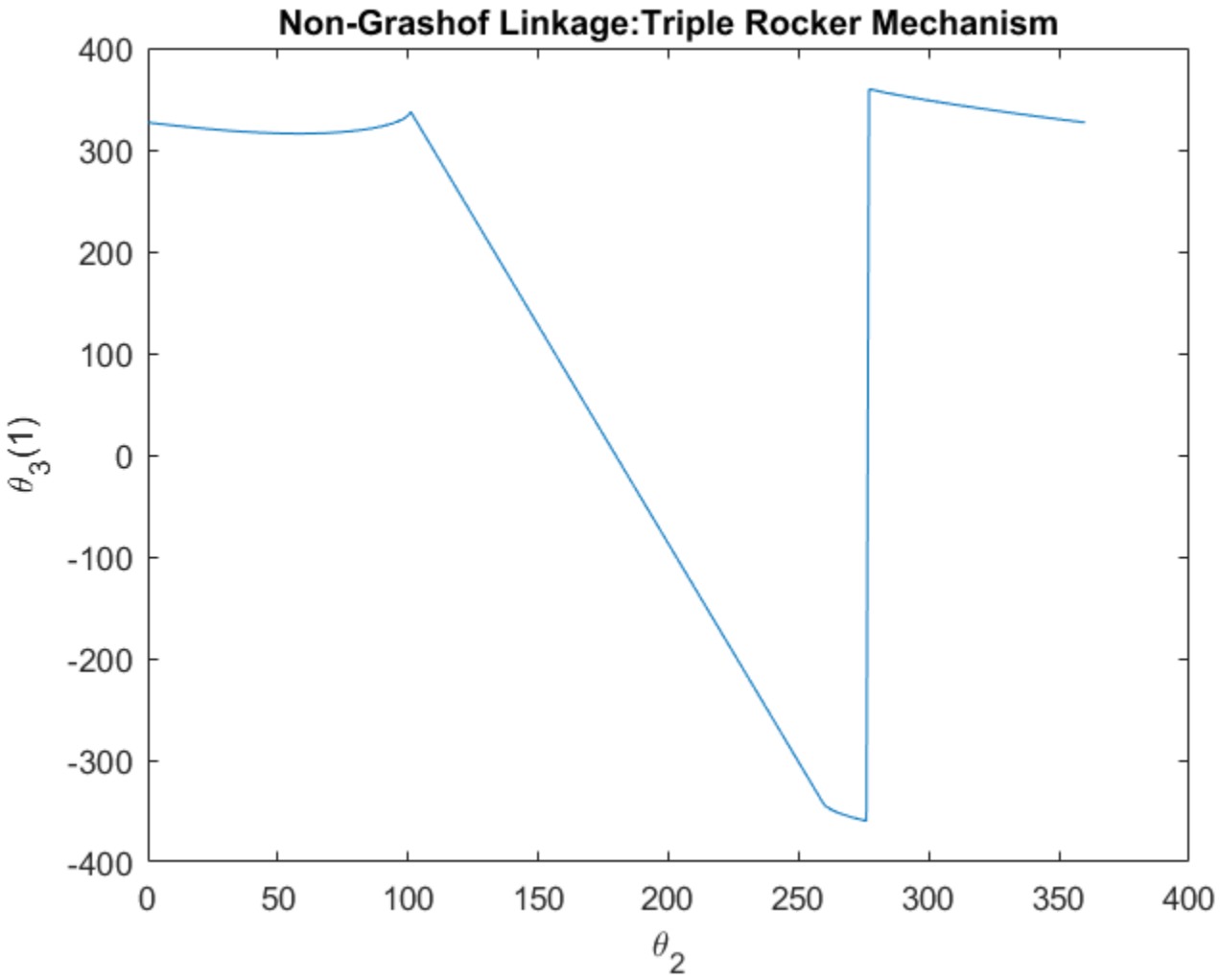
$$K_3 = \frac{a^2 - b^2 + c^2 + d^2}{2ac}$$

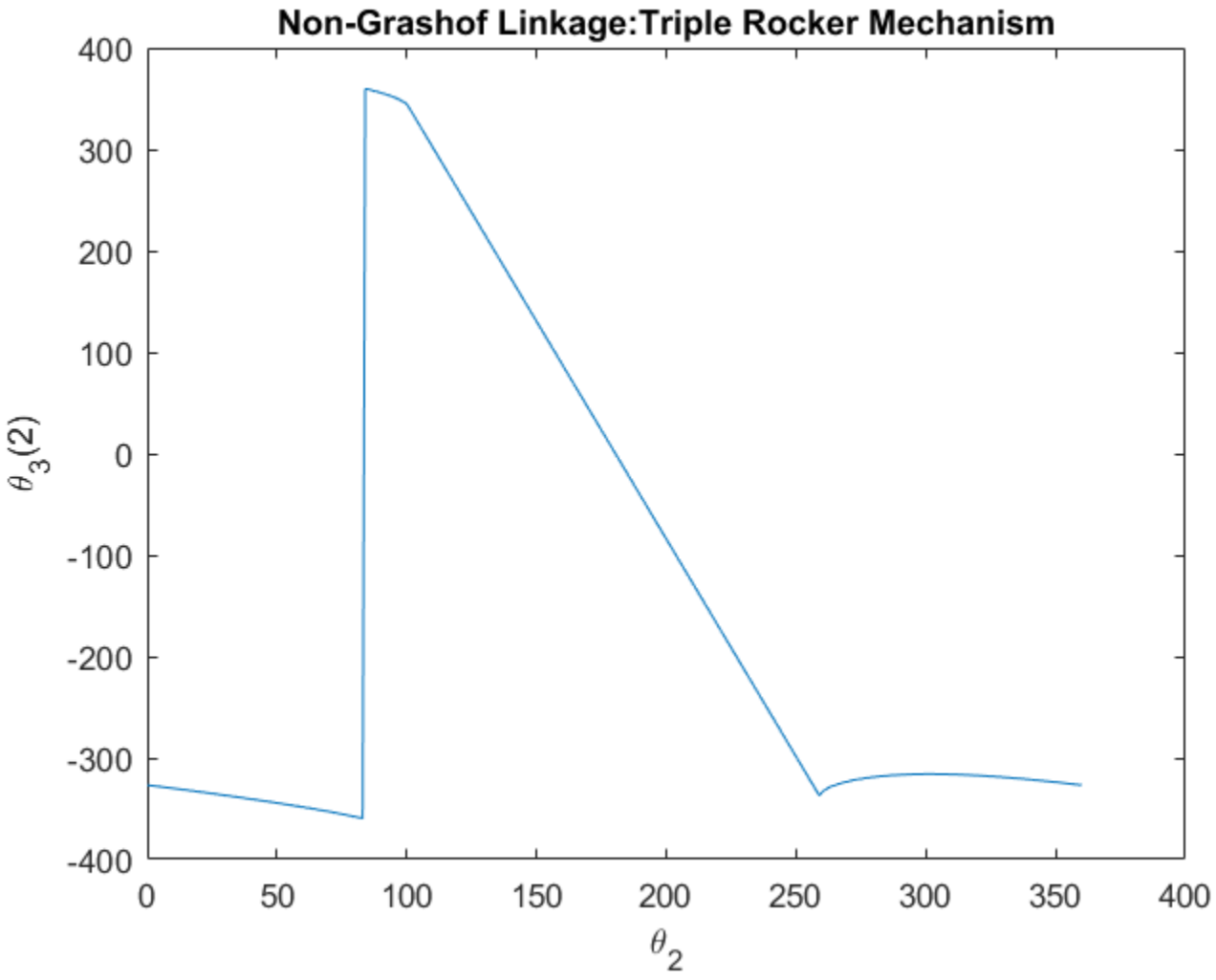
$$K_4 = \frac{d}{b}$$

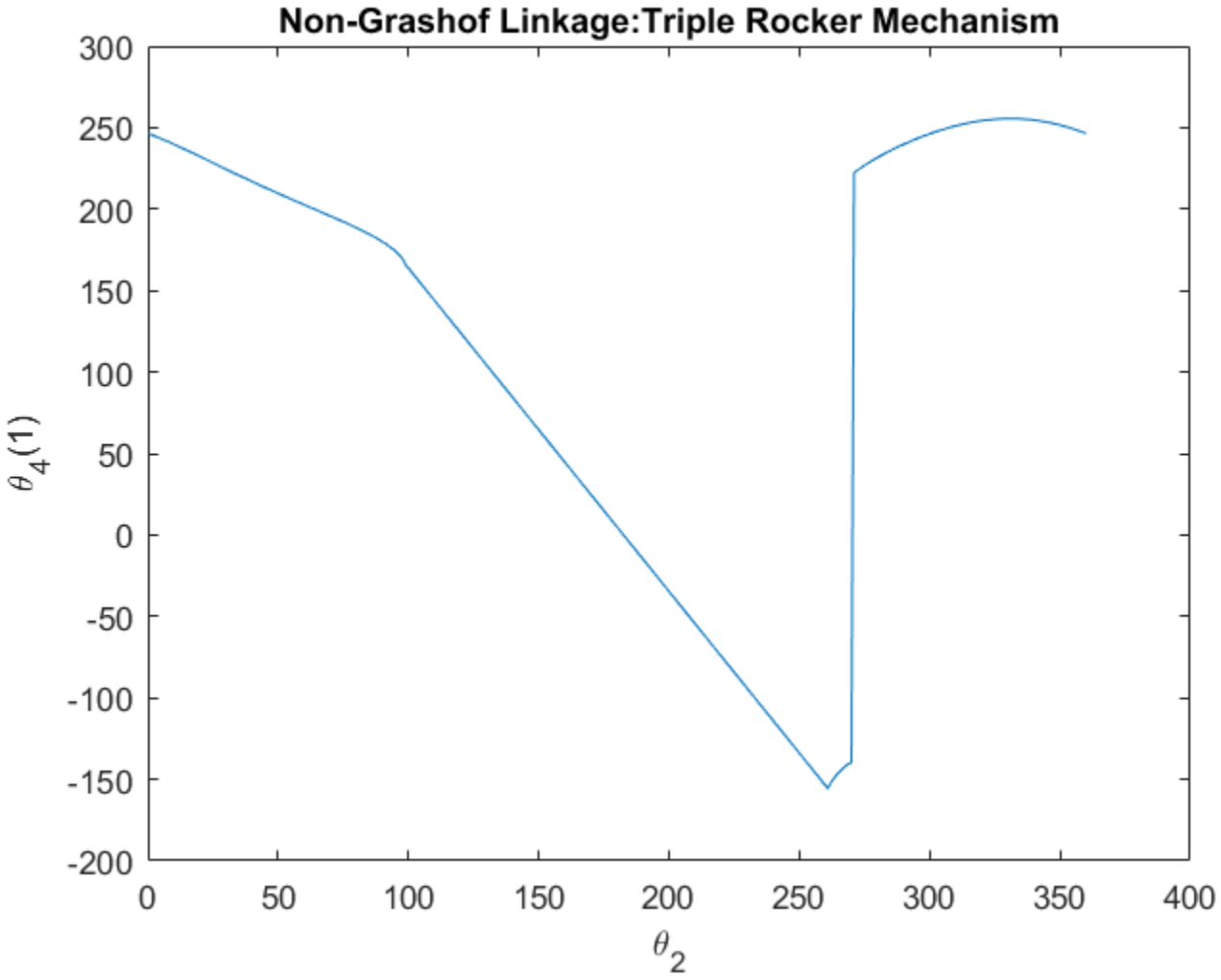
$$K_5 = \frac{c^2 - d^2 - a^2 - b^2}{2ab}$$

