LAB 7 WORKSHEET: POSITION CONTROL USING P, PD AND LEAD CONTROL

7.2. Proportional Position Control.

(1) From the pre-lab, **RECALCULATE** the damping $\zeta$ and $K_p$ that will satisfy the PO design specification. Also obtain $T_p$ and $\omega_d$ for that $K_p$.

(2) **PRINT** the plot, label it 7.2.3.SIM and attach it to the end of the report.

(3) From plot 7.2.3.SIM, **FIND** the simulated percent overshoot, $PO_{sim}$ and $T_{p,sim}$. **COMPARE** the simulated results to the theoretical result from step (1).
(4) Make sure the gain is the calculated $K_p$ and RECORD the calculated damping and frequency, $\zeta_{sim}$ and $\omega_{d,sim}$, respectively. COMPARE these values to the theoretical result from step (1) (ie. calculate the relative error and qualitatively describe whether or not the difference is acceptable.)

(5) For a given step response, PRINT out the screenshot, label it 7.2.8.EXP.

(6) From the plot 7.2.8.EXP, OBTAIN the $PO_{exp}$ and the $T_{p,exp}$ and COMPARE these results with the above simulation and theoretical results.

(7) Now, look at the steady state error. You will notice that it may not be zero even though the theory and simulation both suggest it should be zero. HYPOTHESIZE why the steady state may not zero.
7.3. **PD Position Control,** $b_{sd} = 0$.

(1) **CALCULATE** the damping $\zeta$ and $\omega_n$ that will satisfy the PO and $T_p$ design specifications. Also **CALCULATE** the $\omega_d$.

(2) Then, **WRITE** $\omega_n$ in terms of $K_p$ and the other known parameters, **SOLVE** for $K_p$ using the results from step (1). **WRITE** $\zeta$ in terms of $K_p$ and $K_d$ and solve for $K_d$.

(3) **PRINT** the plot, label it 7.3.5.SIM and attach it to the end of the report.

(4) From plot 7.3.5.SIM, **FIND** the simulated percent overshoot, $PO_{sim}$ and $T_{p,sim}$. **COMPARE** the simulated results to the theoretical result from step (1).
(5) Make sure the gain is the calculated $K_p$ and RECORD the calculated damping and frequency, $\zeta_{sim}$ and $\omega_{d,sim}$, respectively. COMPARE these values to the theoretical result from step (1) (i.e. calculate the relative error and qualitatively describe whether or not the difference is acceptable.)

(6) PRINT out the screenshot, label it 7.3.8.EXP.

(7) From the plot 7.3.8.EXP, OBTAIN the $PO_{exp}$ and the $T_{p,exp}$ and COMPARE these results with the above simulation and theoretical results.

(8) Manually vary the $K_d$ value. DESCRIBE for an increase/decrease of $K_d$ what happens to the overshoot and the peak time. If you were to design the system to meet the design specs, what would be your ultimate suggestion for the $K_p$ and $K_d$ values?
7.4. Lead Compensator Position Control.

(1) **IDENTIFY** the desired coordinate in the root locus for the design specification. This coordinate can be found in the Prelab.

(2) **SKETCH** the new root locus plot and **DISCUSS** what happens as the gain increases (ie. **SKETCH** several time traces corresponding to different gains that illustrate the effect of increasing the gain.)

(3) **PRINT** both the root locus and the time trace (with a marker at the first peak) labeling them 7.4.5RL and 7.4.5TT and attaching them to the end of the report.

(4) **COMMENT** as to whether the 7.4.5TT response satisfies the PO and $T_p$ and $T_s$ design specifications.
(5) If you were to design this controller, **EXPLAIN** whether you would be limited to only passing through the "desired coordinate" or if you had more than one option for a satisfactory compensator.

(6) **WRITE** down the full compensator as $C(s) = K_c \frac{s + z}{s + p}$ (Note that $K_c = C \times p / z$, where $C$ is the compensator value given in MATLAB and $p$ and $z$ is the pole and zero that you added).

(7) **PLOT** the time trace from the simulation and also obtain a time trace from a LABVIEW experiment (be sure to switch to the Lead-Lag Controller), labeling them 7.4.8.SIM and 7.4.8.EXP. **COMMENT** on their similarities/differences.

(8) What would be your recommendation for implementing a Lead Compensator Controller for meeting the design specifications.