

**CDS 101/110: Homework #7**  
(Due Tuesday, November 29, 2016)

**Problem 1 (CDS 101, CDS110):** (15 points) Do Problem 11.3 in Chapter 11 of FBS, 2<sup>nd</sup> edition.

**Problem 2 (CDS 101, CDS110):** (15 points) Do Problem 11.10 in Chapter 11 of FBS, 2<sup>nd</sup> 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:

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

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°.

**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<sup>nd</sup> edition.