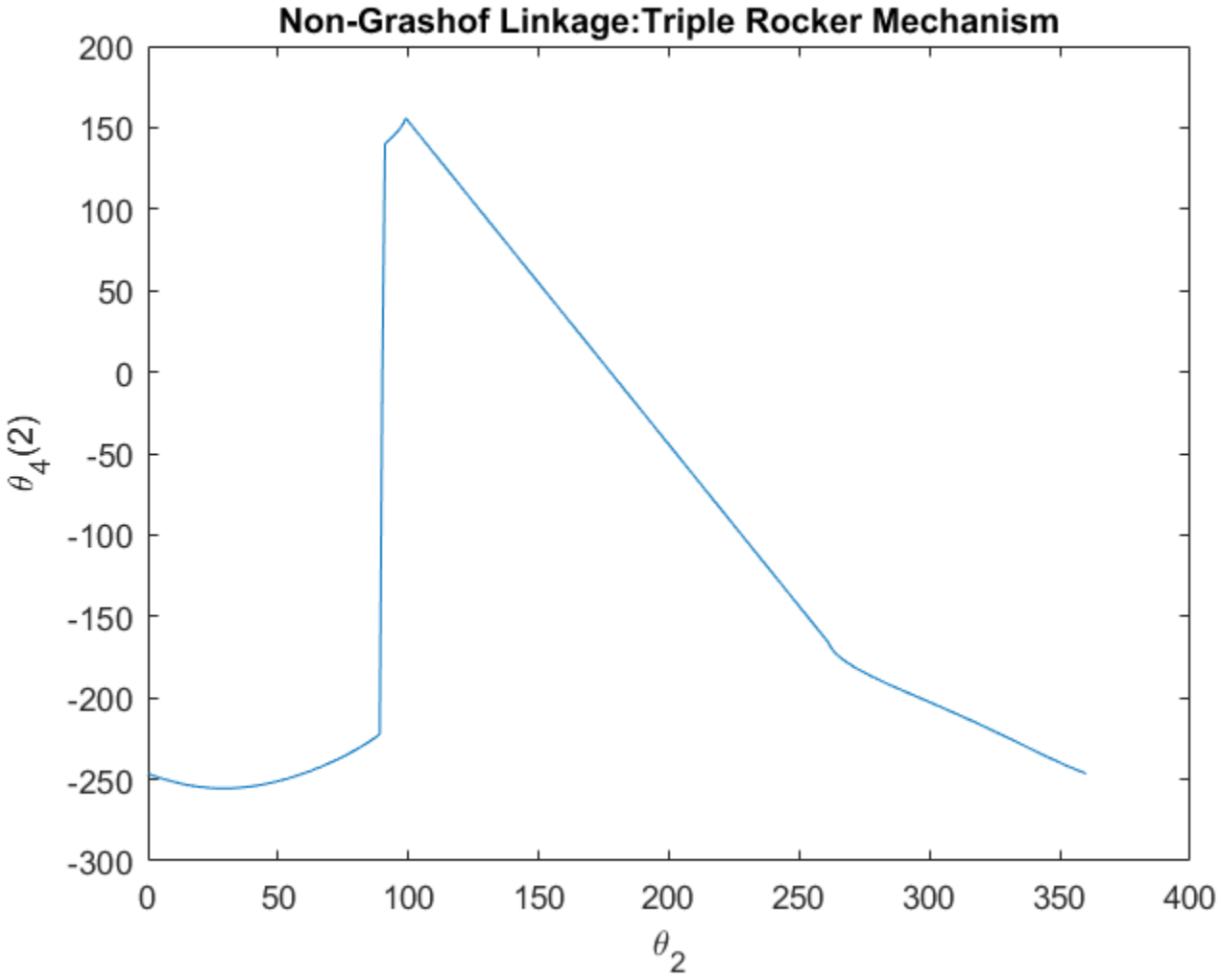
2 Plots and Animations

2.1 Non-Grashof Linkage: Triple Rocker Mechanism




Non-Grashof Linkage:Triple Rocker Mechanism
400
300
200
100
0
-100
-200
-300
-400
$\theta_3(2)$
0
50
100
150
200
250
300
350
400
θ_2


Non-Grashof Linkage:Triple Rocker Mechanism
300
250
200
150
100
50
0
-50
-100
-150
-200
$\theta_4(1)$
0
50
100
150
200
250
300
350
400
θ_2

