# Python Code:

import cvxpy as cp

import numpy as np

# Define system matrices for SYS1

A1 = np.array([[-4, 1], [0, 2]])

B1 = np.array([[1], [0]])

# Define system matrices for SYS2

A2 = np.array([[-3, 2], [4, 1]])

B2 = np.array([[0], [1]])

# Define dimensions

n = 2  # Dimension of state vector

m = 1  # Dimension of control input

# Define the decision variables

P1 = cp.Variable((n, n), symmetric=True)

Z1 = cp.Variable((m, n))

P2 = cp.Variable((n, n), symmetric=True)

Z2 = cp.Variable((m, n))

# Define the LMI constraints for SYS1

constraints1 = [A1@P1 + P1@A1.T + B1@Z1 + Z1.T@B1.T << 0, P1 >> 0.0001\*np.eye(n)]

# Define the LMI constraints for SYS2

constraints2 = [A2@P2 + P2@A2.T + B2@Z2 + Z2.T@B2.T << 0, P2 >> 0.0001\*np.eye(n)]

# Create an optimization problem for SYS1

problem1 = cp.Problem(cp.Minimize(0), constraints1)

# Create an optimization problem for SYS2

problem2 = cp.Problem(cp.Minimize(0), constraints2)

# Solve the LMI for SYS1

problem1.solve()

# Solve the LMI for SYS2

problem2.solve()

# Check the optimization results for SYS1

if problem1.status == cp.OPTIMAL:

    print('SYS1 is stabilizable')

    K1 = Z1.value @ np.linalg.inv(P1.value)

    print("K1 = ", K1)

    Acl1 = A1 + B1@K1

    print("Acl1 = A1 + B1@K1 =\n", Acl1)

    print("Eigenvalues of Acl1:", np.linalg.eig(Acl1)[0])

else:

    print('SYS1 is not stabilizable')

    K1 = None

# Check the optimization results for SYS2

if problem2.status == cp.OPTIMAL:

    print('\nSYS2 is stabilizable')

    K2 = Z2.value @ np.linalg.inv(P2.value)

    print("K2 = ", K2)

    Acl2 = A2 + B2@K2

    print("Acl2 = A2 + B2@K2 =\n", Acl2)

    print("Eigenvalues of Acl2:", np.linalg.eig(Acl2)[0])

else:

    print('SYS2 is not stabilizable')

    K2 = None

# Output:

SYS1 is not stabilizable

SYS2 is stabilizable

K2 = [[-5.862771 -1.10285985]]

Acl2 = A2 + B2@K2 =

[[-3. 2. ]

[-1.862771 -0.10285985]]

Eigenvalues of Acl2: [-1.55142992+1.2756123j -1.55142992-1.2756123j]

Since real parts of eigenvalues of Acl2 are negative, it is successfully verified that system SYS2 is in fact stabilized using static state feedback control.

# Screenshot:

