

Noakhali Science and Technology University
Department of Computer Science and Telecommunication Engineering
3rd Year 1st Term B.Sc. (Engg.) Final Examination-2024

Course Code: CSTE 3103 Course Title: Digital Signal Processing

Time: 4 hours.

Total Marks: 70

[Answer any seven of the following questions. Figures in the right-hand margin indicate full marks]

1. a) Write down the steps for analog to digital conversion and explain briefly. 5
 b) Consider the analog signal $x_a(t) = 6 \cos 50\pi t$ 3

- i. Determine the minimum sampling rate required to avoid aliasing.
 ii. Suppose that the signal is sampled at the rate $F_s = 100 \text{ Hz}$. What is the discrete-time signal obtained after sampling?

- c) Evaluate the convolution of following two signals: - 2

$$x_1(n) = \{-2, 2, -2, 3\}$$

$$x_2(n) = \begin{cases} 2, & 0 \leq n \leq 4 \\ 0, & \text{elsewhere} \end{cases}$$

2. a) Define unit sample signal, unit step signal, unit ramp signal, and exponential signal. 4
 b) Compute the convolution $y(n)$ of the signals 6

$$x(n) = \begin{cases} \frac{n}{3}, & 0 \leq n \leq 6 \\ 0, & \text{elsewhere} \end{cases} \quad h(n) = \begin{cases} 1, & -2 \leq n \leq 2 \\ 0, & \text{elsewhere} \end{cases}$$

- i. Graphically
 ii. Analytically

3. a) Find the inverse transform of $X(z)$ using partial fraction method $X(Z) = \frac{1}{3z^2 - 4z + 1}$ 5
 b) Determine the z-transform and the ROC of the signal $x(n) = [3(2^n) - 4(3^n)]u(n)$ 5

4. a) Determine the autocorrelation sequences of the following signals 5

(i) $x(n) = \{1, 2, 1, 1\}$

(ii) $y(n) = \{1, 1, 2, 1\}$

- b) What do you mean by Recursive and Nonrecursive discrete time systems? Explain briefly. 5

5. a) Determine the zero-input response of the system described by the homogeneous second-order difference equation $y(n) - 3y(n-1) - 4y(n-2) = 0$ 5
 b) Determine the total solution $y(n), n \geq 0$, to the difference equation $y(n) + a_1 y(n-1) = x(n)$ 5

Where $x(n)$ is a unit step sequence and $y(-1)$ is the initial condition.

6. a) State Nyquist sampling theorem. Find the Nyquist rate for the following signal $X_a(t) = 5 \cos 100\pi t + 10 \sin 300\pi t + \sin 150\pi t$. 3

- b) Derive the relationship between Analog frequency and digital frequency with sampling frequency for the sampling of Analog periodic signal. 4

- c) Describe Sample and Hold method in D/A conversion of signal with proper figure. 3

7. a) Distinguish between Fourier series and Fourier transform. 2

- b) Define DTFT and IDTFT with equations. Determine the frequency response $H(e^{j\omega})$ of a system characterized by $h(n)=(0.6)^n\mu(n)$. 5
- c) Write half period, one period, and two period conditions to determine the output response of DTFT system model. 3
8. a) Write the advantages of Z-transform system over DTFT system. Explain the ROC of Z-transform system. Compare between poles and zeros in Z-transform. 6
- b) If $H(Z)=\frac{Z+1}{Z^2-0.9Z+0.81}$, Find: a) its transfer function representation, b) its difference equation representation. 4
9. a) Draw the figures of symmetric and anti-symmetric impulse response $h(n)$ of length M , where M is 11. 2
- b) Write the frequency response and difference equation of a FIR filter. Implement the structure of Cascade form FIR filter model, where length of filter is 9. 4
- c) Design a Direct form FIR filter model using appropriate difference equation of length 7 and describe briefly. 4