University of Toronto
Department of Electrical and Computer Engineering
ECE356S System and Signal Analysis II
Spring 1999
Problem Set #4

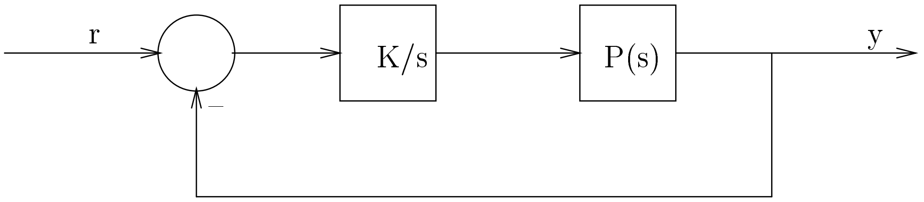
1. Consider the polynomial $p(s) = s^3 + 7s^2 + 17s + 15$.

   (i) Apply the Routh-Hurwitz criterion to check the stability of $p(s)$.

   (ii) If $p(s)$ is stable, we may wish to find out "how stable" it is by checking if all its roots lie to the left of the line $\mathrm{Re}s = -\sigma$, $\sigma > 0$. Modify the Routh-Hurwitz criterion to find if all the roots lie to the left of the line $\mathrm{Re}s = -1$.

   (iii) Repeat (ii) for the line $\mathrm{Re}s = -2$.

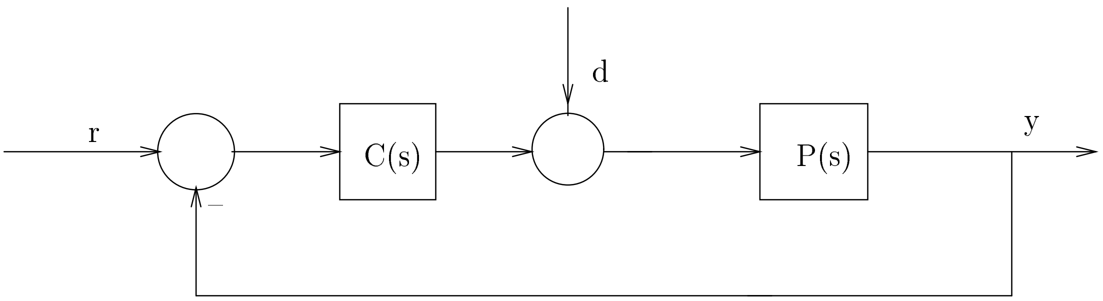
2. (a) Consider the feedback system



If $P(s) = \dfrac{s+1}{(s+2)(s+3)}$, find the range of the value K (using for example the Routh-Hurwitz criterion) such that asymptotic tracking is achieved for a step input.

(b) Repeat the above for $P(s) = \dfrac{s+4}{(s+1)(s+2)}$.

3. Consider the feedback system



Suppose $P(s) = \dfrac{1}{(s+3)(s+4)}$. We would like to design the controller $C(s)$ such that the effects of the sinusoidal disturbance $d(t) = \sin t$ on the output $y(t)$ is removed asymptotically. Design such a controller and verify that the disturbance is indeed rejected asymptotically.

(HINT: Try $C(s) = \dfrac{(s+1)(s+2)}{D_c(s)}$ and determine what $D_c(s)$ should be.)