16.06 10/13/17
Prof. J. P. How Due: 10/20/17
T.A. P. Singh

16.06 Homework Assignment # 6

Format: Please staple your solutions and submit it at the beginning of the session on Friday.

1. Consider the systems below:

$$G_1(s) = \frac{25}{s^2+3s+25} \quad G_2(s) = \frac{25(s-1)}{s^2+3s+25}$$
$$G_3(s) = \frac{25(s-1)}{(s^2+3s+25)(s-1)} \quad G_4(s) = \frac{25\,(s-1)(s+1)}{(s^2+3s+25)(s-1)}$$

   (a) Plot the unit-step response of each of these systems using MATLAB
   (b) Explain the difference in the behavior of responses as it relates to the pole and zero locations. Compare G_2 to G_1, G_3 to G_2, G_4 to G_3, and G_4 to G_1.

2. For the following systems find all system poles and explain if the system is stable, marginally stable or unstable. Make sure your explanations are in accordance with the BIBO Stability Test Theorem.
   (a) $\mathrm{G(s)} = \frac{10}{s^3-2s}$
   (b) $\mathrm{G(s)} = \frac{5}{s^3+4s^2}$
   (c) $\mathrm{G(s)} = \frac{s+10}{s^3+10s^2+31s+30}$
   (d) $\mathrm{G(s)} = \frac{1}{s^3+5s^2+6s}$

3. Consider a polynomial below (it is a denominator of a transfer function).

$$\mathrm{D(s)} = \mathrm{s}^3 + (6+\mathrm{K})\mathrm{s}^2 + (5+6K)s + 5K + 1$$

   (a) Using the Routh-Hurwitz criterion (for all roots of D(s) = 0 to be in the LHP), find which values K the system is stable.
   (b) Modify the Routh-Hurwitz criterion to find those values of K for which all the poles have a real part less than -1.

4. Use the RH-criterion to find the range of gain K for which the system shown is stable and use the root locus (you can use MATLAB) to confirm your calculation.