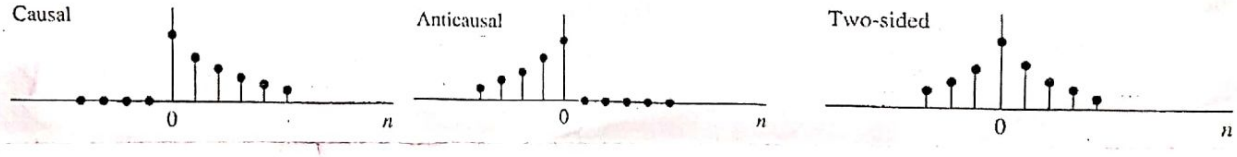
CSE 431, TT#1, Time: 20 min, Marks: 10x1 = 10.

1. Write two of the main advantages of using DSP.
2. Give examples of a one- and two-dimensional natural signals.
3. Give example of a multi-channel natural signal.
4. Draw an analog signal of frequency F = 2 Hz.
5. What can be the highest frequency of a continuous-time sinusoid?
6. What is the highest frequency that can be attained for a discrete-time sinusoid?
7. For a fixed value of a frequency F in an analog signal $x_a(t)$, $x_a(t+T_p) = ?$, where $T_p = 1/F$ is the fundamental time period.
8. What is the Nyquist rate of the analog signal $x_a(t) = \sin(480\pi t) + 3\sin(720\pi t)$?
9. Determine the discrete signals obtained from the analog signals $x_1(t) = \cos 2\pi (10)t$ and $x_2(t) = \cos 2\pi (50)t$ at a sampling rate Fs = 40 Hz?
10. A DT signal $x(n) = 6.35 \cos(\pi/10)n$ is quantized with a resolution $\Delta = 0.1$. How many bits are required in coding the signal?
11. Name the main steps for converting an analog signal to digital signal.
12. Name one method for converting a digital signal to its analog equivalent.

CSE 431, T#2, Marks: 20, Time: 40 min [Answer any five.]

1. Write down the z-transforms of $\delta(n)$, $\delta(n-k)$, and $\delta(n+k)$.
2. Determine the z-transforms of $x(n) = [u(n) - u(n-10)]$.
3. Determine the convolution of the following pairs of signals by means of the z-transform. $x(n) = \{1, -2, 1\}$ and $h(n) = \{1, 1, 1, 1, 1, 1\}$.
4. An LTI system is characterized by the system function $H(z) = \dfrac{3 - 4z^{-1}}{1 - 3.5z^{-1} + 1.5z^{-2}}$. Determine the ROC and $h(n)$ if the system is causal and if the system is anticausal.
5. Determine the system function $H(z)$ and unit impulse response of the system described by $y(n) = 0.5y(n-1) - 2x(n)$.
6. Plot the ROC of the following infinite-duration signals.



CSE 431 (DSP), TT # 4, Time: 30 min, Marks: 20

1. If x(n) and X(k) are N-point DFT pair, then X(k+N) = ?
2. If $X_1(k)$ and $X_2(k)$ are the N-point DFTs of $x_1(n)$ and $x_2(n)$, respectively, then what is the N-point DFT of $x(n) = ax_1(n) + bx_2(n)$?
3. How do you compute the response of the FIR filter with impulse response h(n) to the input sequence x(n)?
4. A finite-duration signal of length L is given as $x(n) = \{1, 1, 1, 1, 1, 1, 1, 1, 1, 1, \ldots\}$. Determine the N-point DFT of this sequence.
5. Explain how the choice of window affects the spectrum estimation.
6. Describe the overlap-add method of linear filtering of long data sequence.

North East University Bangladesh

Department of Computer Science & Engineering

Mid Semester Examination, Summer 2022

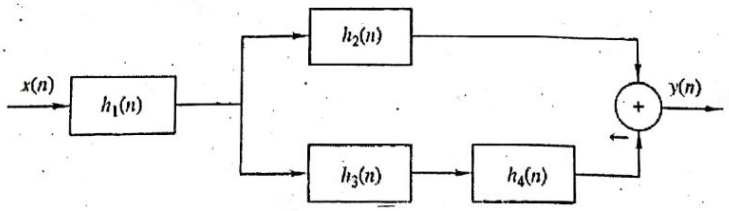
CSE 431 (Digital Signal Processing)

Marks: 30 **Time: 1.5 hour**

1. **Answer any SIX (6 x 1 = 6).**
   a. Give example of a multi-channel and a multi-dimensional natural signal.
   b. Draw an analog signal of frequency F = 2 Hz.
   c. For a fixed value of a frequency F in an analog signal $x_a(t)$, $x_a(t+T_p)$ = ?, where $T_p = 1/F$ is the fundamental time period.
   d. If x(n) is a discrete-time signal, then the value of x(n) at non integer value of 'n' is?
   e. Periodic signals are the power signals. True or false?
   f. How do you relate a discrete-time signal x(n) with x(2n)?
   g. $x(n) * \delta(n-k)$ = ? [Here, the operator * stands for convolution.]
   h. $u(n) - u(n-1)$ = ? [Here, u(n) is the unit step sequence.]

