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Lab Assignment 1

Date: 18-08-2020

**Control Theory Lab 7 dated 16-12-2021.**

**Python Code:**

#Libraries

import numpy as np

import control

import matplotlib.pyplot as plt

import math

#Q1

a0=0

a1=20

a2=12

a3=1

b0=250

num = np.array([b0])

den = np.array([a3,a2,a1,a0])

H = control.tf(num, den)

print("Hs",H)

plt.figure()

control.bode(H,dB=True,Hz=True,label="Bode Plot of Q1")

gm, pm, wg, wp = control.margin(H)

print("Gain Crossover Frequency: ",wg)

print("Phase Crossover Frequency: ",wp)

print("Gain Margin: ",gm)

print("Phase Margin: ",pm)

plt.show()

if wp>wg:

print("System is Stable")

elif wg>wp:

print("System is Unstable")

elif wg==wp:

print("System is Marginally Stable")

Hs

250

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s^3 + 12 s^2 + 20 s

Gain Crossover Frequency: 4.47213595499958

Phase Crossover Frequency: 4.564092030076082

Gain Margin: 0.9600000000000002

Phase Margin: -0.8692031287892803

Chart

Description automatically generated

System is Stable

a0=0

a1=20

a2=12

a3=1

b0=25

num = np.array([b0])

den = np.array([a3,a2,a1,a0])

H = control.tf(num,den)

print("H()s",H)

plt.figure()

control.bode(H,dB=True,Hz=True,label="Bode Plot of Q2")

gm, pm, wg, wp = control.margin(H)

print("Gain Crossover Frequency: ",wg)

print("Phase Crossover Frequency: ",wp)

print("Gain Margin: ",gm)

print("Phase Margin: ",pm)

plt.show()

if wp>wg:

print("System is Stable")

elif wg>wp:

print("System is Unstable")

elif wg==wp:

print("System is Marginally Stable")

H()s

25

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s^3 + 12 s^2 + 20 s

Gain Crossover Frequency: 4.47213595499958

Phase Crossover Frequency: 1.090899650512431

Gain Margin: 9.600000000000001

Phase Margin: 55.16397315739397

Chart, line chart

Description automatically generated

System is Unstable

#Q3

a0=2

a1=2

a2=3

a3=1

a4=1

b0=30

b1=10

num = np.array([b1,b0])

den = np.array([a4,a3,a2,a1,a0])

H = control.tf(num, den)

print("H()s",H)

plt.figure()

control.bode(H,dB=True,Hz=True,label="Bode Plot of Q3")

plt.show()

gm, pm, wg, wp = control.margin(H)

print("Gain Crossover Frequency: ",wg)

print("Phase Crossover Frequency: ",wp)

print("Gain Margin: ",gm)

print("Phase Margin: ",pm)

if wp>wg:

print("System is Stable")

elif wg>wp:

print("System is Unstable")

elif wg==wp:

print("System is Marginally Stable")

H()s

10 s + 30

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s^4 + s^3 + 3 s^2 + 2 s + 2

Chart

Description automatically generated

Gain Crossover Frequency: 1.4142135623730956

Phase Crossover Frequency: 2.7676035823204828

Gain Margin: 6.280369834735101e-17

Phase Margin: -114.74063957303215

System is Stable

**Learning outcomes:**

1. Using Control Library in Python
2. Calculating Gain crossover frequency, Phase crossover frequency, Gain margin, Phase margin using control library
3. Determining the stability of a system

**Conclusion:**

By performing this experiment, we were able to understand how to use bode plots in python and how to use them to find out the stability of any given system. We also learned new libraries, functions, and implementation of concepts learned in class through coding in python.