ECE-521 Linear Control Systems
Laboratory 3

Pre-Lab

1) Print out this lab and **read** it.

2) Show that for a unity negative feedback system with PD controller

$$G_c(s) \;=\; k(s+z)$$

and plant transfer function

$$G_p(s) \;=\; \frac{k_{clg}}{\frac{1}{\omega_n^2}s^2 + 2\frac{\zeta}{\omega_n}s + 1}$$

the position error is given by

$$e_p \;=\; \frac{1}{1 + kk_{clg}z}$$

3) The standard form for a PID controller is

$$G_c(s) \;=\; k_p + k_i\frac{1}{s} + k_d s$$

show that

a) for a PID controller in the form $G_c(s) = k(s+z_1)(s+z_2)/s,\ k_p = k(z_1+z_2),\ k_i = kz_1z_2,\ k_d = k$

b) for a PI controller in the form $G_c(s) = k(s+z)/s,\ k_p = k,\ k_i = kz,\ k_d = 0$

c) for a PD controller in the form $G_c(s) = k(s+z),\ k_p = kz,\ k_i = 0,\ k_d = k$

We generally need to keep the k_p, k_i and k_d less than about 0.1. (Sometimes I have used a k_i of about 9) You need to use the above relationships when choosing where the poles and zeros of your controllers should be.

4) Show that for a unity negative feedback system with P controller

$$G_c(s) \;=\; k_p$$

and plant transfer function

$$G_p(s) \;=\; \frac{k_{clg}}{\frac{1}{\omega_n^2}s^2 + 2\frac{\zeta}{\omega_n}s + 1}$$

show that the steady state output y_{ss} due to a step input of amplitude A is given by

$$y_{ss} \;=\; \frac{Ak_pk_{clg}}{1 + k_pk_{clg}}$$

which can be rewritten as

$$k_{clg} \;=\; \frac{y_{ss}}{k_p}\frac{1}{A - y_{ss}}$$