EECS 361
Homework #14

1. Section 6.10 Participation Activities
- 6.10.1: Transfer function and pole location vs. impulse response
- 6.10.2: Discrete LTI system transfer function, impulse response, and difference equation.
- 6.10.3: Deriving the transfer function from a difference equation.
- 6.10.4: Deriving the system difference equation from the transfer function.

2. Section 6.11 Participation Activities
- 6.11.1: Transfer function and pole location vs. impulse response h[n].
- 6.11.2: Stability and transfer function poles.
- 6.11.3: Transfer function, poles, and stability.

3. (Concepts: Given input and output signals finding the transfer function, impulse response and difference equation)
The step response of an LTI system is given as $3u[n]-(0.3)^n u[n]$.
- a. Find the Transfer Function, H(z).
- 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. (Concept: Poles and zeros for a second order AR system)
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 in polar form as a function of b and ϕ.
- c. Specify the conditions on the parameter b such that the system is BIBO stable

5. (Concepts: Finding the frequency response from a difference equation and scaling the difference equation to achieve unity DC gain)
For a system defined as y[n]=x[n] - 0.25x[n-2] - 0.75y[n-2]
- a. Find $H(e^{j\Omega})$,
- b. Plot $|H(e^{j\Omega})|$.
- c. What is the center frequency of this is a BPF? If the sample spacing is 1 ms, i.e., a sample rate of 1000 samples/sec what is the center frequency in Hz.
- d. Change the difference equation such that $\left|H\left(e^{j\Omega}\right)\right|_{\text{Peak}} =1$.
  Confirm your result by plotting the corresponding magnitude of the discrete-time system frequency response

6. (Concepts: Sinusoidal response of a discrete time system, $A\cos(n\Omega_1)\longrightarrow H\longrightarrow A\left|H\left(e^{j\Omega_1}\right)\right|\cos\left(n\Omega_1+\angle H\left(e^{j\Omega_1}\right)\right)$ and linear phase filtering)
For a system defined as y[n]=x[n]+2x[n-1]+x[n-2],
- a. Find $H(e^{j\Omega})$.
- b. Plot $|H(e^{j\Omega})|$ and $\angle H(e^{j\Omega})$ for $0<\Omega<\pi$. [Hint see Homework 13 Problem 13]

The signal x(t) is sampled at a rate of 4000 samples/sec to form x[n] is the input to this system, find y[n] for:
- c. $x(t)=2\cos(2\pi 750t)$
- d. $x(t)=2\cos(2\pi 500t)$
- e. $x(t)=2\cos(2\pi 10t)$
- f. Is the phase linear with frequency, i.e., is $\angle H(e^{j\Omega})$ a straight line

7. Section 6.12 Participation Activities
6.12.1: Frequency response of a discrete-time lowpass filter.
6.12.2: Discrete-time system frequency response.
6.12.3: Input-Output Pair to Other Descriptions.
6.12.5: Deriving transfer function and difference equation from frequency response.

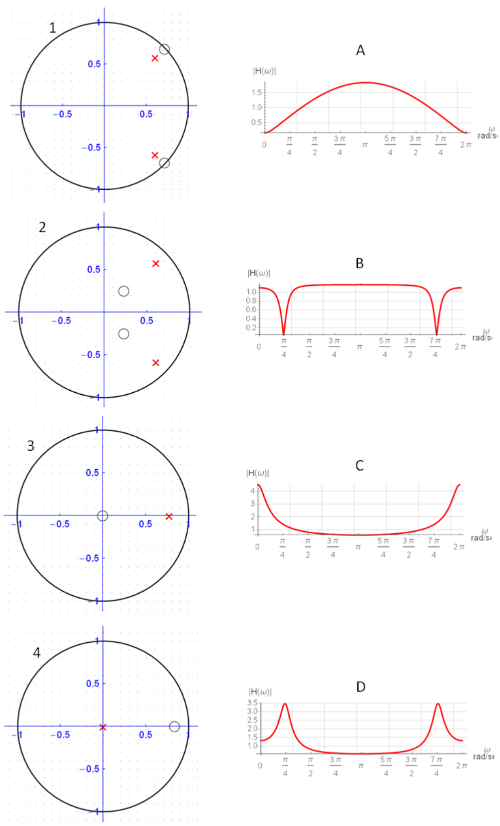
8. Section 6.13 Participation Activities
6.13.1: Moving a zero along the unit circle.
6.13.2: Effect of moving a zero toward the center of the unit circle.
6.13.3: Moving conjugate poles towards the center of the unit circle.
6.13.4: Conjugate pole angles vs. frequency response.
6.13.5: Pole zero placement vs. frequency response.

9. Section 6.14 Participation Activities
6.14.1: Lowpass filter poles, zeroes, transfer function.
6.14.2: Highpass filter.
6.14.3: Bandpass filters.
6.14.4: Bandreject filters.

10. Section 6.15 Participation Activities
6.15.1: 250Hz notch filter design.
6.15.2: Discrete-time notch filters.

11. (Concept: Matching properties of pole-zero diagrams to corresponding frequency responses)
Fill in the table below, that is, match the pole-zero diagram (1, 2, 3, 4)) to a its corresponding frequency response (A, B, C, D)

pole – zero diagram	frequency response
1 :	□
2 :	□
3 :	□
4 :	□



12. (Concept: Finding the output signal for a second order discrete time systems))
Given a system transfer function

$$H(z) = \frac{z^2}{(z-(0.831+j0.344))\,(z-(0.831-j0.344))}$$

a. 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], magnitude $M(e^{\Omega})$, phase of H(z). Provide a screen shot in your solutions.
[Hint: See Homework 13, Problem 12.]

b. Is this a stable system?
c. An analog signal x(t)=cos(2π2000t) is sampled at 32,000 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 in rad/sample and Hz (with f_s=32,000 samples/sec)?
e. What is the discrete time implementation of this system?

13. (Concept: Design of a notch filter)
An analog signal is y(t) = x(t) + cos(2π2000t), where the 1 kHz tone is an interference signal. The signal y(t) is sampled at 32,000 samples/sec to generate y[n]. Design a discrete time system to filter out (reject) the 1.0 kHz interference signal in the sampled signal. Validate your design by plotting the magnitude of the frequency response.