Question Paper

Exam Date & Time: 19-Dec-2022 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

THIRD SEMESTER B.TECH END SEMESTER EXAMINATIONS, DEC 2022

SIGNALS AND SYSTEMS [BME 2155]

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

Answer all the questions.

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

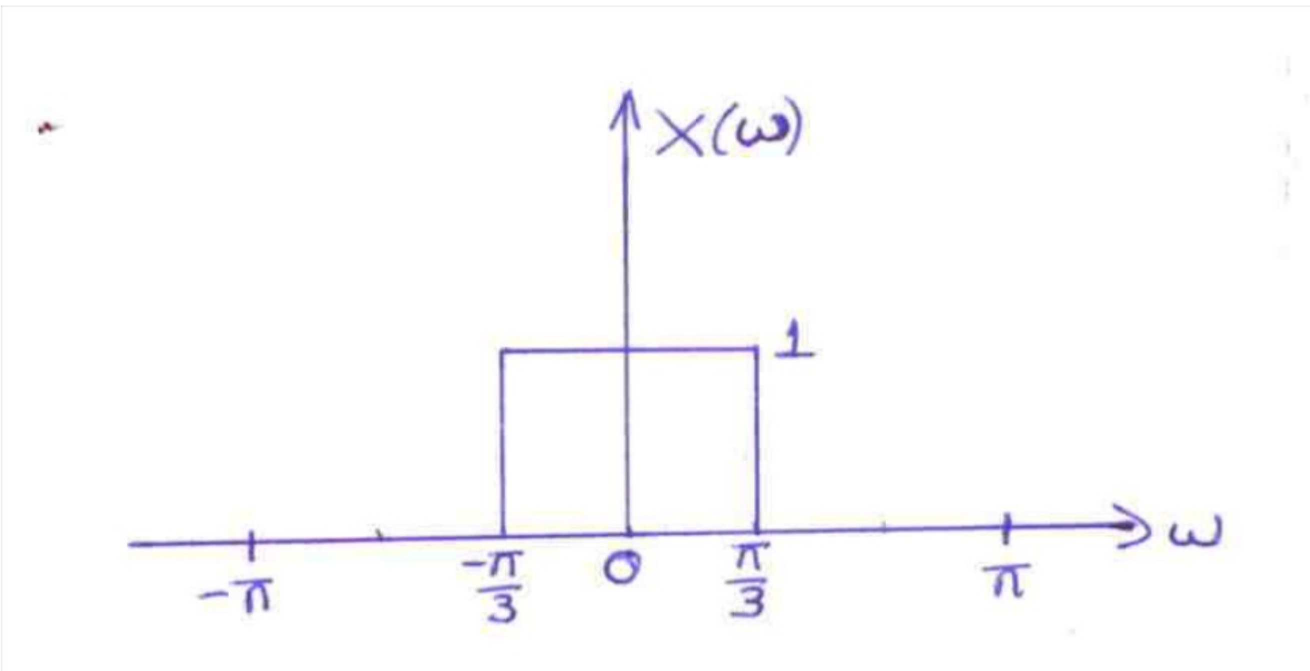
1) Consider a discrete-time sequence (3)

A)

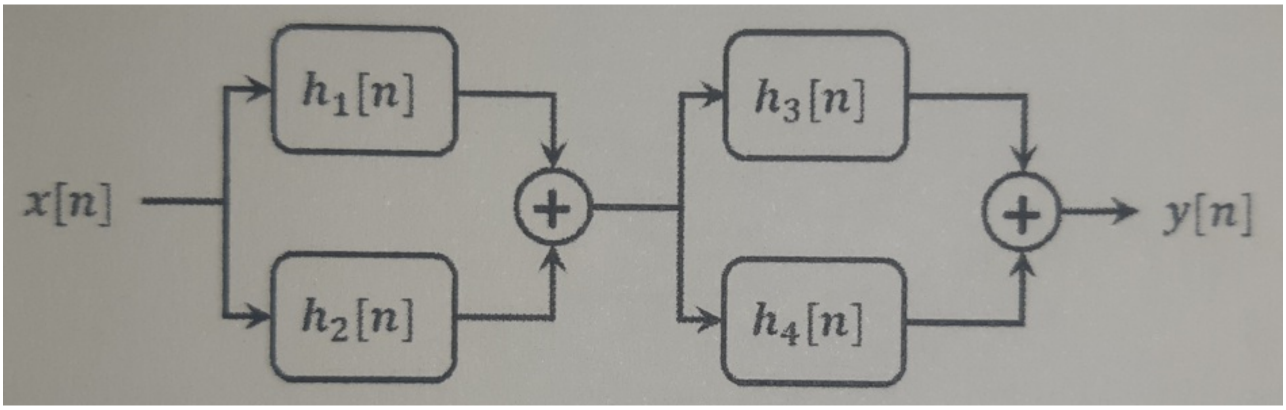
$$x(n) = \{1, 2, \underset{\uparrow}{2}, 1, 1, 2\}$$

Determine graphically, $x(2n) - x(-n) + x(-n+1)$.