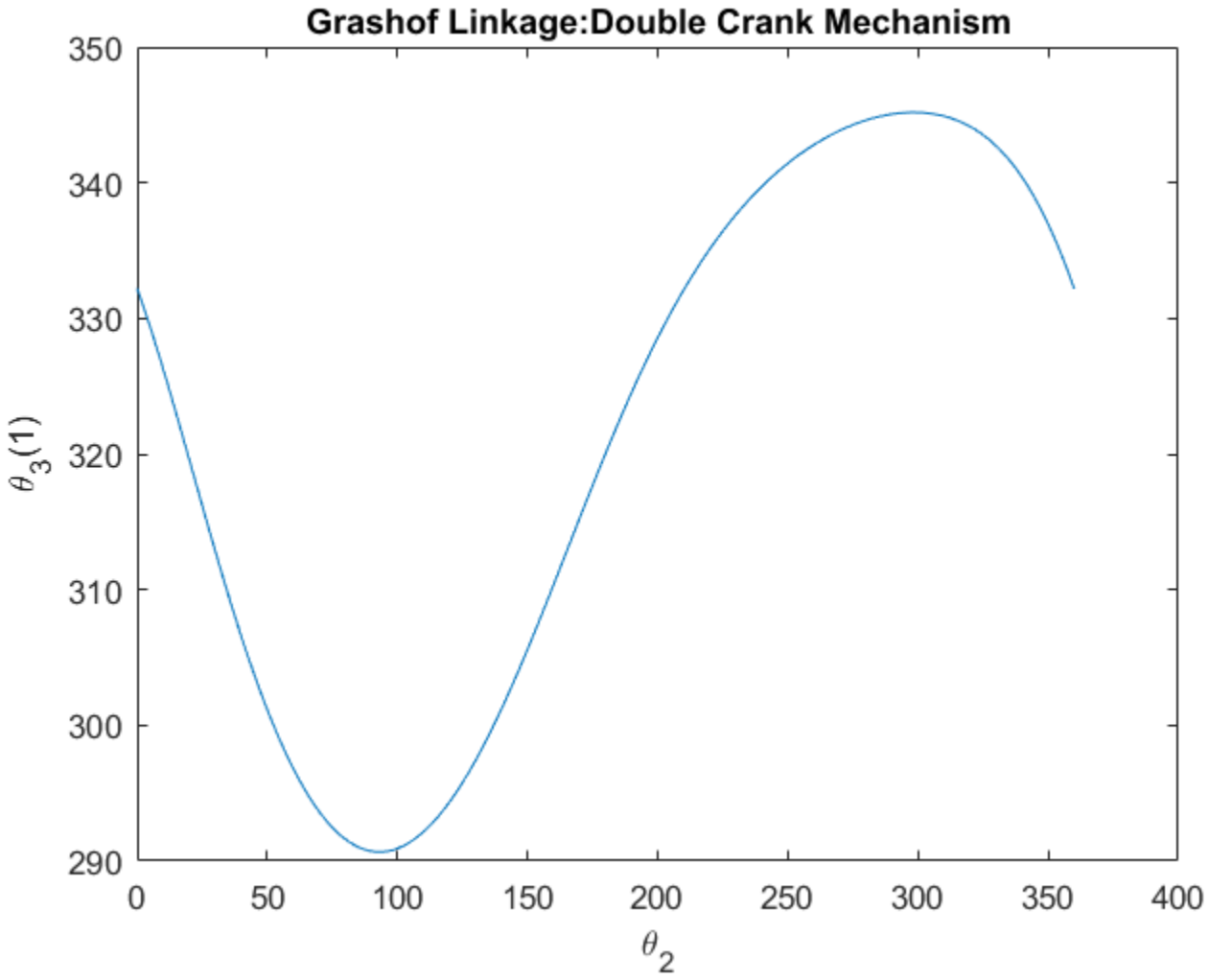


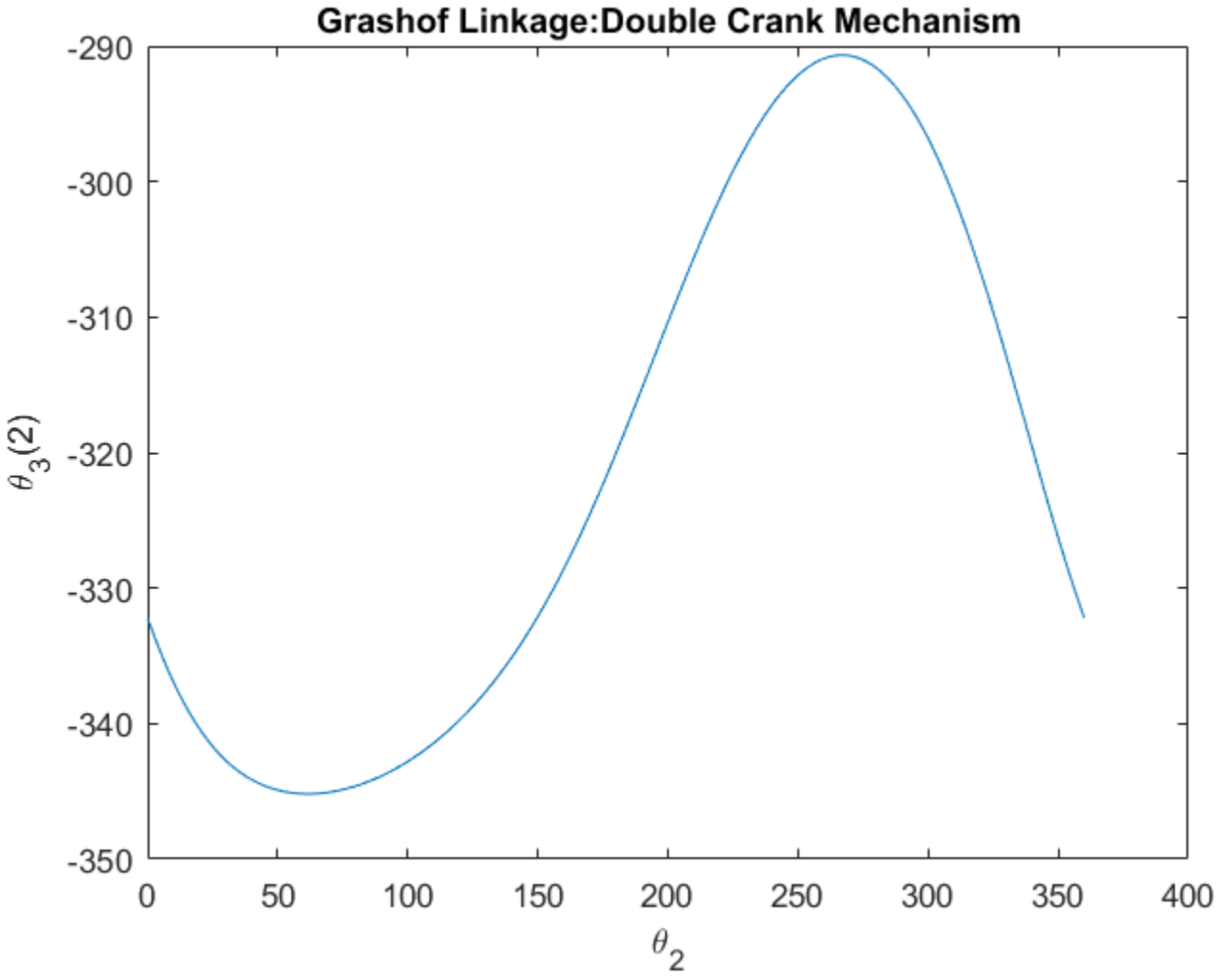
For animation pertaining to the above plots of Non-Grashof Linkage: Triple Rocker Mechanism; Run AnimateFourBarPolodes.m MATLAB function file with Link Lengths as follows:

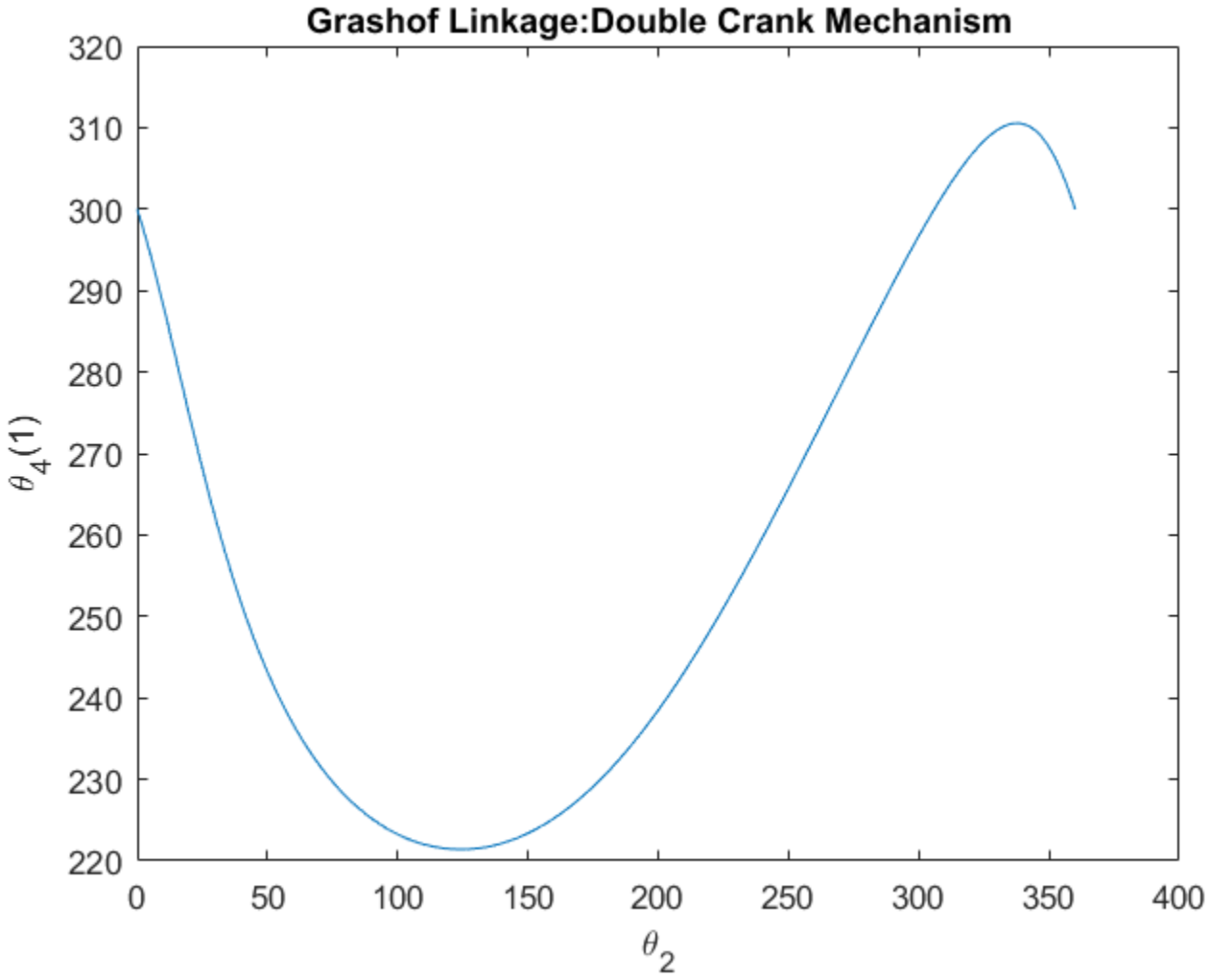
- Input: 8
- Coupler: 4
- Output: 5
- Ground: 3

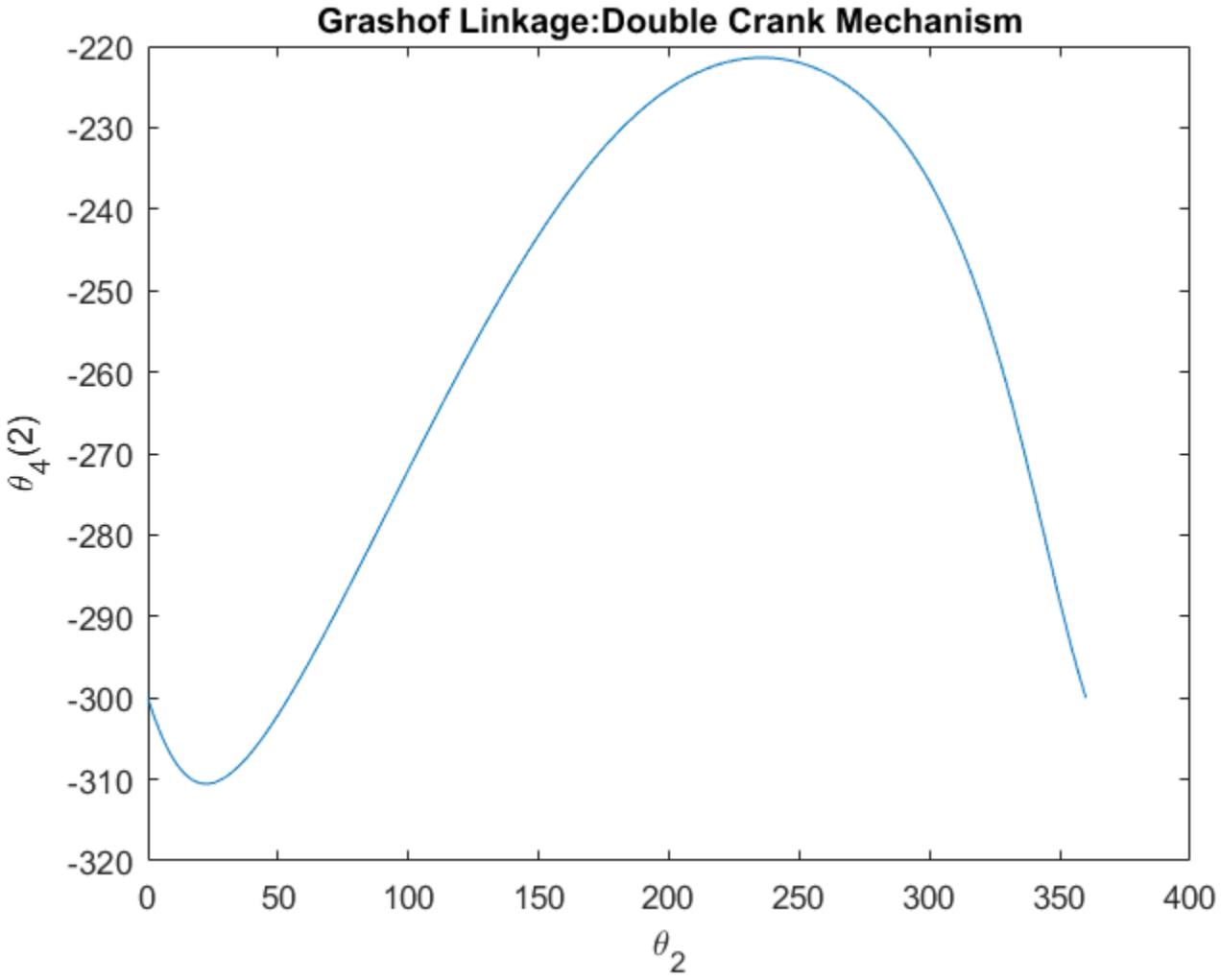
For obtaining the plots, run A2 MATLAB script with link lengths array as: [3 5 4 8].

