HW #5 (3/22/2023)

1) Chapter 8: 8.1, 8.5-9
2) Discretize and simulate a 2nd order system with a settle time of 1 second and overshoot of 15%. Compare the results with Δt=0.1, 0.2, 0.5 seconds and the actual solution. Do this in both state space and transfer function formulations.
3) Design a second order low-pass filter with a damping ration of 0.707 and natural frequency of 5 Hz. Discretize the filter with sample rate of 0.01 seconds.
    a. Compare the continuous and discrete frequency responses (i.e. bode plots)
    b. Process a signal that contains a 1 Hz sine wave and 20 Hz sine wave with your digital filter.
    c. Compare your results with matlab's "butter" and "filter"
4) Determine the closed-loop eigenvalue in the z-domain for problem 4 in HW#4 for different sample rates. Does this explain what you saw in your simulation.
5) Design a lead controller for a simple $\frac{1}{s^2}$ plant that is to be sampled at 0.1 seconds. Simulate the various design approaches below and comment on the difference/advantages of each.
    a. Add delay TF and design in continuous RL and covert K(s) to K(z)
    b. Add delay in Bode and design in continuous bode and convert K(s) to K(z)
    c. Discretize plant and design K(z).
6) Try to design and implement a pure PD controller in discrete for a simple $\frac{1}{s^2}$ plant assuming position and velocity measurements.
7) Using frequency based techniques, take another shot at determining the differential equation for "ID_this_system." If you already used frequency based techniques, then attempt to identify it using transient techniques given some things mentioned about noise in class.
8) Continue to work on your Ball and Beam and Vehicle models as well as the controllers for them.