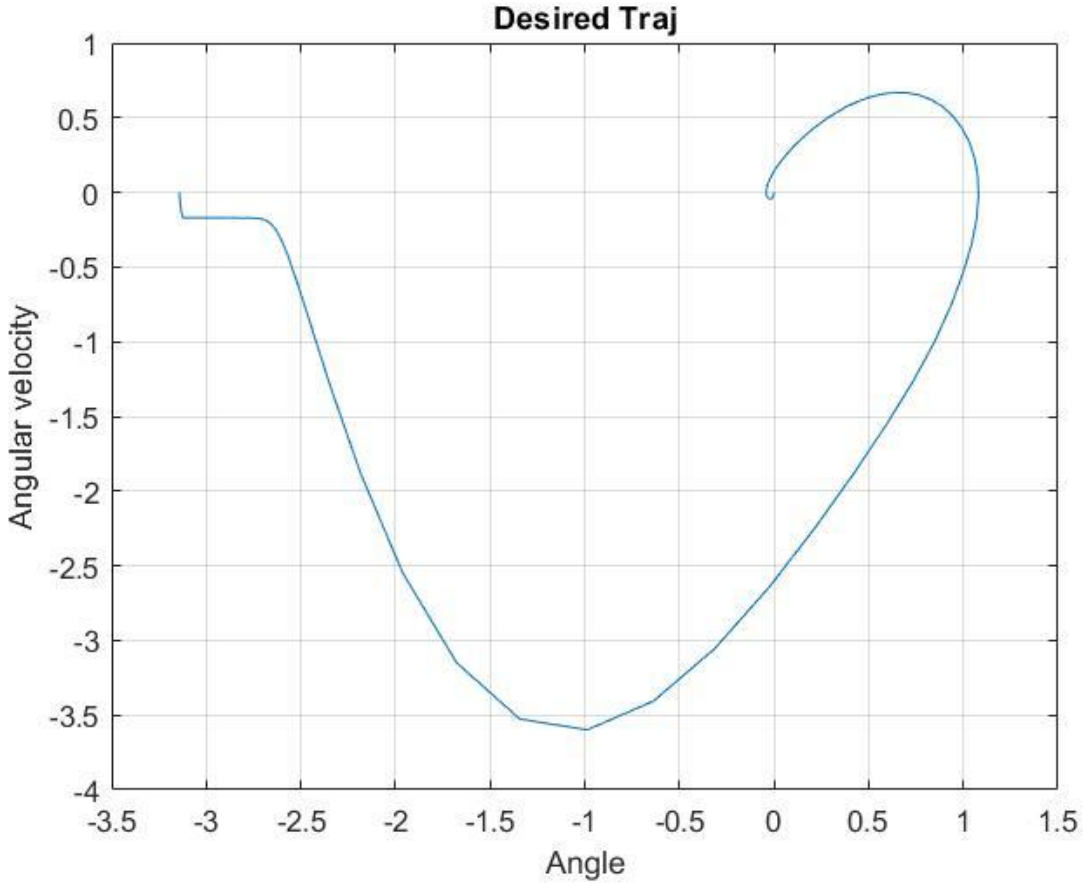
