ELEC 372

Supplementary Problem Set #5

Not to be handed in

These problems form the foundation of Quiz #5

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In problems 1-4, consider the unity feedback control system of Figure 5.1.

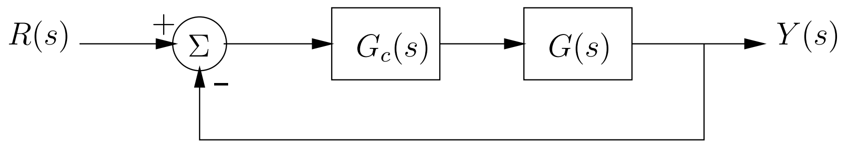

Figure 5.1: Block diagrams of problems 1-4.

Hint for problems 1, 3 and 4: Write the root locus phase and magnitude equations at one of the closed-loop system poles. Solve the two equations to obtain the controller unknown parameters.

1. Let
$$G(s) = \frac{1}{s(s+2)(s+3)}$$
Using the root locus technique, design a lead compensator
$$G_c(s) = K\frac{s+1}{s+p}$$
so that the closed-loop system has a pair of complex conjugate poles at $-1 \pm j2$.

2. Let
$$G(s) = \frac{1}{(s+1)(s+3)}$$
   (a) If $G_c(s) = K$, find the value of K for which the closed-loop system poles are located at $-2 \pm j1$.
   (b) For this part assume you have obtained $K = 3$ in Part (a). Find position error constant K_p.
   Hint: $K_p = \lim_{s\to 0} G_c(s)G(s)$.
   (c) If a position error constant of $K_p = 0.2$ is required, find the value of p in $G_c(s) = 3\frac{s+0.1}{s+p}$.

3. Let

$$G(s) = \frac{1}{(s+1)(s+2)(s+3)}$$

Using the root locus technique, design a PD compensator

$$G_c(s) = K_D s + K_P$$

so that the closed-loop system has a pair of complex conjugate poles at $-2 \pm j1$.

4. Let

$$G(s) = \frac{1}{(s+3)(s+5)}$$

Using the root locus technique, design a PI compensator

$$G_c(s) = K_P + \frac{K_I}{s}$$

so that the closed-loop system has a pair of complex conjugate poles at $-2 \pm j2$.