8.8 MATLAB Laboratory Experiment

Part 1. Consider the control system given in Example 8.8, that is

$$G(s) = \frac{K(s+10)}{(s+1)(s+2)(s+12)}$$

with the transient response requirements determined by a desired operating point located at $s_d = -2 + j3$.

(a) Design a PD controller such that the transient response requirements are met.
(b) Design a PID controller such that the steady state error is reduced to zero.
(c) Design a phase-lead controller for the design problem defined in (a).
(d) Add a phase-lag controller in series with the controller obtained in (c) in order to reduce the steady state error by 50%.

Plot the root loci and unit step responses for (b) and (d) of both the original and compensated systems and compare the results obtained with PID and phase-lag-lead controllers.

Part 2. Use MATLAB to design a phase-lag-lead controller for the control system of Example 8.9 such that $t_s < 2\,\mathrm{s}$, $MPOS < 10\%$, and $e_{ssc} < 0.01$.

Use the MATLAB program from Example 8.8 to find the actual response overshoot and settling time. Find the eigenvalues of the compensated system and check whether the system response is dominated by a pair of complex conjugate poles.

Part 3. For the voltage regulator system considered in Section 8.6.2, use the same PD controller as in Section 8.6.2, but take for a PI controller the following forms:

(a) $G_{PI}(s) = (s + 0.01)/s$.

(b) $G_{PI}(s) = (s + 0.001)/s$.

For both cases, find the unit step responses of the PID compensated systems and determine the transient response parameters. Compare the results obtained with the results from Section 8.6.2.