

CDS 101/110 Homework #8 Solution

Problem 1 (CDS 101, CDS 110): (25 points)

- (a) Any controller that satisfies the requirements are accepted. These requirements have direct implications to the bode plots of $L(s)$. You may find this information in Week 9 Wed lecture slides on page 5 and 6.

In general, you will need an integral control to achieve zero steady state. But, with an integral control, you will have a bad phase margin. So, you will need a lead compensator to increase the phase margin to achieve good overshoot. The proportional control is useful for increasing the gain. The derivative control is useful for increasing the phase margin and gain.

After you obtain a controller that satisfies the requirements, you will need to check the Nyquist plot of the loop transfer function $L(s)$ to ensure stability is achieved.

Then, you will need to check the bode plot of the “Gang of Four” which includes $L(s)/(1+L(s))$, $1/(1+L(s))$, $C(s)/(1+L(s))$, and $P(s)/(1+L(s))$. Most likely, you will find that $C(s)/(1+L(s))$ has a large increasing gain at high frequency which implies that any noise in the system will result in significant actuator activity. So, you will need to add additional pole at high frequency to your controller $C(s)$ to remove this effect.

- (b) The sensitivity function should satisfy all requirements as stated in part (a).