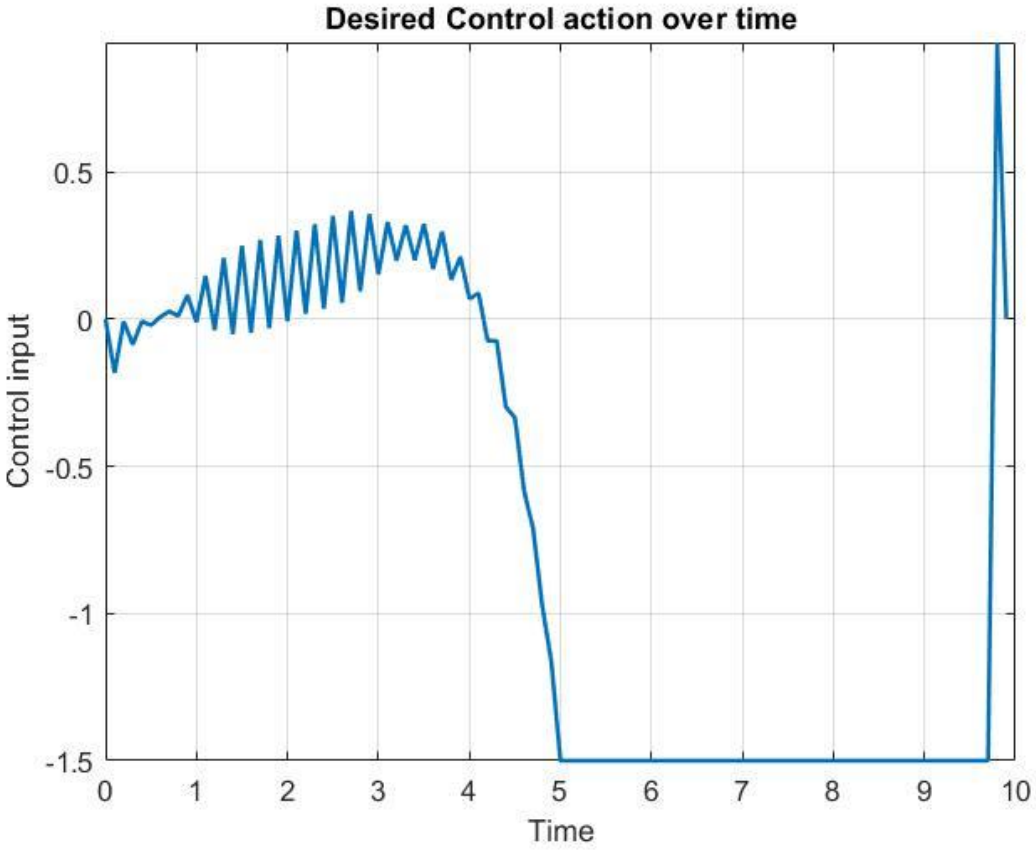
Homework – 2

