**Note: For this assignment, your Handwritten, hard-copy solution is**

**due on or before December 22nd, 2012.**

**Question No. 1**

Given the following difference equation,

$$y\left(n\right)=0.5 x\left(n\right)+0.5 x(n-1)$$

1. Find the transfer function$ H\left(z\right)$;
2. Determine the impulse response$ y\left(n\right)$ if the input is$ x\left(n\right)=4 δ\left(n\right)$;
3. Determine the step response$ y\left(n\right)$ if the input is$ x\left(n\right)=10 u\left(n\right)$.

**Question No. 2**

Given the following difference equation,

$$y\left(n\right)=x\left(n\right)-0.5 y(n-1)$$

1. Find the transfer function$ H\left(z\right)$;
2. Determine the impulse response$ y\left(n\right)$ if the input is$ x\left(n\right)=δ\left(n\right)$;
3. Determine the step response$ y\left(n\right)$ if the input is$ x\left(n\right)=u\left(n\right)$.

**Question No. 3**

Convert each of the following transfer functions into its difference equation

1. $H\left(z\right)=\frac{z^{2} – 0.25}{z^{2} + 1.1 z + 0.18}$
2. $H\left(z\right)=\frac{z^{2}- 0.1 z + 0.3}{z^{3}}$

**Question No. 4**

Convert each of the following transfer functions into its pole-zero form

$$H\left(z\right)=\frac{1 – 0.16 z^{-2}}{1 + 0.7 z^{-1} + 0.1 z^{-2}}$$

**Question No. 5**

Given each of the following transfer functions describe digital systems, sketch the z-plane pole-zero plot and determine the stability status for the digital system.

1. $H\left(z\right)=\frac{\left(z- 0.5\right)}{\left(z+0.25\right)\left(z^{2} + z + 0.8\right)}$
2. $H\left(z\right)=\frac{\left(z^{2} + 0.25\right)}{\left(z-0.5\right)\left(z^{2} + 4 z + 7\right)}$
3. $H\left(z\right)=\frac{\left(z + 0.5\right)}{\left(z+0.2\right)\left(z^{2} + 1.4141 z + 1\right)}$
4. $H\left(z\right)=\frac{\left(z^{2} + z + 0.25\right)}{\left( z-1\right)\left(z+1\right)^{2}\left( z-0.36\right)}$

**Question No. 6**

Given the following digital system with a sampling rate of 8000 Hz,

$$y\left(n\right)=0.5 x\left(n\right)+0.5x\left(n-2\right)$$

1. Determine the frequency response of the system;
2. Calculate and plot the magnitude and phase frequency responses;
3. Determine the filter type, based on the magnitude frequency response.

**Question No. 7**

Given the following digital system with a sampling rate of 8000 Hz,

$$y\left(n\right)=x\left(n\right)-0.5y\left(n-2\right)$$

1. Determine the frequency response of the system;
2. Calculate and plot the magnitude and phase frequency responses;
3. Determine the filter type, based on the magnitude frequency response.

**Question No. 8**

Given the following difference equation for a digital system,

$$y\left(n\right)=x\left(n\right)-2\cos(\left(α\right))x\left(n-1\right)+x\left(n-2\right)+2 γ\cos(\left(α\right))-γ^{2}$$

where$ γ=0.8$ and$ α=60°$,

1. Find the transfer function$ H\left(z\right)$;
2. Plot the poles and zeros on the z-plane with the unit circle;
3. Determine the stability of the system from the pole-zero plot;
4. Calculate the amplitude (magnitude) frequency response of$ H\left(z\right)$;
5. Calculate the phase frequency response of$ H\left(z\right)$;

**Question No. 9**

Given the first-order IIR system

$$H\left(z\right)=\frac{1 – 2 z^{-1}}{1- 0.5 z^{-1} }$$

Realize$ H\left(z\right)$ and develop the difference equations using the following forms:

1. Direct-form I
2. Direct-form II

**Question No. 10**

Given the filter

$$H\left(z\right)=\frac{1- 0.9 z^{-1}- 0.1 z^{-2}}{1- 0.3 z^{-1}- 0.04 z^{-2} }$$

Realize$ H\left(z\right)$ and develop the difference equations using the following forms:

1. Direct-form I
2. Direct-form II
3. Cascade (series) form via the first-order sections
4. Parallel form via the first-order sections

**MATLAB Problems**

**Question No. 11**

Given the filter

$$H\left(z\right)=\frac{1+2 z^{-1}+ z^{-2}}{1- 0.5 z^{-1}+ 0.25 z^{-2} }$$

Use MATLAB to plot:

1. Its magnitude frequency response;
2. Its phase frequency response.

**Question No. 12**

Given the difference equation

$$y\left(n\right)=x\left(n-1\right)-0.75 y\left(n-1\right)+0.125 y\left(n-2\right)$$

1. Use the MATLAB functions **filter()** and **filtic()** to calculate the system response $y\left(n\right)$ for$ n=0,1,2,3,4$ with the input of $x\left(n\right)=\left(0.5\right)^{n} u\left(n\right)$ and initial conditions:$ x\left(-1\right)=-1, y\left(-2\right)=2$ and$ y\left(-1\right)=1$;
2. Use the MATLAB functions **filter()** and **filtic()** to calculate the system response $y\left(n\right)$ for$ n=0,1,2,3,4$ with the input of $x\left(n\right)=\left(0.5\right)^{n} u\left(n\right)$ and zero initial conditions:$ x\left(-1\right)=0, y\left(-2\right)=0$ and$ y\left(-1\right)=0$.

**Question No. 13**

Given the filter

$$H\left(z\right)=\frac{1- z^{-1}+ z^{-2}}{1- 0.9 z^{-1}+ 0.81 z^{-2} }$$

1. Plot the magnitude frequency response and phase response using MATLAB;
2. Specify the type of filtering;
3. Find the difference equation;
4. Perform filtering, that is, calculate$ y\left(n\right)$ for the first 1000 samples for each of following inputs using MATLAB, assuming that all initial conditions are zeros and the sampling rate is 8000Hz:
5. $x\left(n\right)=\cos(\left(π∙10^{3}∙n/8000\right))$ (3) $ x\left(n\right)=\cos(\left(\frac{8}{3}π∙10^{3}∙n/8000\right))$
6. $x\left(n\right)=\cos(\left(6π∙10^{3}∙n/8000\right))$
7. Repeat part (d) using MATLAB function **filter()**.