ELEC 341 – Graded Assignments

Assignment A-4

10 Marks

Learning Objectives

- Block Diagram Manipulation
- Model Simplification
- Matlab
  - Plot markers
  - zpkdata()
  - minreal()
  - axis equal
- Simulink
  - System Comparisons
  - Error Value
  - Plot Precision

Calc 1 3 mark(s) Block Diagram Manipulation

Use block diagram manipulation to find the following transfer function of the MIMO Block Diagram.

- C1_G11 = y1/u1

Assume the input and output have the same physical units, so the transfer function is pure.

Fig 1 1 mark(s) Poles & Zeros

Use **zpkdata()** to find the poles & zeros of your transfer function.

Plot the poles & zeros in the complex plane using 'x' as a marker for your poles, and 'o' as a marker for your zeros.

- Set **MarkerSize** = 15 (so you can see them easily)

*When you use **zpkdata()**, check the help page about the 'v' option.*

Pole-Zero plots don't have any lines, just 'x' and 'o' where the poles & zeros are.

Poles & zeros that are very close can complicate a transfer function without having any meaningful effect on its response. Are any of your poles and zeros practically on top of each other ???

What's the order of your transfer function ??? Wouldn't it be nice if you could reduce that with some numerator, denominator cancellations ???

Fig 2 1 mark(s) Simplify Transfer Function

Use **minreal()** to eliminate redundant poles & zeros. Use the following tolerances:

a) tol0 = None (default = 0)
b) tol3 = 1e-3
c) tol1 = 1e-1

Re-generate the previous Pole-Zero plot and superimpose the Pole-Zero plot of your most simplified (tol = 1e-1) transfer function.

- tol0 black
- tol1 red, line width = 3

Matlab draws markers just like lines so you can set the line width to make them thicker.

Did mineral decrease the order of G11 much ??? Did the tolerance matter ???

In the future, what tolerance should you use ??? How do you find it ???

Did you lose any poles that did not seem to overlap a zero ???

*Try using the **axis equal** command. Maybe that will shed some light on what's going on.*

Fig 3 1 mark(s) Comparison

Plot the step response of the 3 simplified systems, all on the same plot, and as follows:

- Tol0 = None green, width = 15
- Tol3 = 1e-3 black, width = 8
- Tol1 = 1e-1 red, width = 2

Are all the original poles & zeros necessary, or is the simplified model better ???

Display both transfer functions in your Matlab screen. Maybe that will help you decide.

You can simulate any system using Simulink to find its response. But to use the techniques you will learn in this course, it must be condensed into a transfer function. Either way, the responses should be identical, or at least almost identical.

Fig 4 2 mark(s) Brute Force Model

Use Simulink to model the original system (as drawn).
Include an LTI System block for your Simplified System using **Tol0**.

- Simulink Model

Fig 5 1 mark(s) Step Response

Plot both Step Responses on the same scope.

- Original System (solid red line)
- Simplified System (dashed green line)

Fig 6 1 mark(s) Error Plot

Plot the error between the Brute-Force and Simplified system response in a separate scope window.

- error (solid purple line)

Why plot error separately ??? Why not add it to the other plot ???

Does it have anything to do with Precision ??? Try it !!!

"Precision" is defined differently by the English community (the dictionary) and the Statistical community. Engineers use the Statistical definition. When communicating with other engineers, speak like one !!!

Does the error plot suggest you solved the problem correctly ???

MIMO Block Diagram

- G1 = 1/(s+#A)
- G2 = 1/(s+#B)
- G3 = 1/(s+#C)
- G4 = 1/(s+#D)
- G5 = 1/(s+#E)

- H1 = 1/(s+#F)
- H2 = 1/(s+#G)