ELEC ENG 4CL4 – Control System Design

Homework Assignment #4

Submission deadline: 12 noon on Friday, March 19, 2004, in the designated drop box in CRL-101B (the CRL photocopying room).

1. The nominal model for a plant is given by:

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

Assume that this plant has to be controlled in a one-d.o.f. feedback loop such that the closed-loop poles are all at $s = -3$. Using the pole placement method, choose an appropriate minimum degree $A_{cl}(s)$ and synthesize a *biproper* controller $C(s)$ that has integration (i.e., one pole at $s = 0$). **(25 pts)**

2. Consider the nominal plant model:

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

Using the pole placement method, design a *strictly proper* controller (i.e., it should have more poles than zeros) that gives the characteristic closed-loop polynomial $A_{cl}(s) = (s^2 + 4s + 9)(s+2)^k$, where you should choose k to be the smallest integer that gives an $A_{cl}(s)$ of the appropriate degree. **(25 pts)**

3. The nominal model for a plant is given by:

$$G_o(s) = \frac{10(s-2)}{(s+2)(s-4)}.$$

   a. List the constraints that the poles and zeros of this plant model place on the appropriate bandwidth of a one-d.o.f., unity-feedback control loop.

   b. Given these constraints, what would you consider an appropriate closed-loop bandwidth? **(25 pts)**

4. Consider a one-d.o.f., unity-feedback loop incorporating a controller *with integration* and the nominal plant model:

$$G_o(s) = \frac{4}{(s+2)^2}.$$

Show that the output of the control loop $y(t)$ must exhibit overshoot in response to the reference signal $r(t) = te^{-t/2}, \quad t \geq 0$. **(25 pts)**