2.2 Grashof Linkage: Double Crank Mechanism




Grashof Linkage:Double Crank Mechanism
-290
-300
-310
-320
-330
-340
-350
$\theta_3(2)$
0
50
100
150
200
250
300
350
400
θ_2


Grashof Linkage:Double Crank Mechanism
320
310
300
290
280
270
260
250
240
230
220
$\theta_4(1)$
0
50
100
150
200
250
300
350
400
θ_2

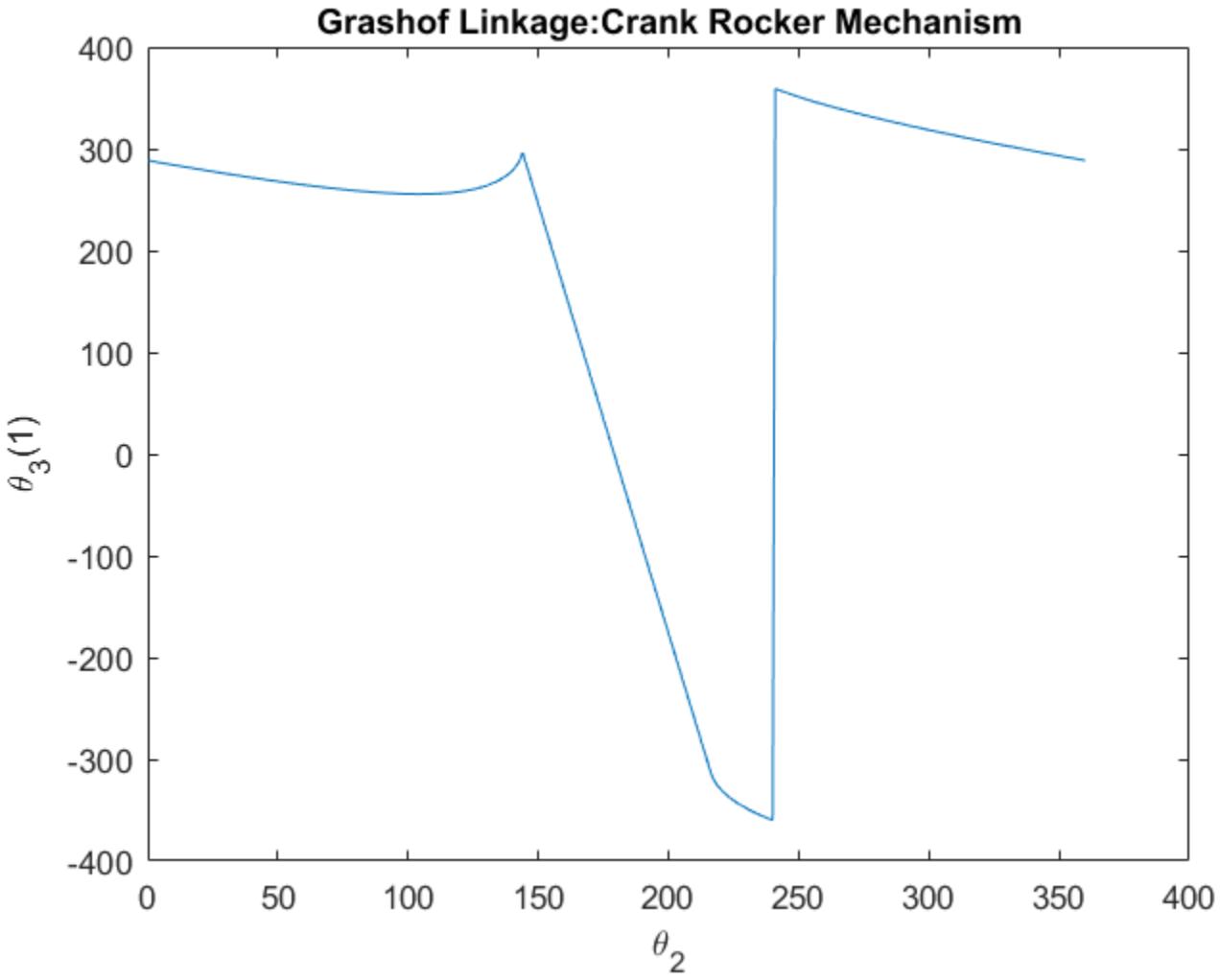


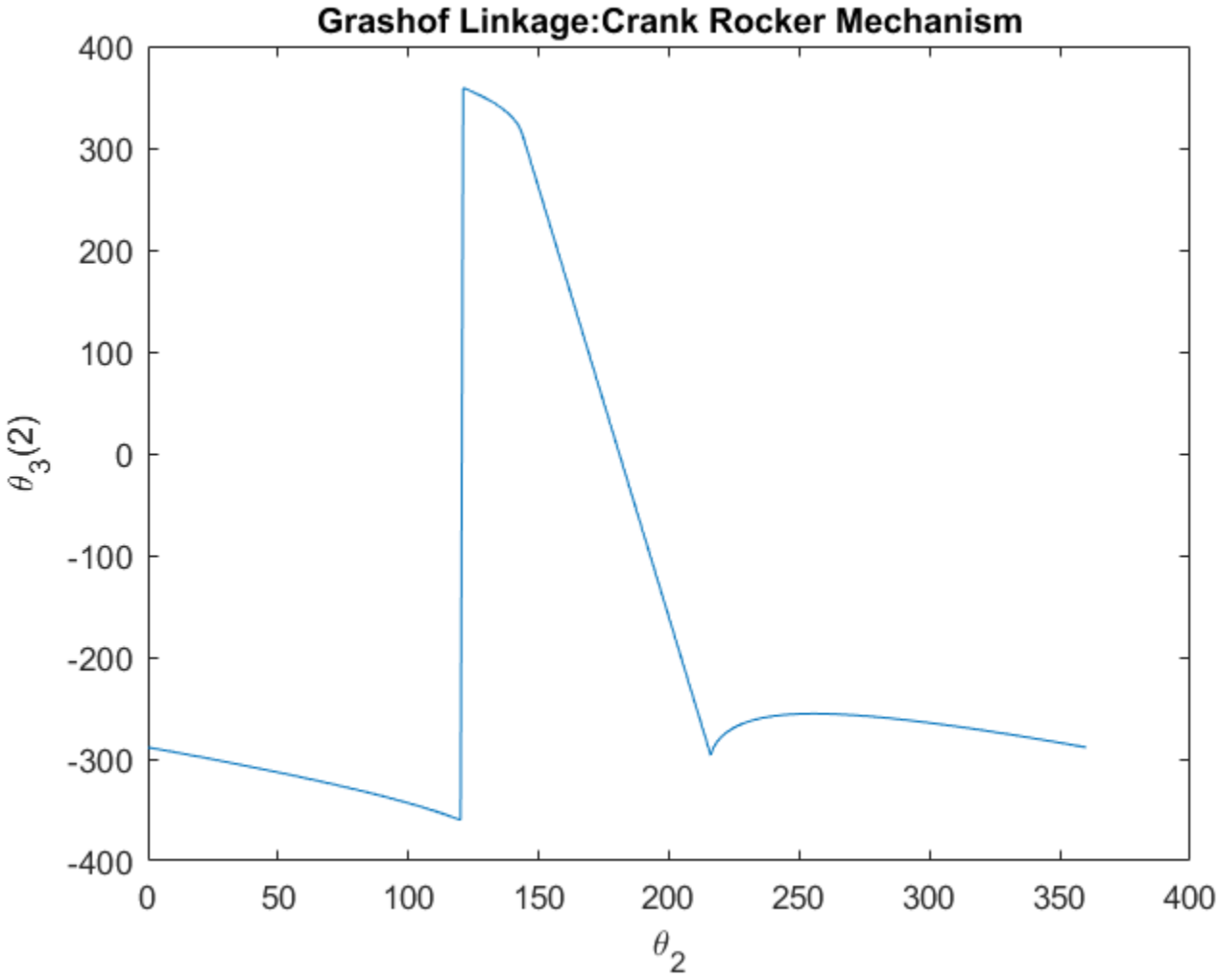
For animation pertaining to the above plots of Grashof Linkage: Double Crank Mechanism; Run AnimateFourBarPolodes.m MATLAB function file with Link Lengths as follows:

