EE 105 Homework 5 Due in class, October 15 2019

Problem 1: ζ and ω_n

For each of the following transfer functions, compute the damping ratio and natural frequency. If this parameterization is invalid (i.e., ζ and/or ω_n are meaningless), explain why.

a)

 $D(s) = \frac{2}{0.001s^2 + 0.004s + 10^{-6}}$

b)

$$F(s) = \frac{s+1}{12s^2 + 6s + 192}$$

c)

$$G(s) = \frac{1200}{s^2 + 0.01s - 1}$$

Problem 2: Transient details

For transfer functions D and F above, examine the step response and find the maximum overshoot as a percentage of the final value and the settling time to within 5% of the final value.

Problem 3: Control time

For each of these problems, apply proportional, derivative, PD, or PID feedback control to the system to achieve the desired behavior. Make sure to document what type of controller you used and what the gains are. Please attach your MATLAB code to your homework.

- a) Apply feedback control to D(s) so that the system is critically damped.
- b) Apply feedback control to F(s) so that the maximum overshoot is less than 5%.
- c) Apply feedback control to G(s) so that the system reaches 90% of the final value in under 1 second with no overshoot.

Problem 4: Cruise control redux

Redo the cruise control problem from Homework 1 using a PID controller. Note that since the system is nonlinear, you won't be able to find a clean analytical solution, but you should be able to control it quite nicely. Since this problem is discrete rather than continuous, you'll need to calculate the derivatives as the difference between the previous run and the current run.

Tune your PID parameters until you would be willing to ride in this car. (For reference, I would not be willing to ride in a car powered by most of the controllers from HW1.)

Submit your code with provide. Just submit the MATLAB file (cruisepid.m); please don't zip it up or change the name of the file.

Problem 5: Reflection

- a) Approximately how long did you spend on this problem set?
- b) What questions do you have about this problem set, or about the course material so far?