ECE442 “Mass Spring Damper” Lab 1 outline

System Identification.

Uses directions similar to the continuous time system ID Lab. Main differences: use the “Discrete” mode of the ECP software, with the sample rate set to the lowest possible value.

1. Starting with a value of ~100, adjust the ’Trajectory’ input, until a steady state position near 2000 (+/- 200 is OK) is achieved. (Personally I find this a bit less confusing than adjusting the gain value because then you don’t have two different gain numbers to deal with. You can compute the DC gain of the continuous time system directly from the steady state position & the input value). Example: desired trajectory of 124 results in a steady state position of 2150. DC Gain is (2150/124) = 17.34
2. Export the data. Either in Matlab or [quicker / easier] notepad, find the percent overshoot and time-to-peak. Use these to calculate the damped frequency and zeta in the continuous time transfer function. Compute . Find the natural frequency ()
3. Use the DC gain from (1) and the parameters obtained from (2) to compute the transfer function
4. Select an appropriate sample frequency (using the rule of thumb from class: Fs = 1/T = 30 \* wn / 2\*pi) Using the ECP software, find the closest supported sample period T in the software (I have noticed that the ECP software displays a value that is ½ of the real sample period)
5. Use the matlab C2D function to find the equivalent discrete approximation of H(s). Use the transfer function obtained from (3) and the sample period obtained from (4)
6. How many poles and zeros appear in the discrete equivalent system?

ECE442 Lab 2 outline

Proportional control of a mass spring damper

1. Find the poles and zeros from your discrete equivalent H(z) from lab 1.
2. Sketch the root locus for a proportional controller for H(z). Is it possible to stabilize this system using a proportional controller?
3. Using Matlab, (numerically) find the range of K that results in a stable closed loop system. [example code needed]
4. Select a few (3?) values of K within this stable range.
5. For each K selected, plot the step response in Matlab [example code needed]
   1. Does the system appear to get more or less well behaved as K is increased?
   2. Visually compare some of the key parameters of the system (overshoot, DC accuracy, settling time) and summarize the differences for different values of K.
6. Using the ECP software, generate a step response for each value of K selected
   1. Observe the behavior of the mass spring damper system.
   2. Plot the step response x(n). How close is it to the simulated step response in Matlab?
   3. Are the DC gain, peak time, and percent overshoot similar to what was expected?

ECE442 Lab outline 3

PI control of mass spring damper system.

Would like to try to guide the students towards a “good” choice for and . So I could maybe use some help with that. Here is what I have for a first cut.

1. Start by selecting . [A value of 0.9?]
2. Compute the new
3. Use matlab to generate a root locus for .
4. Use matlab to compute the range of k that results in a stable system [example matlab code needed]
5. Select a value of “” within the stable range. [My idea is to have different lab groups use different values: 20%, 50%, and 80% of the ‘stable’ range].
6. Use Matlab to find the transfer function of the closed loop system
7. Use Matlab to plot the step response of the closed loop system.
8. Compute
9. Use the ECP software to implement the PI controller (use the PID controller with “D” = 0)
10. Plot the step response from (9) and compare to the one generated with Matlab. Compare the properties of systems generated with different values of “K