**ECE-320**: Linear Control Systems
Homework 10

Due: Tuesday November 8 at 2 PM

1) Consider the following characteristic equations

$$\Delta(s) = s^2 + bs + 1$$
$$\Delta(s) = s^3 + bs^2 + cs + 1$$
$$\Delta(s) = s^4 + bs^3 + cs^2 + ds + 1$$

a) Show that for the 2nd order system we need $b > 0$ for no RHP poles

b) Show that for the 3rd order system we need $b > 0$, $c > 0$, and $bc - 1 > 0$ for no RHP poles

c) Show that for the 4th order system we need $b > 0$, $c > 0$, $d > 0$ and $bcd - d^2 - b^2 > 0$ for no RHP poles

2) For $\Delta(s) = s^3 + s^2 + 2s + 2$,

a) determine if there are any poles in the RHP

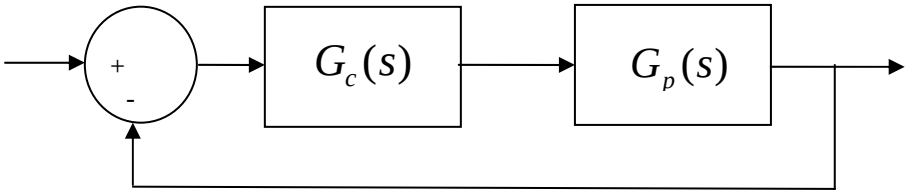
b) if possible factor the characteristic equation and determine all of the poles

3) For $\Delta(s) = s^4 + 2s^3 + 4s^2 + 6s + 3$,

a) determine if there are any poles in the RHP

b) if possible factor the characteristic equation and determine all of the poles

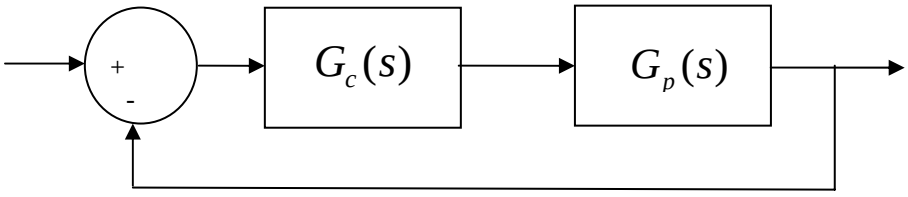
4) Consider the following control system with plant $G_p(s) = \dfrac{1}{s^2 + s + 1}$




a) For the integral controller $G_c(s) = \dfrac{k}{s}$, use the Routh array to show that there are no poles in the RHP for $0 < k < 1$. Verify your results using Matlab (either sisotool or the rlocus command).

b) For the PI controller $G_c(s) = \dfrac{k(s+z)}{s}$, with $z > 0$, show that for no RHP poles we must have $z < 1$ and $k > 0$, or for $z > 1$ we must have $0 < k < \dfrac{1}{z-1}$. Determine the factors of $\Delta(s)$. Verify your results using Matlab (either *sisotool* or the *rlocus* command).

5) Consider the following control system with plant $G_p(s) = \dfrac{1}{s^2 + 2s + 1}$




a) For the integral controller $G_c(s) = \dfrac{k}{s}$, use the Routh array to show that there are no poles in the RHP for $0 < k < 2$. Verify your results using Matlab (either sisotool or the rlocus command).

b) For the PI controller $G_c(s) = \dfrac{k(s+z)}{s}$, with $z > 0$, show that for no RHP poles we must have $0 < z < 2$ and $k > 0$, or for $z > 2$ we must have $0 < k < \dfrac{2}{z-2}$

Determine the factors of $\Delta(s)$. Verify your results using Matlab (either *sisotool* or the *rlocus* command).