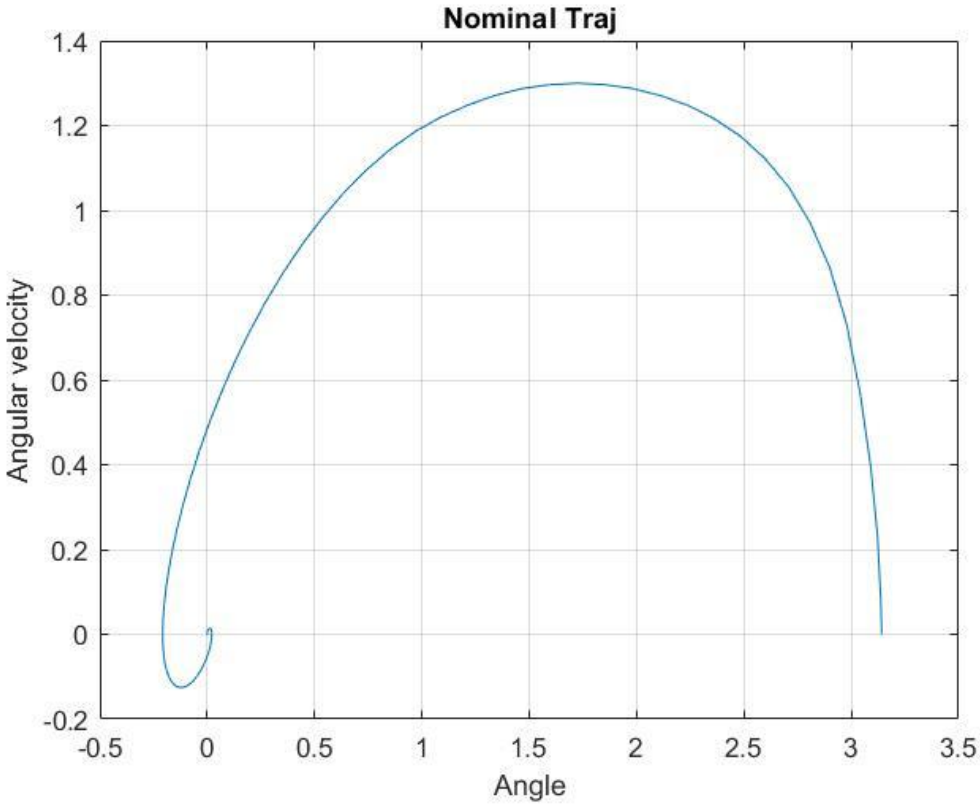
Problem #1

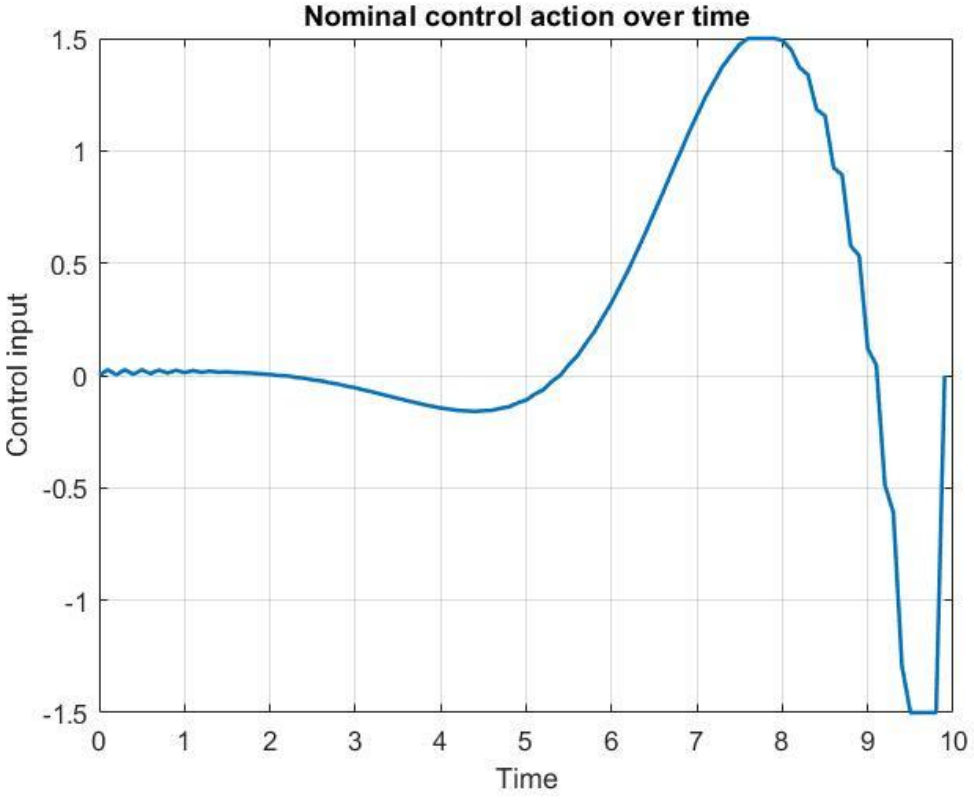
Part a – Direct collocation for augmented pendulum