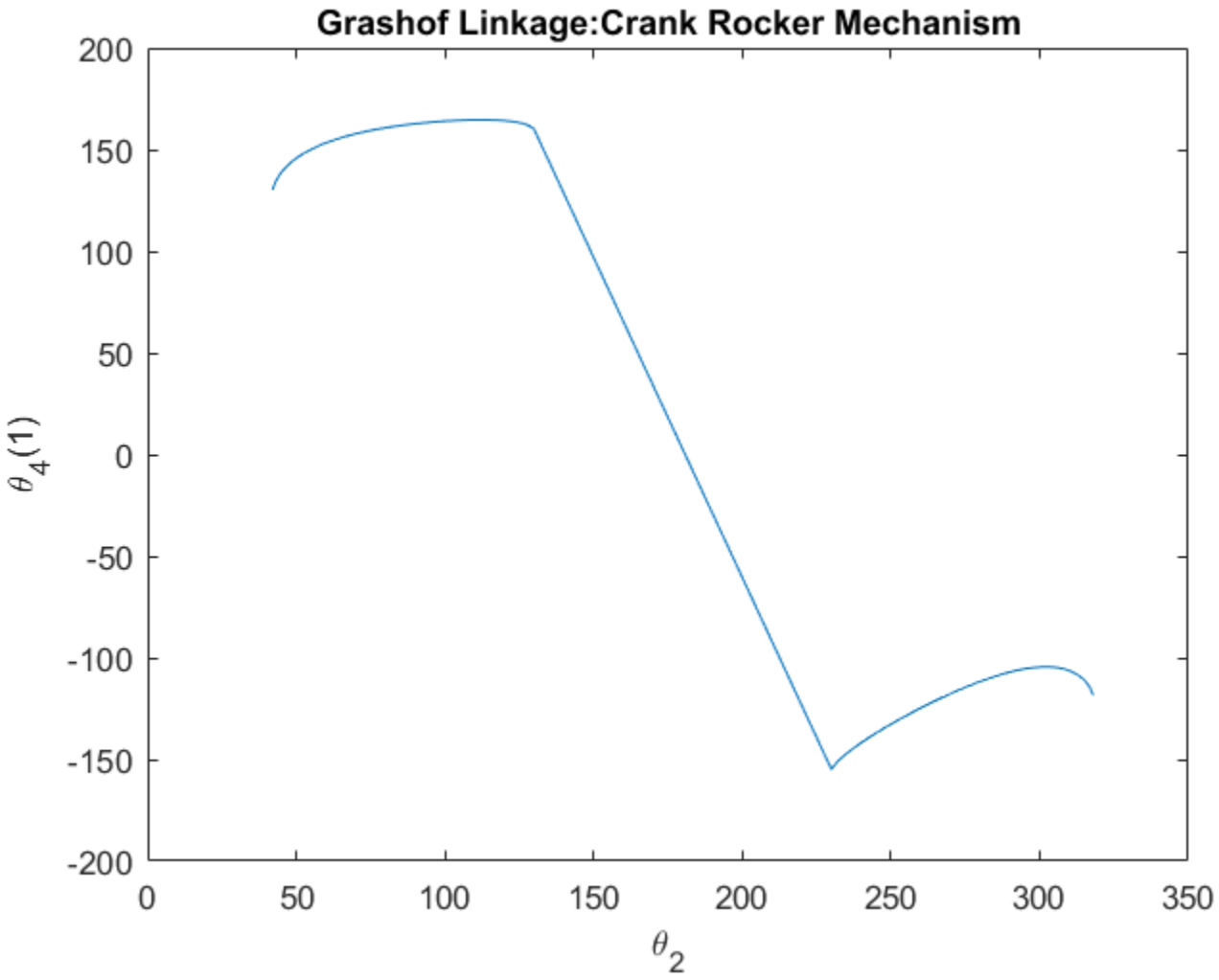
- Input: 5
- Coupler: 7
- Output: 6
- Ground: 3

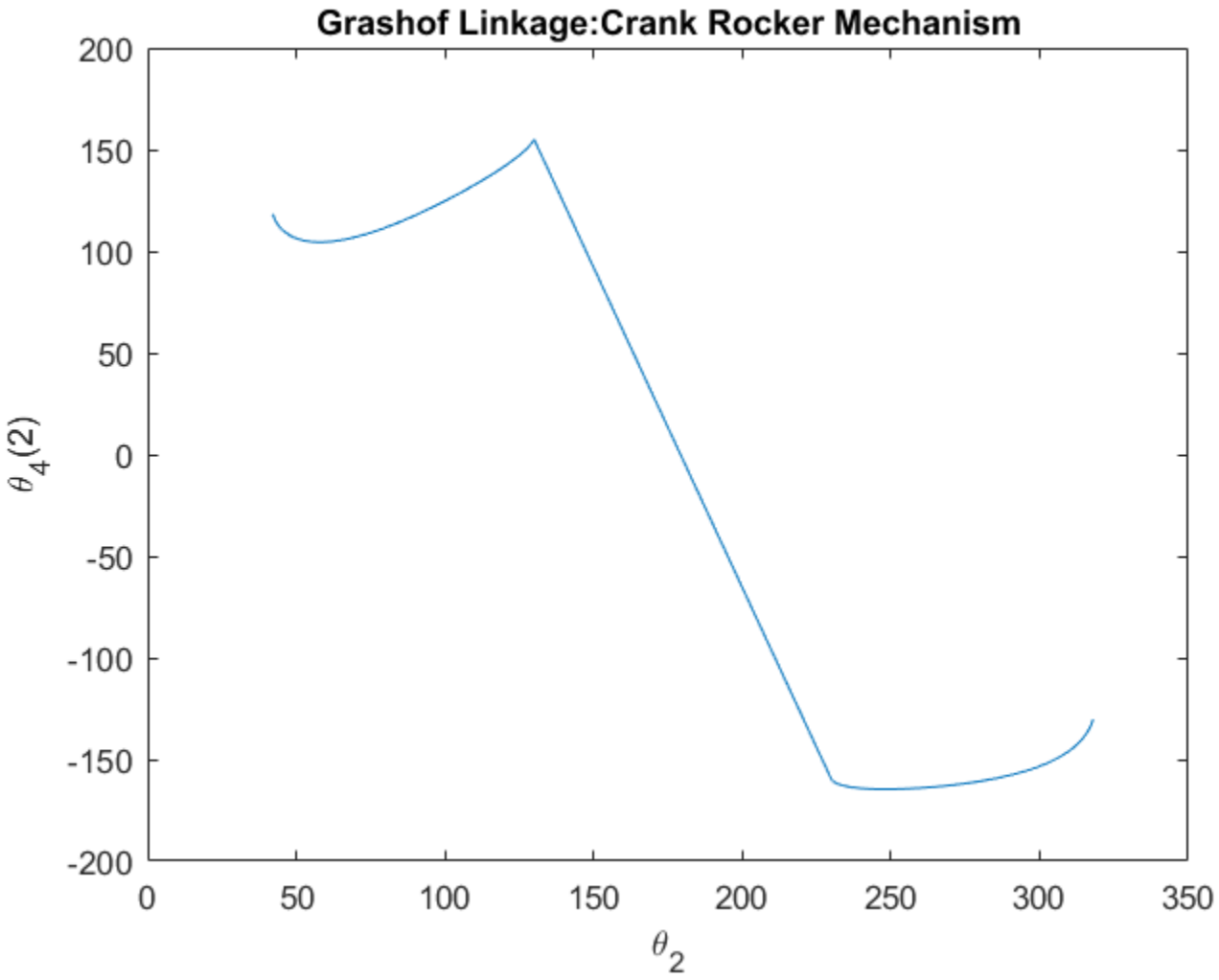
For obtaining the plots, run A2 MATLAB script with link lengths array as: [3 7 5 6].

2.3 Grashof Linkage: Crank Rocker Mechanism




Grashof Linkage:Crank Rocker Mechanism
400
300
200
100
0
-100
-200
-300
-400
$\theta_3(2)$
0
50
100
150
200
250
300
350
400
θ_2


Grashof Linkage:Crank Rocker Mechanism
200
150
100
50
0
-50
-100
-150
-200
0
50
100
150
200
250
300
350
$\theta_4(1)$
θ_2

