ECE327: Laboratory Exercise 1: Transfer Function Models and System Characteristics and Responses

1) Consider the polynomial

$$p(t) = t^2 - 2t + 1.$$

a. Calculate the polynomial roots.
b. Calculate the value of the polynomial for $t = 1$.

2) a. Find the rational functional $X(s)$ that corresponds to the following sum of partial fractions

$$\frac{3}{s-1} + \frac{1.5}{s+4.3} - \frac{1}{s-2} + 2$$

b. A system has zeros at -6, -5, 0, and poles at $-3 \pm j4$, -2, -1, and a gain of 1. Determine the system transfer function.

3) Consider the transfer functions

$$G(s) = \frac{6s^2 + 1}{s^3 + 3s^2 + 3s + 1}$$

and

$$H(s) = \frac{(s+1)(s+2)}{(s+2j)(s-2j)(s+3)}$$

a. Compute the poles of $G(s)$
b. Find the characteristic equation of $H(s)$, and divide $G(s)$ by $H(s)$.
c. Plot the pole-zero map of $G(s)/H(s)$ in the complex plane.

4) (i) Use Matlab and the Symbolic Math toolbox to find the Laplace transform of the following time functions:

a) $f(t) = 8t^2 \cos(3t + 45^o)$
b) $f(t) = 3te^{-2t} \sin(4t + 60^o)$

(ii) Use Matlab and the Symbolic Math toolbox to find the inverse Laplace transform of the following frequency functions:

a) $G(s) = \frac{(s^2+3s+10)(s+5)}{(s+3)(s+4)(s^2+2s+100)}$

b) $G(s) = \frac{s^3+4s^2+2s+6}{(s+8)(s^2+8s+3)(s^2+5s+7)}$

5) Consider a system with transfer function

$$H(s) = -2\frac{s}{(s+2)(s^2+2s+2)}$$

Define the transfer function to Matlab. Then in a tab with two sub-windows design the impulse and step response of the system.

6) Consider a system with the following transfer function

$$H(s) = \frac{s+0.5}{(s+2)(s+5)}$$

What is the step response of the above system and after find the system's features (overshoot, rise time, peak time, settling time) using both methods we have discussed.

7) Consider a system with the following transfer function

$$G(s) = \frac{s^2+2s+1}{s^3+3.8s^2+8.76s+5.96}$$

Find the poles and zeros of the system and then in a tab (with 3 sub-windows) plot:

a. The impulse response of the system.
b. The step response of the system.
c. The response when we have as input the signal $2\cos(1.6t)$, in the interval [0,10].