EECS 361
Homework #14

1. Section 6.10 Participation Activities
   6.10.1: Transfer function and pole location vs. impulse response
   6.10.2: Stability and transfer function poles.
   6.10.3: Transfer function, poles, and stability.

2. Section 6.10 Challenge Activity
   6.10.1: BIBO stability of H(z)

3. The step response of an LTI system is given as $4u[n]-(0.25)^n u[n]$.
   a. Find the Transfer Function
   b. Determine the number of poles and zeros and their location in the z-plane .
   c. Find the system impulse response, plot h[n] for n=-1...5.
   d. Find the corresponding difference equation.
   e. Is this system BIBO stable

4. Given a difference equation $y[n]=x[n]+2b\cos(\phi)y[n-1]-b^2y[n-2]$
   a. Find the transfer function H(z).
   b. Find the poles and zeros.
   c. Specify the conditions on the parameter b such that the system is BIBO stable

5. Section 6.11 Participation Activities
   6.11.1: Frequency response of a lowpass filter.
   6.11.2: Discrete-time system frequency response.
   6.11.3: Example: Input-Output Pair to Other Descriptions.

6. Section 6.11 Challenge Activity
   6.11.1: System frequency response.

7. For a system defined as $y[n]=x[n]-x[n-1]-y[n-2]$ find $H(e^{j\Omega})$, simplify your answer.

8. For a system defined as $y[n]=x[n]+0.5x[n-1]+x[n-2]$ find $H(e^{j\Omega})$,
   a. Find $H(e^{j\Omega})$
   b. Plot $|H(e^{j\Omega})|$ and $\angle H(e^{j\Omega})$
   c. An analog signal $2\cos(2\pi 1000t)$ is sampled at a rate of 4000 samples/sec to form x[n], x[n] is the input to this system, find y[n].

9. Show $X(z) = 1 + 2z^{-1} + 3z^{-2} + 2z^{-3} + 1z^{-4} = \frac{1z^4+2z^3+3z^2+2z+1}{z^4}$

10. Section 6.12 Participation Activities
    6.12.1: Moving a zero along the unit circle.
    6.12.2: Effect of moving a zero toward the center of the unit circle.
    6.12.3: Moving conjugate poles towards the center of the unit circle.
    6.12.4: Conjugate pole angles vs. frequency response.
    6.12.5: Pole zero placement vs. frequency response.
    6.12.6: Lowpass filter poles, zeroes, transfer function.
    6.12.7: Highpass filter.
    6.12.8: Bandpass filters.
    6.12.9: Bandreject filters.

11. Design a BIBO stable digital lowpass filter, that is find the transfer function and corresponding difference equation. This filter has one zero on the unit circle and one pole 0.01 from the unit circle and a dc gain = 1. Plot the magnitude of the frequency response. What is the impact of changing the pole location to 0.1 from the unit circle. (You can use any plotting tool including Transfer Function Analysis by Manipulation of Poles and Zeros)

12. Section 6.13 Participation Activities
    6.13.1: 250Hz notch filter design.
    6.13.2: Discrete-time notch filters.

13. Given a system transfer function

$$H(z) = \frac{z^2}{(z - (0.78 + j0.45))\,(z - (0.78 - j0.45))}$$

a. Draw the pole-zero diagram.
b. Is this a stable system?
c. An analog signal x(t)=cos(2π1000t) is sampled at 12,000 samples/sec to form x[n].
Find the output y[n] with x[n] input to this filter.
d. This a BPF, what is its center frequency.
e. What is the discrete time implementation of this system?
f. Check your answers above using: Complex z-Plane Plot and Frequency Response for System with 2 Poles
Transfer Function Analysis by Manipulation of Poles and Zeros

14. An analog signal is y(t) = x(t) + cos(2π1000t), where the 1 kHz tone is an interference signal. The signal y(t) is sampled at 12000 samples/sec to generate y[n]. Design a discrete time system to filter out (reject) the 1 kHz interference signal in the sampled signal. Validate your design.