Answer any EIGHT (8 x 3 = 24).

2. Draw the basic block diagram of analog to digital converter. Define the functionality of every stage.
3. Show that the highest rate of oscillation in a discrete-time sinusoid is attained when $\omega = \pi$.
4. An analog signal $x_a(t) = \sin(480\pi t) + 3\sin(720\pi t)$ is sampled 600 times per second. Determine the Nyquist sampling rate for $x_a(t)$. Determine x(n).
5. A DT signal $x(n) = 6.35\cos(\pi/10)n$ is quantized with a resolution $\Delta = 0.1$. How many bits are required in coding the signal?
6. A DT signal x(n) = {1, 3, 0, 2, 3, 4, 4} is given. Sketch x(n-2), x(-n), and x(2n).
7. Determine the energy and power of the unit step sequence.
8. Determine if the system y(n) = x(-n) are linear, stable, and causal.
9. Sketch the block-diagram representation of the discrete-time system described by the input-output relation y(n) = 0.25y(n-1) + 0.5x(n)+0.5x(n-1), where x(n) is the input and y(n) is the output.
10. What is the overall impulse-response of the following interconnected LTI system?



11. Determine the convolution y(n) = x(n) * h(n) of the causal signals x(n) = {2, 1, -3} and h(n) = {1, 0, -1}.

North East University Bangladesh

Department of Computer Science & Engineering

Semester Final Examination, Summer 2022

CSE 431 (Digital Signal Processing)

Marks: 40 **Time: 2 hours**

1. Answer any FOUR (4 x 2 = 8).

i. Write down the z-transforms of δ(n), δ(n-k), and δ(n+k).

ii. In which condition linear convolution is equivalent to circular convolution?

iii. Define power density spectrum of a DT signal.

iv. What is the relation of Fourier Transform with the z-transform?

v. If $W_4^{100}=W_x^{200}$, where $W_N = e^{-j2\pi/N}$, then what is the value of x?

vi. How do you obtain the convolution of two DT signals by means of z-Transform?

Answer any EIGHT (8 x 4 = 32).

2. Determine the z-transform of the signal $x(n) = 2^n u(n) + 3^n u(-n-1)$. Specify the ROC of $X(z)$.

3. An LTI system is characterized by the system function $H(z)=\dfrac{3-4z^{-1}}{1-3.5z^{-1}+1.5z^{-2}}$.

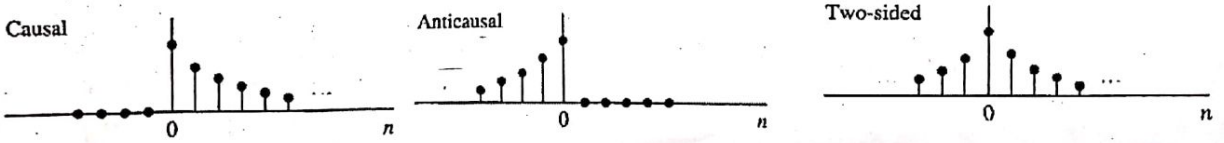
Determine the inverse z-transform $h(n)$ for the conditions: i) if the system is causal and ii) if the system is anticausal.

4. Determine the convolution of $x(n) = \{1, -2, 1\}$ and $h(n) = \{1, 1, 1, 1, 1, 1\}$ by means of the z-transform.

5. Determine the system function $H(z)$ and impulse response $h(n)$ of the system described by $y(n) = 0.5y(n-1) - 2x(n)$.

6. Illustrate with figures the overlap-add method of linear filtering for processing long data sequence.

7. Plot the ROC of the following infinite-duration signals.



8. How many complex multiplications and additions are required to compute an N-point DFT? What properties are used in reducing the computational complexity of FFT?

9. Draw the butterfly diagram for 8-point decimation in time FFT.

10. Sketch the frequency characteristics of ideal low-pass, high-pass, band-pass, and band-stop filters. Why is an ideal filter not achievable?

11. Explain the spectral inversion method for converting a low-pass filter to a high-pass filter.

12. Write down the equation for an M-order moving average filter. Show with example how random noise is reduced using a moving average filter.