EE 4CL4 – Control System Design

Homework Assignment #6

1. For the system with the open-loop frequency response generating the Nyquist plot shown in Fig. 1, estimate the:
   a. stability gain margin,
   b. stability phase margin, and
   c. sensitivity peak. **(25 pts)**

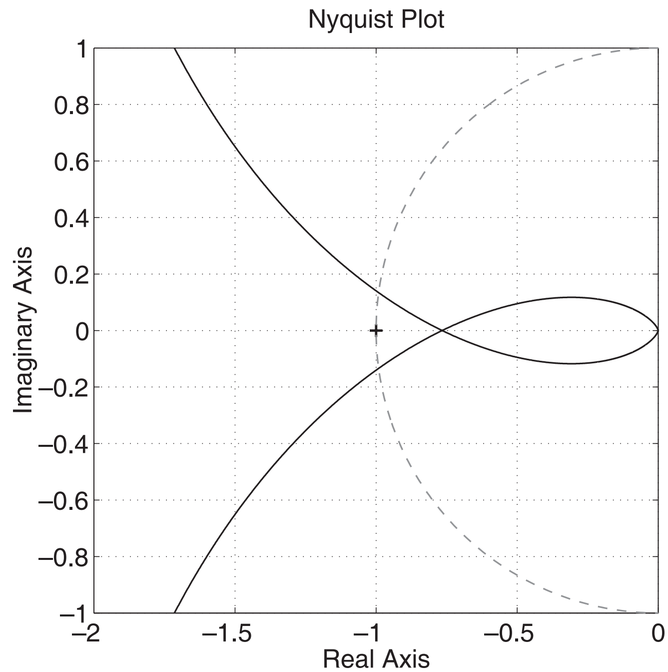

Figure 1

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

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

Assume that this plant has to be controlled in a one-d.o.f. feedback loop such that the closed-loop characteristic polynomial is dominated by the factor $s^2 + 7s + 25$. Using the pole placement method, choose an appropriate minimum degree $A_{cl}(s)$ and synthesize a *biproper* controller $C(s)$ that has forced integration (i.e., one pole at $s = 0$). **(25 pts)**

3. Consider the feedback control of an unstable plant. Prove that the controller output $u(t)$, exhibits undershoot for any step reference and for any step-output disturbance. **(25 pts)**

QUESTION 4 ON BACK OF PAGE!

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

$$G_o(s) = \frac{5(s-1)}{(s+1)(s-5)}.$$

This plant has to be controlled in a one-d.o.f. unity-feedback loop.

a. Determine the time-domain *integral constraints* for the plant input $u(t)$, the plant output y(t), and the controller error $e(t)$ in the loop. Assume exact inversion at $\omega = 0$ (see page 210 of Goodwin et al.) and step-like reference and disturbances (input and output).

b. Discuss why the control of this nominal plant especially difficult. Hint: What constraints should be placed on the closed-loop bandwidth? **(25 pts)**