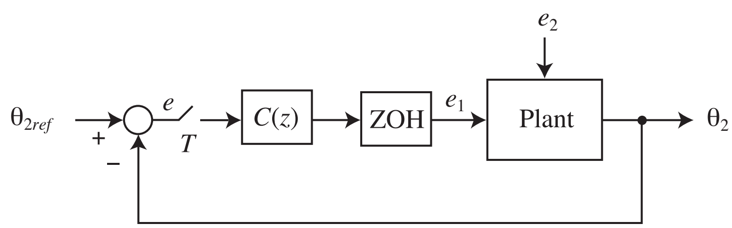
AA/EE/ME 581
Digital Control System Design

Homework #8

Reading: Sections 10.3 & 10.4

Textbook problems: none

Special problem:



1. Consider the closed-loop system shown above, with the Plant block representing the dynamics of the DC motors apparatus defined by the `dcmtrs` file. For its controller

$$C(z) = K\,\frac{(z - z_{z1})}{(z - z_{p1})}\,\frac{(z - z_{z2})}{(z - z_{p2})}$$

use the loopshaping controller/compensator design method to determine values for the controller's parameters $K, z_{z1}, z_{z2},\ z_{p1}$, and z_{p2}. Use $T = 0.02$ sec for the sampling period. The design objectives are:

(a) Bandwidth for θ_2 tracking of θ_{2ref} to be very close to $20\,\pi$ rad/sec.

(b) $\theta_2 = 0$, in the steady state, in response to an e_2 step input, when $\theta_{2ref} = 0$.

(c) Rejection of the effects, on θ_2, of low frequency e_2 disturbances to the extent that the amplitude of the steady-state θ_2 response to $e_2(t) = \sin(\omega t)$ volts is less than 0.1 rad (peak-to-peak amplitude less than 0.2 rad) for all $\omega \le 0.1$ rad/sec.

(d) Phase margin about 60 degrees.

Design your controller to be no more aggressive than is necessary, i.e., so that it meets, but does not significantly exceed, the design objectives.

Include, in your solution:

- The numerical values you determined for $K, z_{z1}, z_{z2},\ z_{p1}$, and z_{p2}.
- A clearly written description of your design procedure.
- Simulation plots that show the extent to which your controller satisfies the design objectives.

Objective (c) involves the continuous-time θ_2 response to a continuous-time e_2 input. You could use Simulink/`sampled_data_system` to test for satisfaction of this objective. Here, however, the designated maximum 0.1 rad/sec frequency for the sinusoidal e_2 input is low enough, compared to the Nyquist frequency, that, for the purpose of testing for satisfaction this objective, you can model the system as if it had a sampler and zero-order hold between its continuous-time e_2 input and the Plant block.