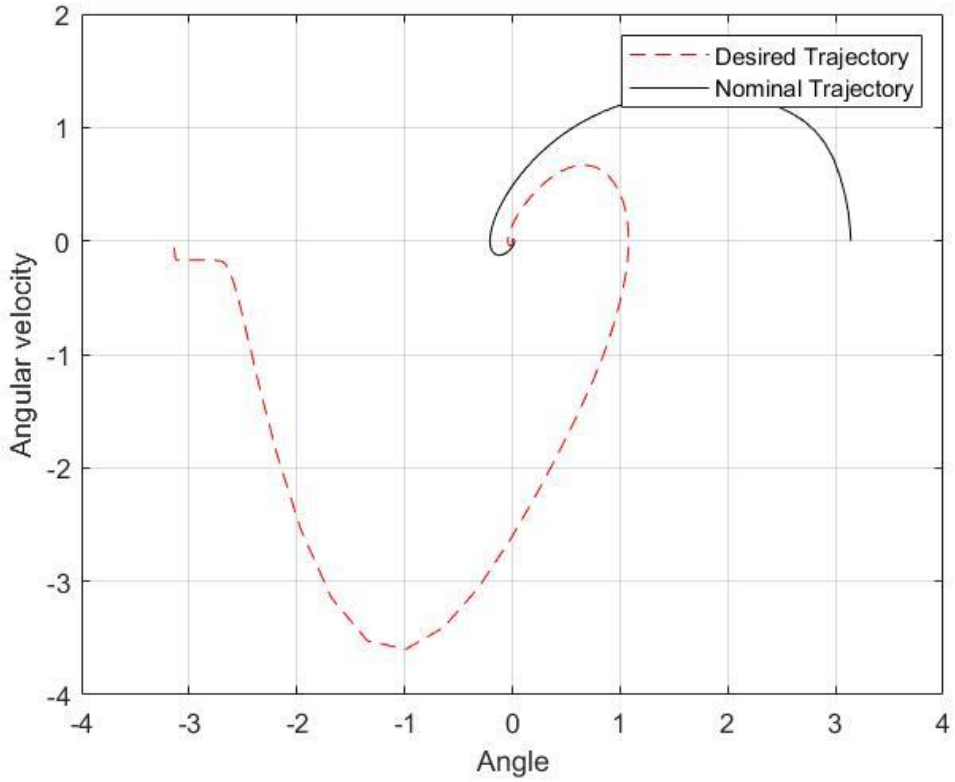

Desired Control action over time
Control input
0.5
0
-0.5
-1
-1.5
0
1
2
3
4
5
6
7
8
9
10
Time

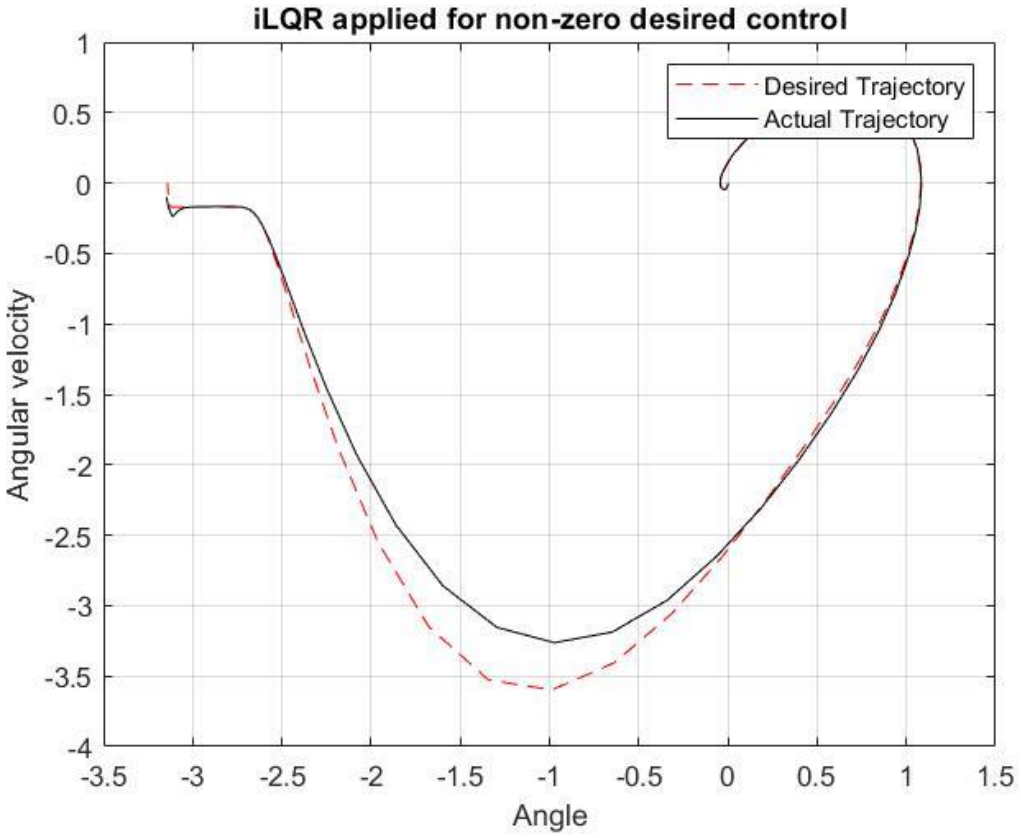
Part b – Direct collocation for simple pendulum

