Question Paper

Exam Date & Time: 12-Jan-2024 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

THIRD SEMESTER B.TECH END SEMESTER MAKEUP EXAMINATIONS, JAN 2024

SIGNALS and SYSTEMS [BME 2125]

Marks: 50 **Duration: 180 mins.**

Answer all the questions.

Instructions to Candidates: Answer ALL questions. Missing data may be suitably assumed.

1)

A) If $h_{lpf}(n)$ is the impulse response of a discrete-time low pass filter with cutoff frequency π/4 radians per sec and, frequency response $H_{lpf}(w)$ as shown in Figure 1, (3)

Interpret the statement - "The discrete-time filter with impulse response, $h(n) = e^{jn\pi} h_{lpf}(n)$ is a high-pass filter with cutoff frequency 3π/4 radians per sec."

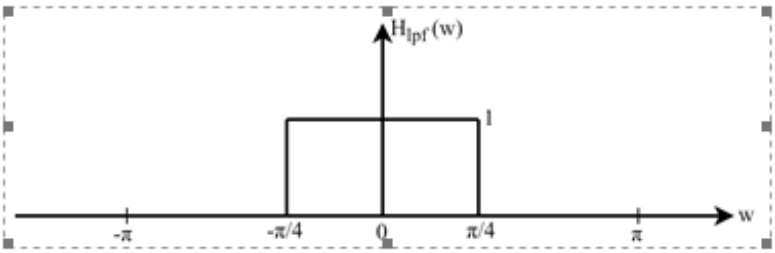

Figure 1

B) Determine the Z-transform of the discrete-time sequence (2)

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

Further, using the Z-transform, determine the discrete-time Fourier transform of $x(n)$.

C) Without explicitly solving for the Z-transform of $x(n)$, determine the region of convergence of the following sequences: (5)

(i) $x(n) = \left(\frac{1}{3}\right)^n u(n)$

(ii)

$$x(n) = \{3, 2, 1, 2, 3\}$$
$$\uparrow$$

(iii) $x(n) = 2^n\, u(-n-1)$

2) Illustrate the "time-reversal" property of Z-transform with suitable examples. (3)

A)

B) Consider an LSI system described by the constant coefficient difference equation, (3)

$y(n) - 0.5\, y(n-1) = x(n) + 0.5\, x(n-1)$. Determine the output $y(n)$ of the system, when the input $x(n) = \delta(n)$.

C) Analyze the following linear systems and identify which of these are LSI systems: (4)

(i) $y(n) = -2\, x(-n-5)$

(ii) $y(n) = 5\, x\left(\frac{n}{2}\right)$

(iii) $y(n) = 2\, x(n-3)$

Justify your answer.

3) The frequency response of the discrete-time high pass filter is given by, $H(w) = 1 - e^{-jw}$. (3)

A) (i) Determine the impulse response $h(n)$ of the system.

(ii) Determine and sketch the magnitude response $|H(w)|$ over $-\pi \leq w \leq +\pi$.

B) "The region of convergence of a left-sided sequence is the interior of a circle with radius R_{x_+} i.e. (3)

$|Z| < R_{x_+}$." Illustrate this with an example.

C) Distinguish graphically the following two relations: (4)

$x(n)\delta(n) = x(0)\delta(n)$

$x(n) * \delta(n) = x(n)$

4) Determine the convolution of two sequences given below: (4)

A) $h(n) = u(n)$ & $x(n) = 0.5^n\, u(n)$

using the Z-transform.

B) Two LSI systems with impulse responses as, (4)

$h_1(n) = u(n) - u(n-1)$ & $h_2(n) = u(n-1) + \delta(n)$ are connected in series. Determine the overall impulse response of the system.

C) A discrete-time signal is given by (2)

$$x(n) = \begin{cases} 1; & -2 \leq n \leq 2 \\ 0; & |n| > 2 \end{cases}$$

Determine graphically the following version of the sequence using the precedence rule:
$y(n) = x(2n+3)$

5) Interpret the statement - "The Z-transform is a more general version of DTFT." (3)

A)

B) The impulse response of a discrete-time low-pass filter is given as: (4)

$h(n) = \delta(n) + \delta(n-1)$.

Determine the frequency response $H(w)$ of the system and sketch the magnitude response $|H(w)|$ over $-\pi \leq w \leq +\pi$.

C) Analyze the following discrete-time Linear-Shift Invariant system, (3)

$$h(n) = a^n\, u(n-2)$$

and identify if the system is Memoryless? Causal? Stable? Justify your answer.

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