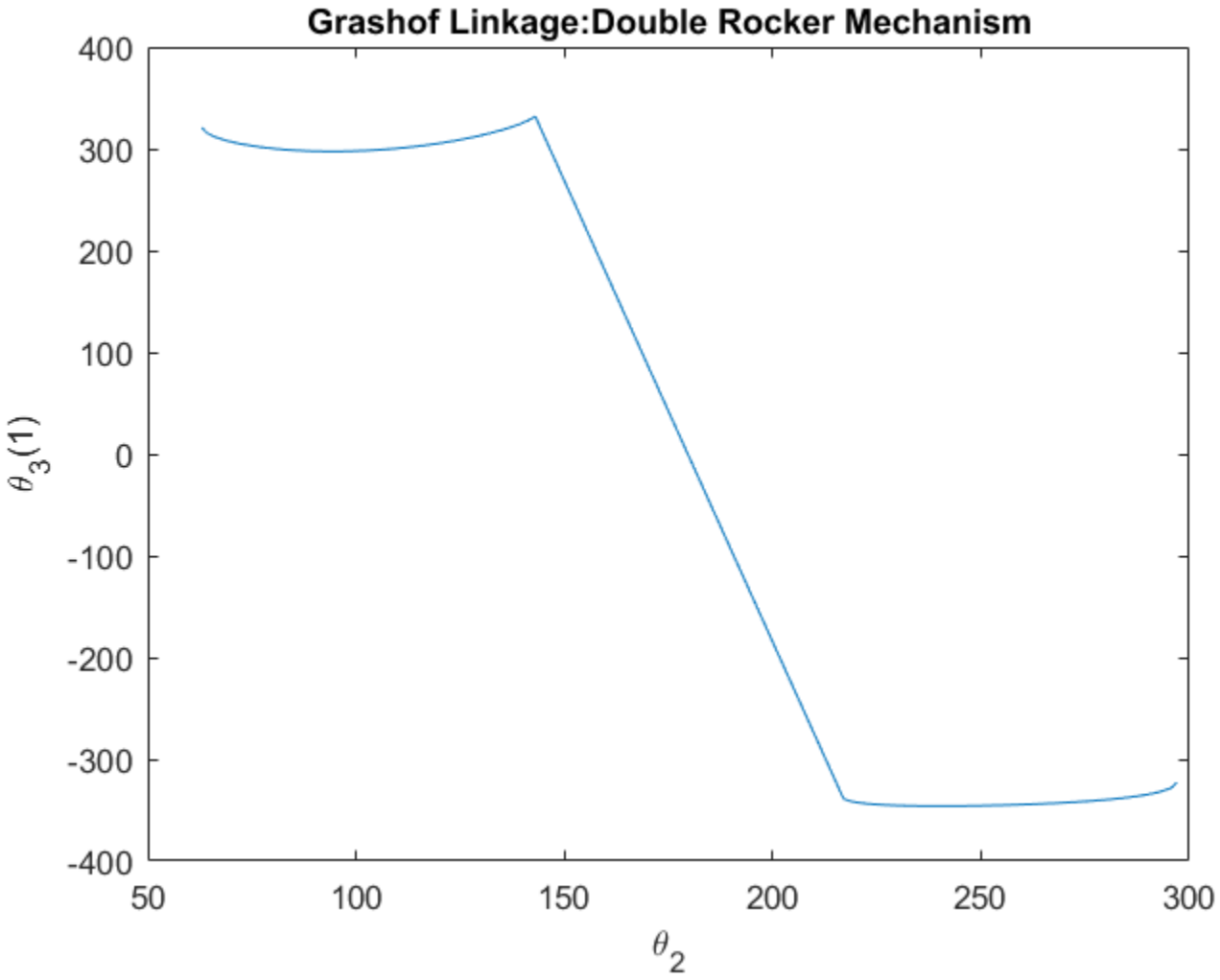


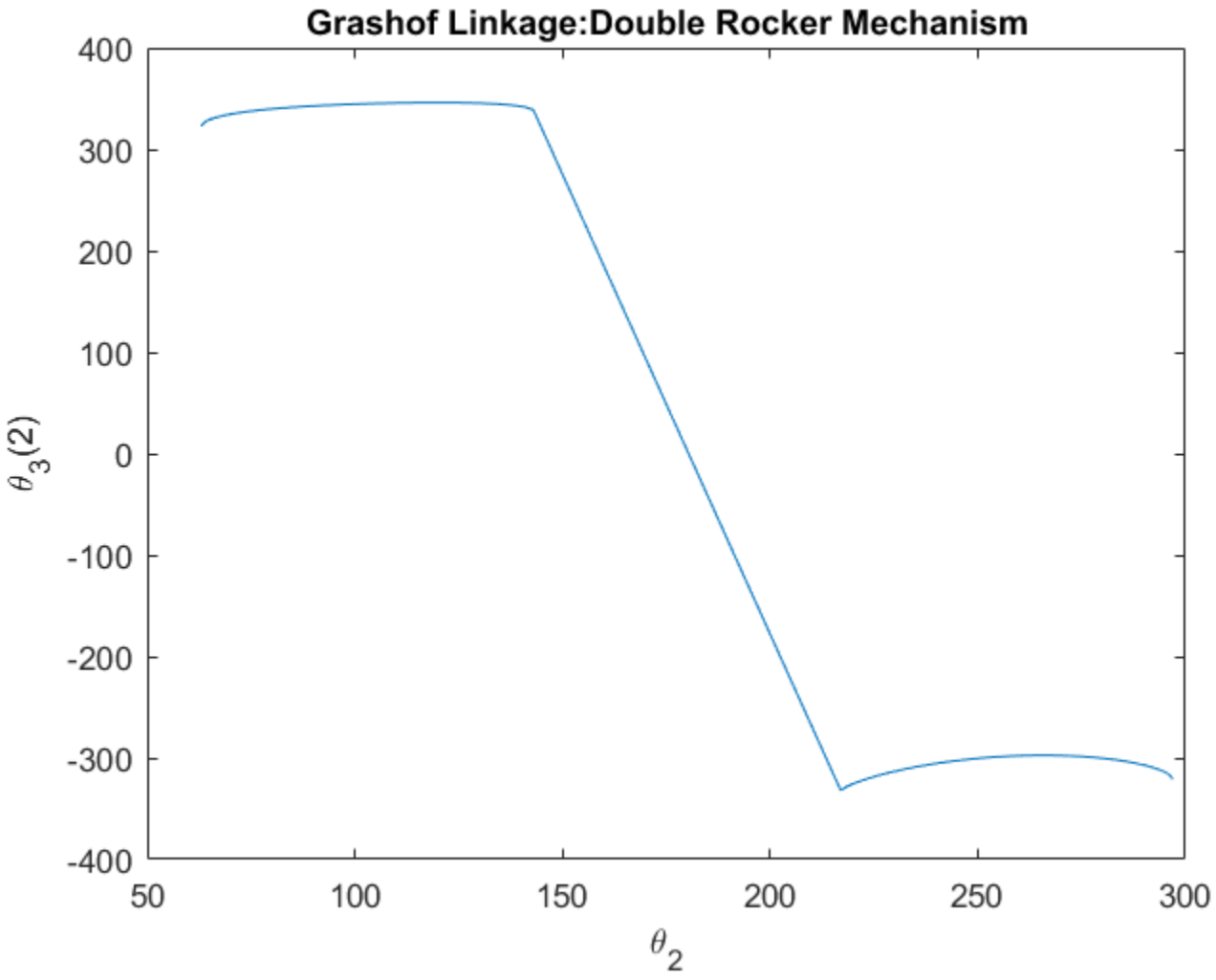
For animation pertaining to the above plots of Grashof Linkage: Crank Rocker Mechanism; Run AnimateFourBarPolodes.m MATLAB function file with Link Lengths as follows:

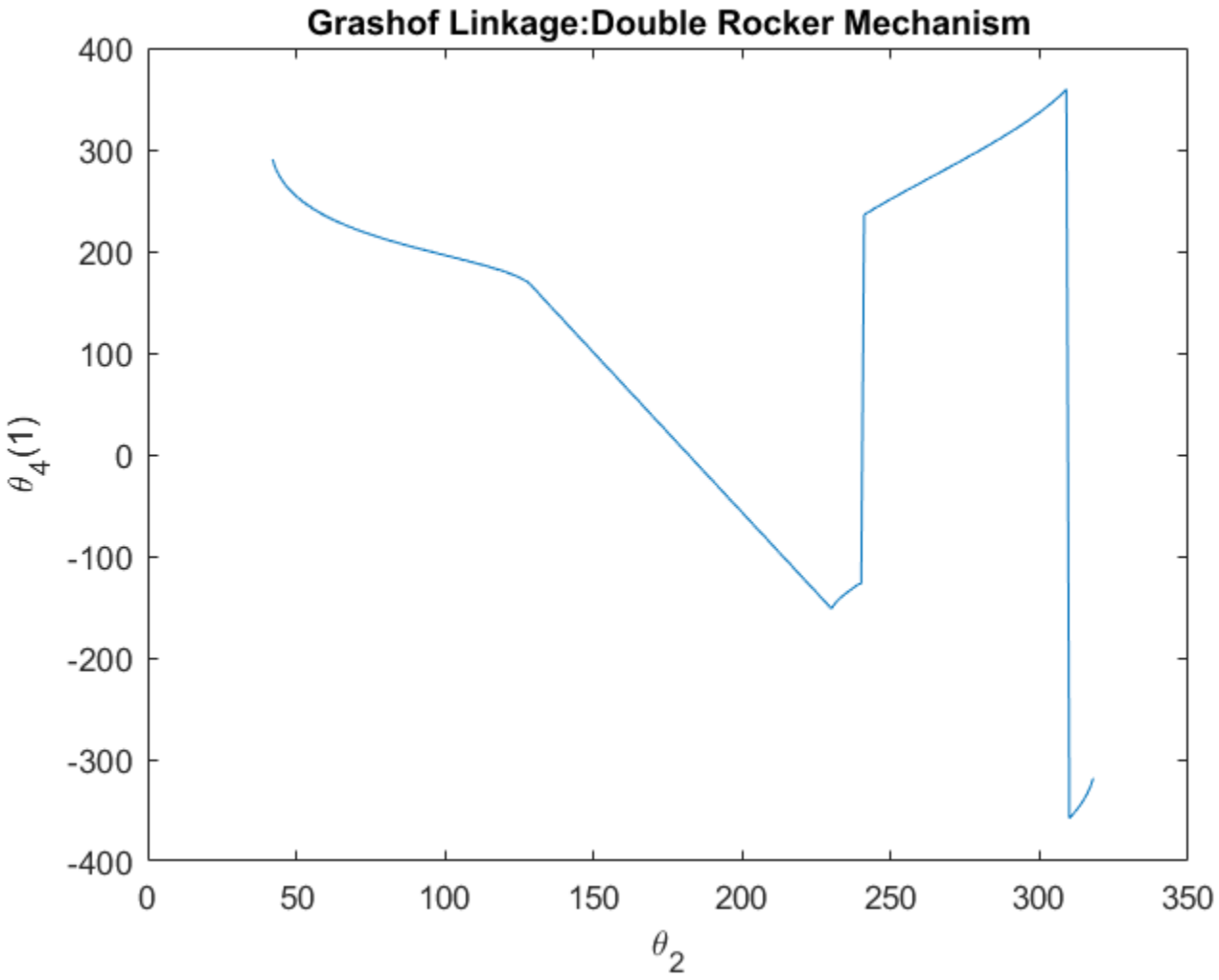
- Input: 3
- Coupler: 7
- Output: 6
- Ground: 5

