Question Paper

Exam Date & Time: 07-Dec-2023 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

III SEMESTER B.TECH END SEMESTER EXAMINATIONS, NOV/DEC 2023

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 frequency response $H_{lpf}(w)$ as shown in Figure 1, (3)

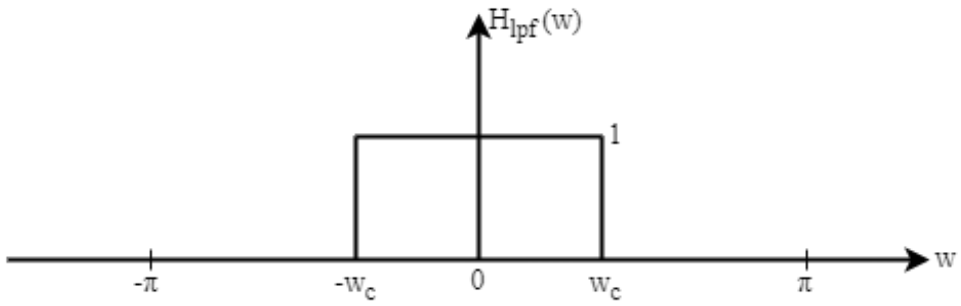

Figure 1

Interpret the statement - "The discrete-time filter with impulse response, $h(n) = (-1)^n h_{lpf}(n)$ is a high-pass filter."

B) Determine the series and the Z-transform of the series that has the Fourier transform, $X(w) = 1 + \cos(w)$. (2)

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

(i) $x(n) = \left[\left(\frac{1}{2}\right)^n + \left(\frac{3}{4}\right)^n\right] u(n)$

(ii) $x(n) = \begin{cases} 1; & -10 \le n \le +10 \\ 0; & otherwise \end{cases}$

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

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

B) Consider an LSI system described by the constant co-efficient difference equation, (3)

$y(n) - 0.25\, y(n-1) = x(n) - x(n-2)$. 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) $y(n) = -5\, x(n-10)$

(ii) $y(n) = 4\, x(n^2)$

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

Justify your answer.

3) The frequency response of the discrete-time low 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 right-sided sequence is the exterior 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)

$$x(n)\delta(n-n_0) = x(n_0)\delta(n-n_0)$$

$$x(n) * \delta(n-n_0) = x(n-n_0)$$

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

A) $h(n) = (0.5)^n\, u(n)$ &
$x(n) = 3^n\, u(-n)$
using the Z-transform.

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

$h_1(n) = \delta(n) - \delta(n-1)$, $h_2(n) = u(n)$ & $h_3(n) = h(n)$ are connected in series.
Determine the overall impulse response of the system.

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

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

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

5) Interpret the statement - "The Z-transform reduces to DTFT along the unity circle in the complex 'Z' plane." (3)

A)

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

$h(n) = 2\delta(n) + 2\delta(n-1) - 2\delta(n-2) - 2\delta(n-3)$.

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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