B) A sequence $x(n)$ has a zero-phase DTFT $X(w)$ as sketched in the figure below. Use a suitable property of DTFT and sketch the DTFT of the sequence $x(n)e^{-jn\frac{\pi}{3}}$. (2)

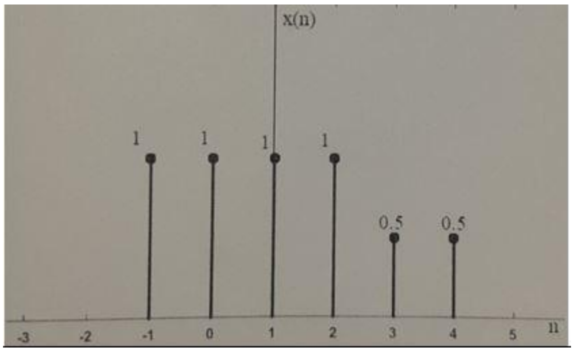


C) Consider the LSI system built by the interconnections of sub-systems with impulse responses $h_1[n] = u[n]$, $h_2[n] = -u[n-1]$, $h_3[n] = u[n-1]$ and $h_4[n] = \delta[n]$ as shown in the figure below. Determine the response $y[n]$ of the system for a given input $x[n] = \delta[n]$. (5)



2) A discrete-time signal $x(n)$ is given by: (3)

A)



Determine graphically each of the following versions of the signal.

(i) $x(n+2)u(2-n)$

(ii) $x(n-1)\delta(n-3)$

B) Using DTFT, Solve $y(n) = x(n) * h(n)$ (3)

where

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

$h(n) = \delta(n-2) - \delta(n-4)$.

C) Calculate the inverse Z-transform of (4)

$X(z) = \frac{z}{3z^2 - 4z + 1}$

for the following ROCs:

$|z| > 1$

(i)

$|z| < \frac{1}{3}$

(ii)

$\frac{1}{3} < |z| < 1$

(iii)

3) A continuous-time signal $x(t)$ is described by (3)

A) $x(t) = 6\cos(50\pi t) + 3\sin(200\pi t) - 3\cos(100\pi t)$. Determine the following:

(i) minimum sampling frequency required to sample the signal.

(ii) corresponding discrete-time sequence.

B) A discrete-time signal is given by (3)

$$x(n) = \{-3, 4, 2, 0, 1, \underset{\uparrow}{-1}, 3, -2\}$$

Determine graphically each of the following versions of the signal using the precedence rule:

(i) $x(-n-1)$

(ii) $x(1-n)$

C) Analyze the discrete-time system defined by $y(n) = x^2(n) + n\,x(n+1)$. Which of the following is true about this system? Justify your answer. (4)

a) Non-linear Time-variant Non-causal system

b) Non-linear Time-invariant Non-causal system

c) Linear Time-invariant Causal system

d) Linear Time-variant Causal system

4) Consider an LSI system described by the difference equation, $y(n) = x(n) - x(n-1)$. (4)

A) (i) Determine the frequency response $H(w)$ and the impulse response $h(n)$ of the system.

(ii) Sketch the magnitude response $|H(w)|$ over $-\pi \le w \le +\pi$ and identify the system.

B) Calculate the response $y(n)$ of the LSI system whose impulse response (4)

$$h(n) = \begin{cases} 1 & -2 \le n \le 2 \\ 0 & Otherwise \end{cases}$$

and the input

$$x(n) = \begin{cases} \frac{n}{3} & 0 \le n \le 6 \\ 0 & Otherwise \end{cases}$$

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

5) Analyze and find out whether the following LSI systems are Causal? Stable? (Justify your answers). (3)

A) (i) $h(n) = 2u(n) - 2u(n-1)$

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

B) Determine the Z-transform $X(z)$ and sketch the pole-zero plot with the ROC for each of the following sequences: (4)

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

(ii) $x(n) = \left(\frac{1}{3}\right)^n u(n) + \left(\frac{1}{2}\right)^n u(-n-1)$

C) Show that the LSI system described by the difference equation, $y(n) = x(n) + x(n-1)$, represents a low pass filter. (3)

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