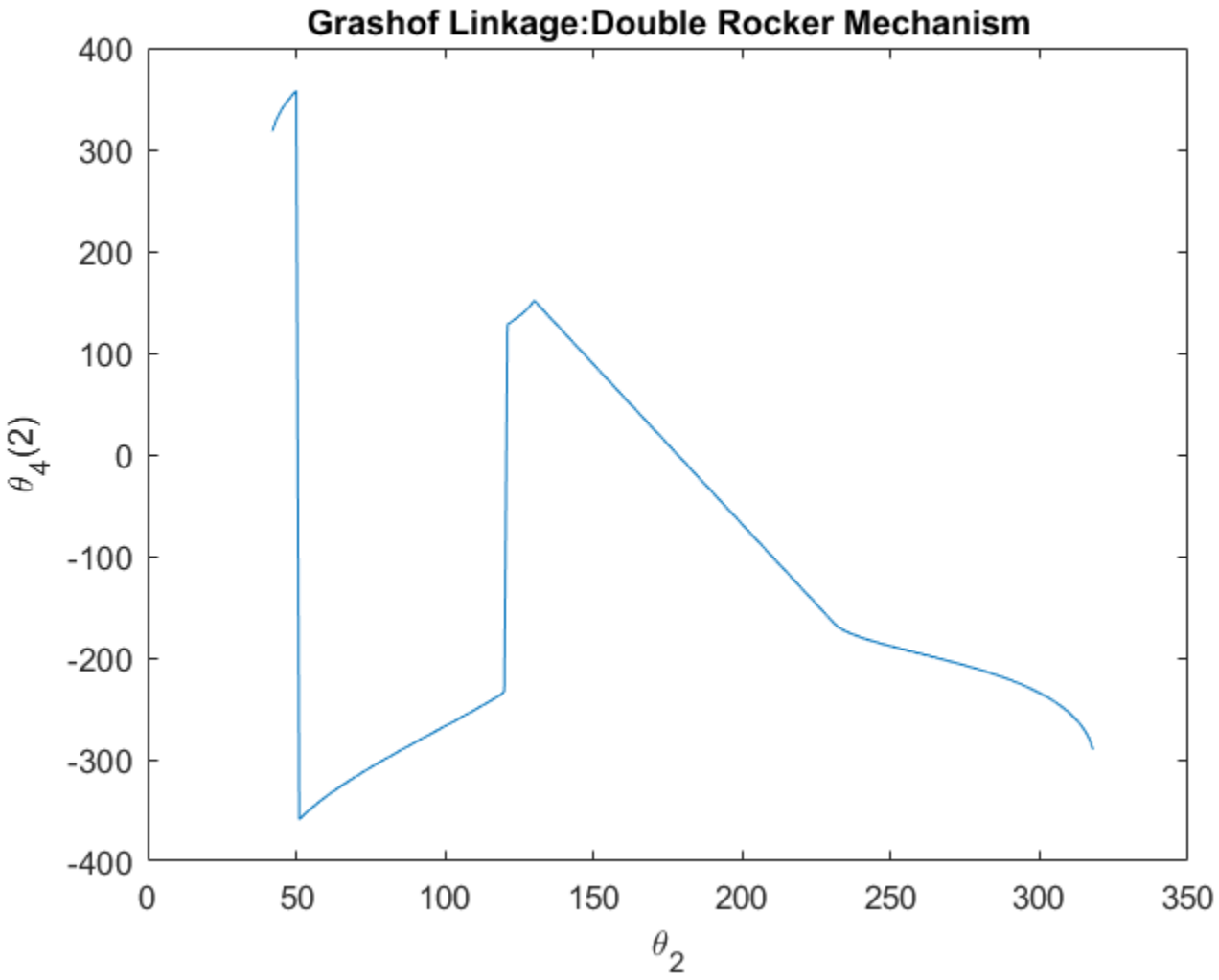
For obtaining the plots, run A2 MATLAB script with link lengths array as: [5 3 7 6].

2.4 Grashof Linkage: Double Rocker Mechanism




Grashof Linkage:Double Rocker Mechanism
400
300
200
100
0
-100
-200
-300
-400
50
100
150
200
250
300
$\theta_3(2)$
θ_2


Grashof Linkage:Double Rocker Mechanism
400
300
200
100
0
-100
-200
-300
-400
0
50
100
150
200
250
300
350
$\theta_4(1)$
θ_2

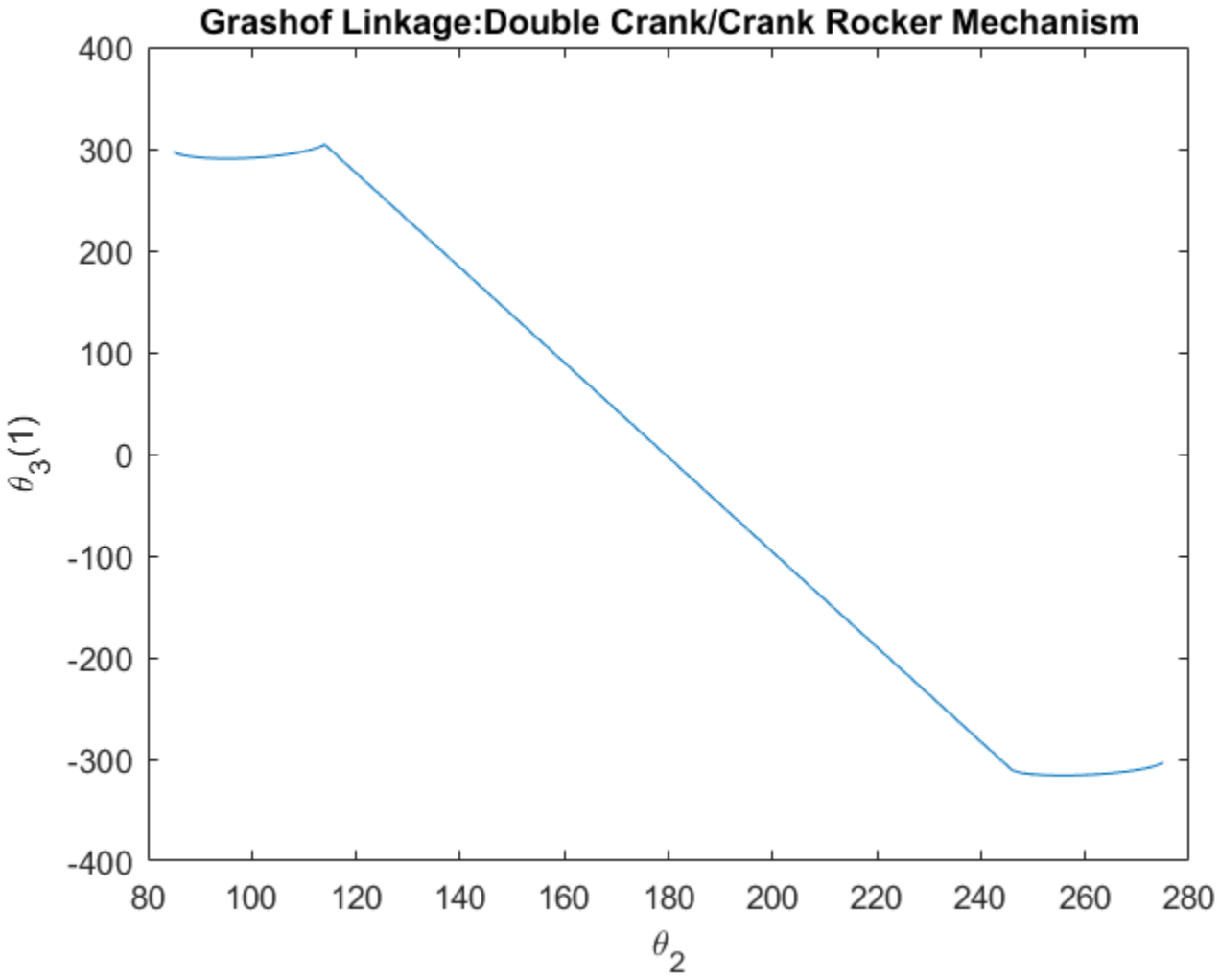


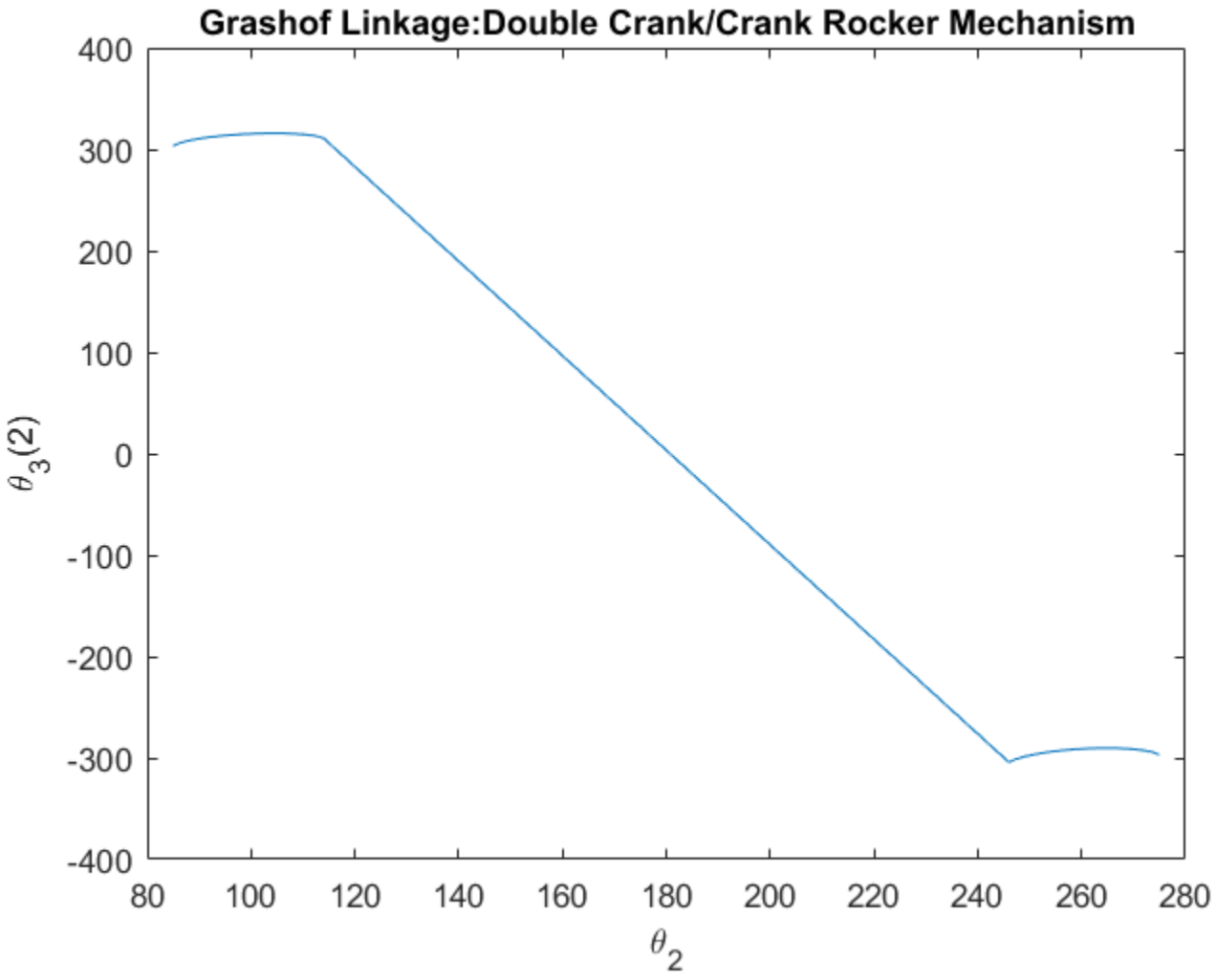
For animation pertaining to the above plots of Grashof Linkage: Double Rocker Mechanism; Run AnimateFourBarPolodes.m MATLAB function file with Link Lengths as follows:

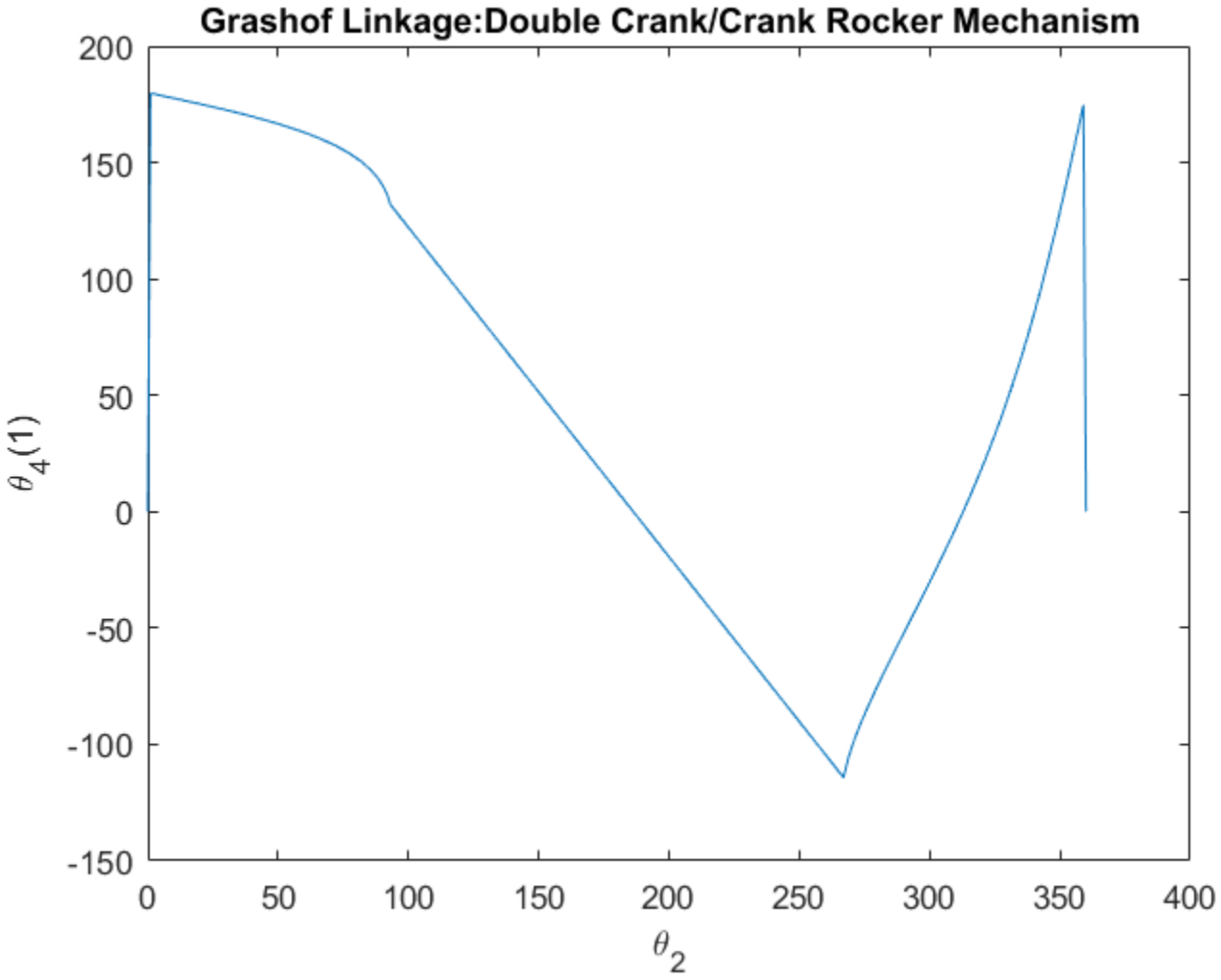
- Input: 6
- Coupler: 7
- Output: 3
- Ground: 5

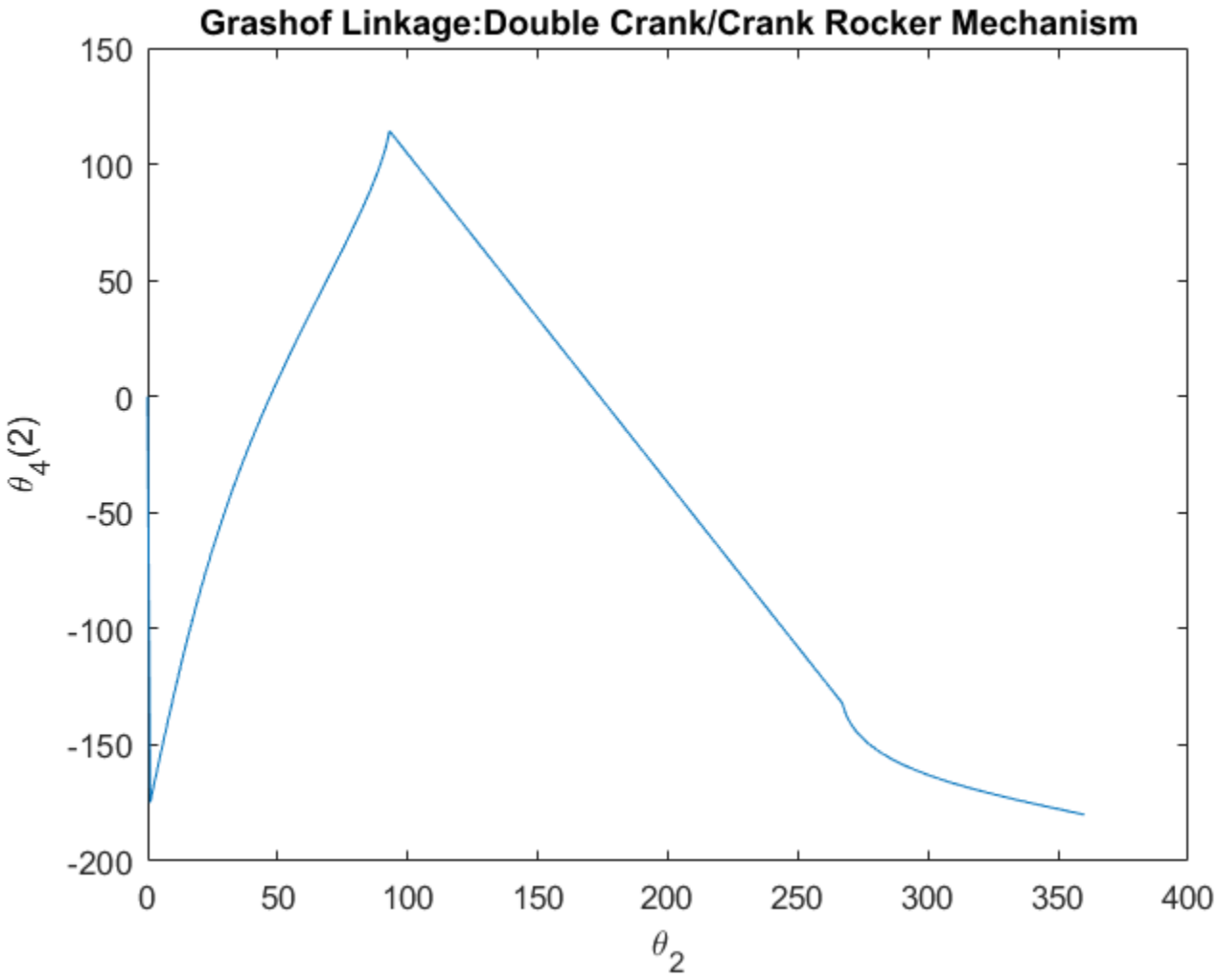
For obtaining the plots, run A2 MATLAB script with link lengths array as: [5 7 3 6].

2.5 Grashof Linkage: Parallelogram Form




Grashof Linkage:Double Crank/Crank Rocker Mechanism
400
300
200
100
0
-100
-200
-300
-400
80
100
120
140
160
180
200
220
240
260
280
$\theta_3(2)$
θ_2


Grashof Linkage:Double Crank/Crank Rocker Mechanism
200
150
100
50
0
-50
-100
-150
$\theta_4(1)$
0
50
100
150
200
250
300
350
400
θ_2



For animation pertaining to the above plots of Grashof Linkage: Parallelogram Form; Run AnimateFourBarPolodes.m MATLAB function file with Link Lengths as follows:

- Double Crank Mechanism
- Input: 5
- Coupler: 3
- Output: 4
- Ground: 2

- Crank Rocker Mechanism
- Input: 2
- Coupler: 3
- Output: 4
- Ground: 5

For obtaining the plots, run A2 MATLAB script with link lengths array as: [5 4 2 3].

3 Conclusions

- For validating the plots in each of the five scenarios, I took help of animation generated from AnimateFourBarPolodes.m function which is used as a tool here and concluded that the plots indeed represent real scenarios as can be seen from the animation generated.

4 References and Acknowledgements

- Please note that the MATLAB function AnimateFourBarPolodes.m used for animation is only for visualization. The function is not hard-coded by me and is used just as a tool for visualization, if you find it violating the honor code please do not include the same. Here is the link for the original MATLAB function:
  https://in.mathworks.com/matlabcentral/fileexchange/30006-four-bar-polode-animation
- Also I have not zoomed the plots for better visualization as I wanted to show the entire response; however if you want to view a zoomed response please run A2.m MATLAB script as mentioned in Plots and Animations Section and then zoom in into the MATLAB figure. Hope this is not much of work for you.
- Note that I am aware of using animatedline function of MATLAB to animate 4-bar linkage using the outputs generated by the code. However as I had already found out a more resourceful tool for doing the animation I preferred on using AnimateFourBarPolodes.m function as an animation generation tool instead of hard coding the animation myself. Also if I had hard coded I would not be able to learn more unique concepts about 4-bar mechanisms like Polodes which is included in the AnimateFourBarPolodes.m MATLAB function.