CDS 101/110: Homework #6

(Due Tuesday, November 29, 2016)

Problem 1 (CDS 101, CDS110): (15 points) Do Problem 11.3 in Chapter 11 of FBS, 2^{nd} edition.

Problem 2 (CDS 101, CDS110): (15 points) Do Problem 11.10 in Chapter 11 of FBS, 2^{nd} edition.

Problem 3 (CDS CDS110): (30 points)

This problem considers the design of a PID compensator for a vectored thrust aircraft (see Example 2.9 in FBS-2e for a description). Use the following transfer function to represent the dynamics from the lateral input to the roll angle of the aircraft:

$$P(s) = \frac{r}{Js^2 + cs + mgl} \tag{1}$$

where $g = 9.8m/s^2$, $m = 1.5kg$, $c = 0.05kg/s$, $l = 0.05m$, $J = 0.0475kgm^2$, and $r = 0.25m$. Design a feedback controller that tracks a given reference input with the following specifications:

- Steady-state error of less than 1%
- Tracking error of less than 5% from 0 to 1 Hz (remember to convert this to rad/s).
- Phase margin of at least 30^o.

Part (a): Plot the open loop Bode plot for the system and mark on the plot the various frequency domain constraints in the above specification.

Part (b): Design a PID compensator for the system that satisfies the specification. You should include appropriate plots or calculations showing that all specifications are met. (Note: you may not need all of the three terms in the PID controller)

Part (c): Plot the step and frequency response of the resulting closed loop control system. For the step response, compute or estimate the steady-state error, rise time, overshoot and settling time of your controller.

Problem 4 (CDS 110:) (20 points) Do Problem 10.7 in Chapter 10 of FBS, 2^{nd} edition.