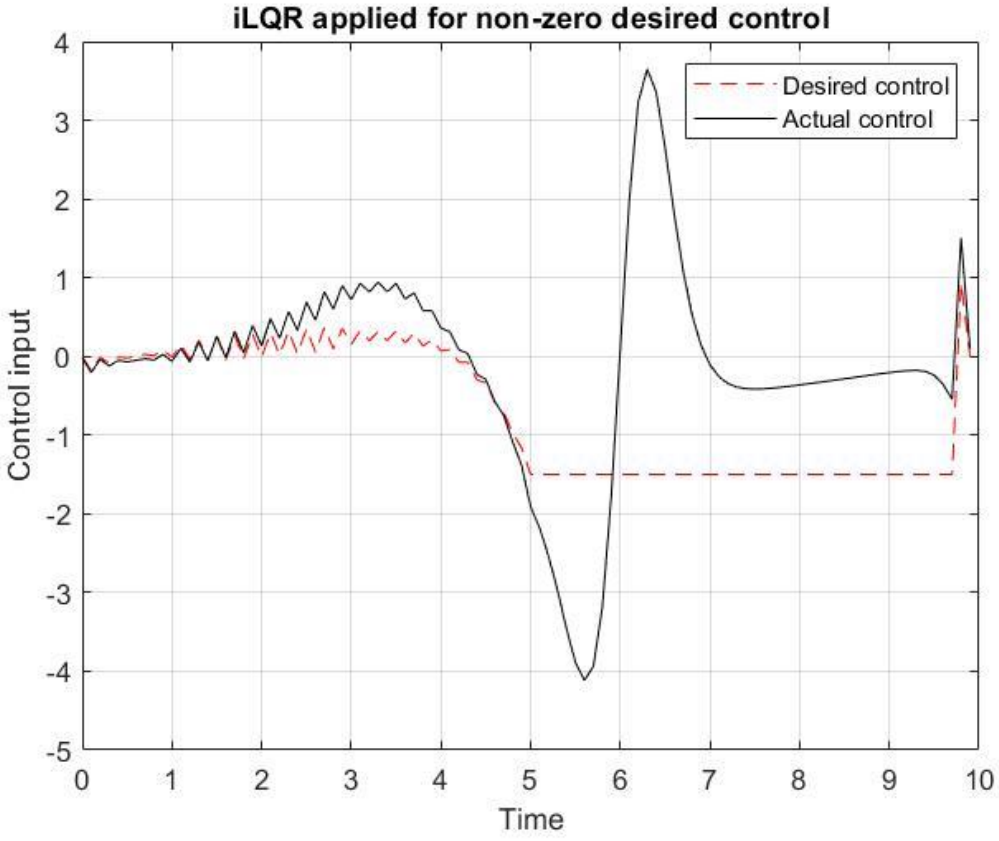




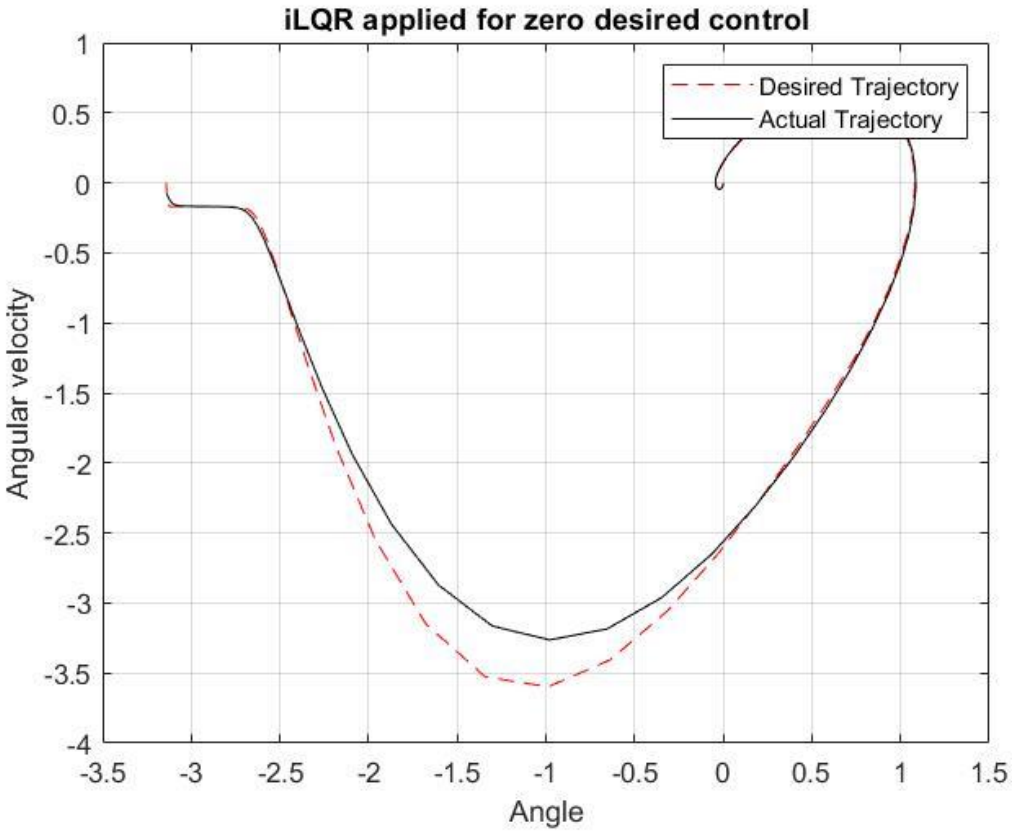
Part c – iLQR for non-zero desired control input

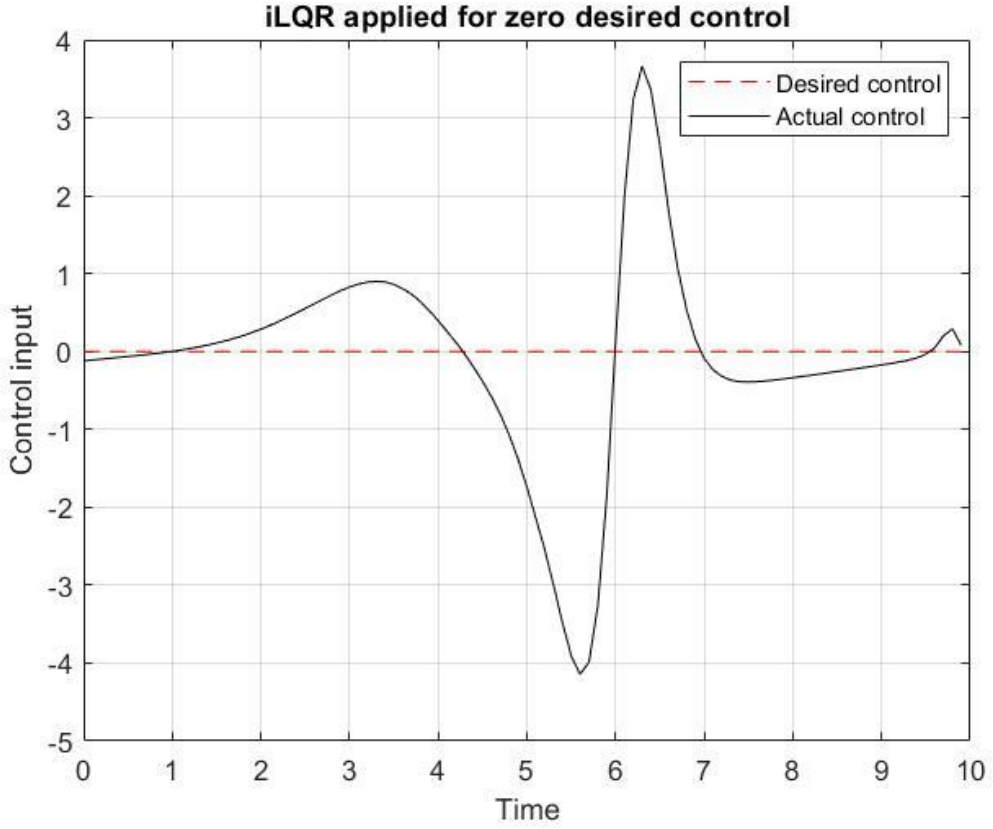



iLQR applied for non-zero desired control
Desired Trajectory
Actual Trajectory
Angular velocity
Angle
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5


iLQR applied for non-zero desired control
Desired control
Actual control
Control input
Time
4
3
2
1
0
-1
-2
-3
-4
-5
0
1
2
3
4
5
6
7
8
9
10

