ELEC 341 – Graded Assignments

Assignment A-2

12 Marks

Learning Objectives

- 2^{nd} Order System Performance Metrics
- 2^{nd} Order System Approximations
- Improving Approximations

- Matlab
  - set
  - gca
  - roots
  - pzmap

- Simulink
  - n/a

When you use off-the-shelf (OTS) sub-components, you have no idea what's inside and must rely on information provided in the data sheet. This is called a "Black Box" system.

Data sheets often contain experimental curves, but rarely provide a linear model. If you want to use the device in a control system, you must develop your own linear model that represents its behaviour as closely as possible. A linear approximation will never be perfect, but It's better than nothing. And if you do a good enough job, it's a lot better than nothing.

Calc 1 2 mark(s) Experimental Data from a Data-Sheet

Load the experimental data file you generate in Assignment 1. Plot it.

From the plot, estimate:

- C1_tr = Rise Time (msec)
- C1_tp = Peak Time (msec)
- C1_ts = Settle Time (msec)
- C1_os = Overshoot (%)

In this case, should you use Tr or Tr1 for Rise Time ??? Which is more relevant ???

Since you actually have the raw data, you could extract these values. But when you only have a printed plot from a data-sheet, you don't have this luxury so avoid that. Just use your best judgement.

Calc 2 2 mark(s) Estimate #1

Use Overshoot to compute the damping co-efficient & Settle Time to compute the natural frequency.

- C2_zeta = ζ (pure)
- C2_wn = ωn (rad/s)

Calc 3 1 mark(s) Estimate #2

Re-Calculate ωn using the Peak Time. Use the same ζ value.

- C3_wn = ωn (rad/s)

Calc 4 1 mark(s) Estimate #3

Re-Calculate ωn using the Rise Time. Use the same ζ value.

- C4_wn = ωn (rad/s)

Fig 1 3 mark(s) Plot Results

Compute the transfer functions for Estimates 1-3. Plot the Experimental Data and all 3 step responses, all on the same graph. Change the time axis so that it stops exactly when the data stops, to show as much detail as possible.

- Time scale in msec
- LineWidth = 3 (all of the following)
- Experimental: Solid green
- Estimate #1: Dotted red
- Estimate #2: Dotted black
- Estimate #3: Dotted blue
- Include a Legend (bottom, right hand corner of plot)

Calc 5 1 mark(s) Accurate Values

Find the Overshoot and Settle Time by zooming in on the plot. A zoom icon shows up when you hover the cursor over the plot window. Click it and draw a box around the part of the curve you are interested in.

- C5_ts = Settle Time (ms)
- C5_os = Overshoot (%)

*Recall, Ts is the time it takes for the error to drop **BELOW 2%**, and stay there.*

How far off was your estimate ???

Calc 6 1 mark(s) Poles & Zeros

Use your plot to choose the most accurate estimate. From that estimate, compute the poles.

- C6_p = Vector of poles

Fig 2 1 mark(s) Poles & Zeros

Use the poles that you computed to generate a pole-zero plot.

- Pole-zero plot (investigate the pzmap function)

Which value was hardest to read accurately from the plotted data ??? If you have the same problem with a data-sheet plot, how could you get around that ???

*Make sure you **understand** what was accomplished in each step. Even if you had trouble reading certain values from the plot, you probably ended up with a good approximation. And the curve you were trying to model is not a 2nd order system !!! It's higher order.h*