EECS 361
Homework #13

1. Section 6.6 Participation Activities
   6.6.1: z-transform definition.
   6.6.2: z-transform of a finite duration sequence.
   6.6.4: Visualizing the z-transform.
   6.6.6: z -transform of sinusoids.
   6.6.7: z-transforms of some sinusoids.
   6.6.8: z-transform pairs.

2. (Concept: Finding the z-transform of a discrete time signal)
   Find the z-transforms for the following signals

   a. $\{\underline{1}, 2, 1\}$
   b. $(-0.8)^n\, u[n]$
   c. $\cos(0.8\, n)\, u[n]$
   d. $0.8^n \cos(0.8\, n)\, u[n]$
   e. $0.8^n(1+\cos(0.8n))u[n]$
   f. u[n]-u[n-8]
   g. $\delta[n-1]+2\delta[n-2]+1\delta[n-3]$

3. (Concept: Finding the z-transform of a discrete time signal)
   Given x[n] =$\{\underline{0}, 0, 2, 2, 3, 2, 2, 0, 0\}$ find X(z).

4. (Concept: Finding the z-transform of a discrete time signal and forming the z-transform as a ratio of two polynomials)
   For x[n] =$\{\underline{0}, 4, 6, 8, 6, 4, 0\}$ find X(z) and expressed X(z) the in the form of a ratio of two polynomials.

5. Section 6.7 Participation Activities
   6.7.2: Convolution property of the z-transform
   6.7.3: z-transform properties.
   6.7.4: z-transform properties-part 2

6. Section 6.8 Participation Activities
   6.8.1: Inverse z-transforms.

7. (Concept: Inverse z-transform)
   Exercise 6.8.1 a & b

8. (Concept: Linearity of the z-transform)
   Find x[n] given $X(z) = \frac{z}{z-0.4} - \frac{4z}{z+0.4} + \frac{z}{z-0.6}$ and plot x[n] for n=0...10

9. (Concept: z-transform of $\sin(n\Omega)$)
   Find x[n] given $X(z) = \frac{z\sin(\Omega)}{z^2-2\,z\cos(\Omega)+1}$ for $\Omega = \frac{\pi}{4}$ and plot x[n] for n=0...20.

10. (Concept: Finding the discrete time impulse response given the system transfer function)
    Given a transfer function $H(z)=0.5z^{-1} + 0.75\, z^{-3} + z^{-5}$ find the impulse response and plot h[n].

11. (Concept: Finding the system transfer function given a difference equation)
    Given these difference equations find the corresponding transfer functions H(z) put H(z) in the form with all positive exponents of z, e.g., $z^{+k}$.

    a. $y[n] = \frac{1}{3}x[n]+\frac{1}{3}x[n-1]+\frac{1}{3}x[n-2]$
    b. y[n]=0.8y[n-1]+x[n]+2x[n-1]
    c. y[n]=x[n]+1.66y[n-1]-0.81y[n-2]

12. (Concepts: Finding the frequency response function from a difference equation and proprieties of second order discrete time systems)
    Given a difference equation $y[n]=x[n]+2b\cos(\phi)y[n-1]-b^2y[n-2]$ .
    a. Find transfer function H(z), put H(z) in the form with all positive exponents of z, e.g., $z^{+k}$.
    b. Set b=0.9 and $\phi = \frac{\pi}{8}$ and compare to the result to H(z) found in part c. of problem 11?

c. Use **Design of First and Second Order Digital Filters** tool to plot the pole/zero diagram, surface diagram of H(z) [pick a convenient viewing angle], and the magnitude $M(e^{\Omega})$, phase of H(z). Provide a screen shot in your solutions.

d. Repeat part c. with b=0.975 and $\phi = \frac{\pi}{8}$. Where to the poles move?

e. Discuss the difference between the frequency responses.

**13.** (Concepts: Linear phase transfer function H(z))
Given h[n] = {1, 2, 1}

a. Find H(z).

b. In H(z) set $z = e^{j\Omega}$ and find $|H(e^{j\Omega})|$ as a function of Ω.

c. In H(z) set $z = e^{j\Omega}$ and find the phase of $H(e^{j\Omega})$ as a function of Ω.

d. Let $h_c[n]$ = h[n-1] ={1, 2, 1} find $|H_c(e^{j\Omega})|$ as a function of Ω. Compare to part b.

e. Let $h_c[n]$ = h[n-1] ={1, 2, 1} find the phase of $H_c(e^{j\Omega})$ as a function of Ω. Is the phase a linear function of the frequency Ω?

**14.** (Concepts: Given a design specification, design a discrete time filter and using a MatLab tool to confirm design)
Design of a discrete-time lowpass filter.

a. Obtain the transfer function of a BIBO stable, discrete-time lowpass filter with a single pole and a single zero, given that the zero is on the unit circle, and the pole is at a location within 0.1 from the unit circle. Set the DC gain =1, i.e., $H(e^{j0})=1$.

b. Given a. find the associate difference equation.

c. Use **MatLab Filter Design Tool** to plot magnitude $M(e^{\Omega})$ of this filter, verify your design by providing a screen shot.

d. Given the design found in part a. move the location of the pole to within 0.2 from the unit circle then use **MatLab Filter Design Tool** to plot magnitude $M(e^{\Omega})$ of this filter, provide a screen shot. Explain the difference between the frequency response found above.