ELEC ENG 4CL4 – Control System Design

Homework Assignment #2

Submission deadline: 12 noon on Friday, February 13, 2004, in the designated drop box in CRL-101B (the CRL photocopying room).

1. A system has the transfer function:

$$H(s) = \frac{s + \frac{1}{2}}{s^2 + 2s + 1}.$$

   a. Will the step response of this system exhibit undershoot or overshoot? Explain your answer in terms of the locations of the poles and zeros of the transfer function.

   b. If the step response does exhibit undershoot or overshoot, find both the *magnitude* and the *time* of maximum undershoot or overshoot. **(25 pts)**

2. A one-d.o.f., unity-feedback control loop has the following controller and plant the transfer functions:

$$C(s) = \frac{2(s+1)}{s} \qquad \text{and} \qquad G_o(s) = \frac{s+3}{(s+2)(s+4)}.$$

   a. Use the Final Value Theorem (given in the table of Laplace transform properties) to calculate the *steady-state* plant output y_∞ in response to a unit step change in the reference, i.e., $r(t) = \mu(t)$.

   b. Find the steady-state plant output $y(t)$ for the output disturbance $d_o(t) = 0.5\sin(2t)$. **(25 pts)**

3. Find the range of values of K for which the controller:

$$C(s) = \frac{K(s+3)}{s+2}$$

   stabilizes the unstable plant model:

$$G_o(s) = \frac{2}{(s+4)(s-1)}$$

   when placed together in a one-d.o.f., unity-feedback control loop. **(25 pts)**

4. Find the additive modeling error (AME) $G_\epsilon(s)$ and the multiplicative modeling error (MME) $G_\Delta(s)$ when the calibration and nominal plant models are given by:

$$G(s) = \frac{-\frac{1}{2}s + 1}{(s+1)^2} \qquad \text{and} \qquad G_o(s) = \frac{1}{(s+1)^2},$$

   respectively

   Is the AME low-pass, band-pass or high-pass? What about the MME? **(25 pts)**