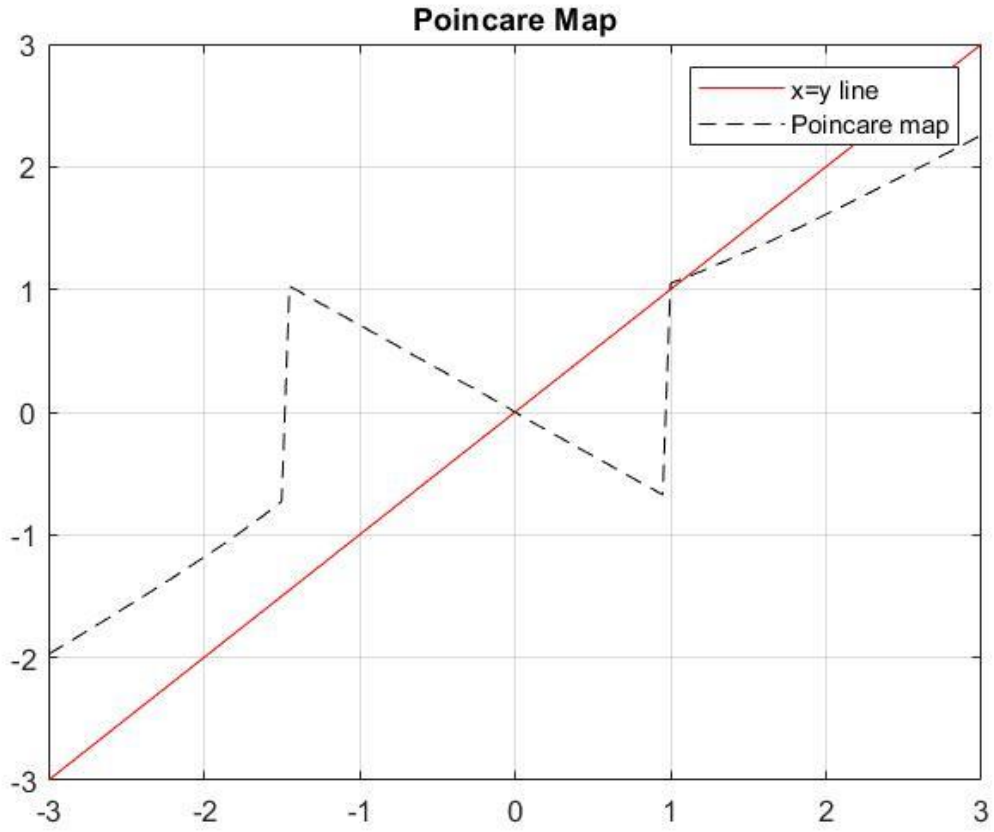
Part d – iLQR for zero desired control input





Problem #2 – Rimless Wheel Walker

Part a – Using Tedrake's simulation



Using Matlab's curve intersection function, we can observe fixed points as –

{ (0, 0), (0.9985, 0.9985), (1.0963, 1.0963) }

Part b – Numerically evaluate fixed point

The fixed point converges to $(\theta, \dot{\theta})$ = (-0.3127, 1.0949) from the given initial condition.

Now to check stability, we check the eigenvalues of the linearized system about the fixed point. After calculating Jacobian of the Poincare map evaluated at the fixed point, we obtain eigenvalues (0.4995, 0). Since we have a discrete LTI system, and both the eigenvalues have magnitude less than 1, this implies that the fixed point is stable.

We can also use the Poincare map in Part a to verify that the fixed point should be stable.