Question Paper

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

MANIPAL ACADEMY OF HIGHER EDUCATION

THIRD SEMESTER B.TECH END SEMESTER MAKE-UP EXAMINATIONS, JAN 2023

SIGNALS AND SYSTEMS [BME 2155]

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

A

Answer all the questions.

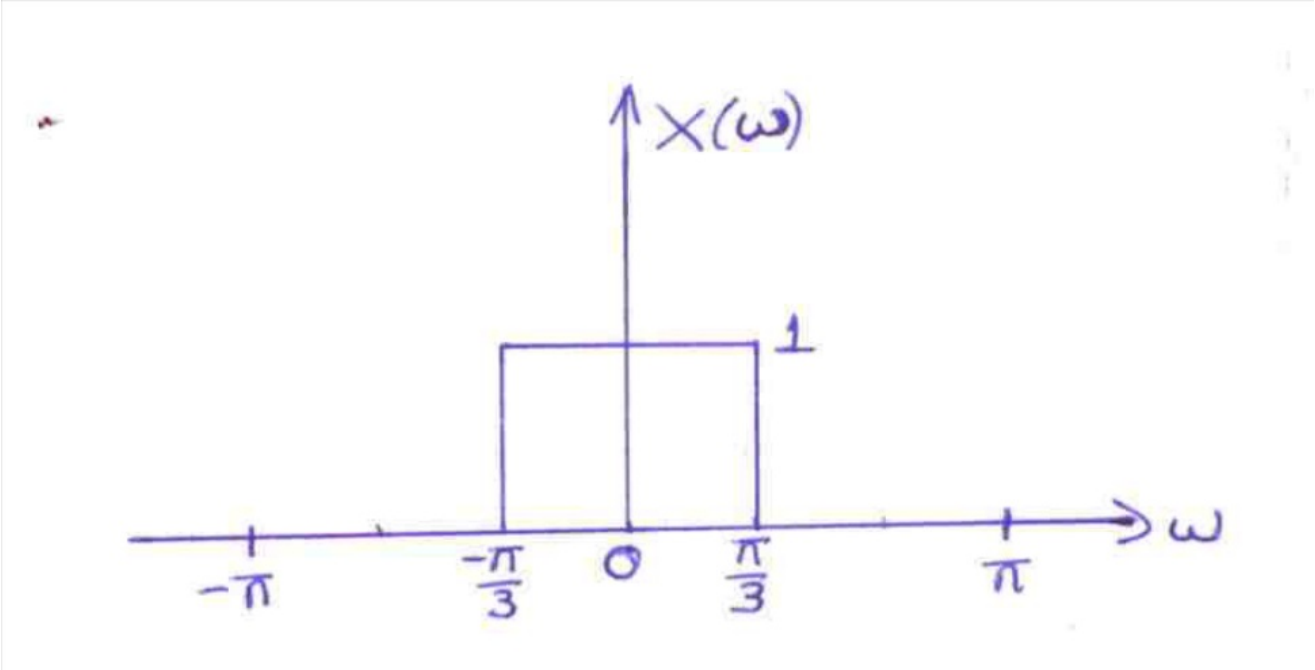
Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1) Consider a discrete-time sequence, (3)

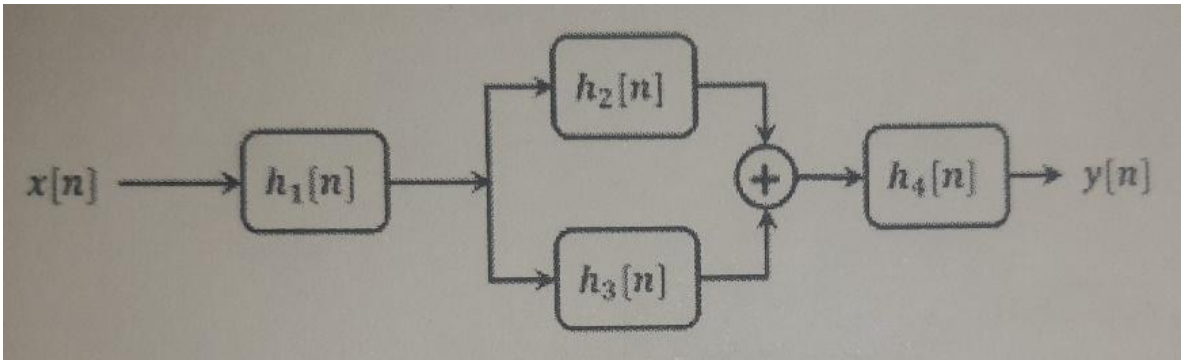
A) $x(n) = \{1, 2, 0, -1, -2\}$ (↑ at 2)

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

B) A sequence $x(n)$ has a DTFT $X(w)$ as sketched in the figure below. Use a suitable property of DTFT and sketch the DTFT of the sequence $x(n)e^{jn\frac{\pi}{8}}$. (2)



C) Consider the LSI system built by the interconnections of sub-systems with impulse responses $h_1[n] = u[n]$, $h_2[n] = \delta[n]$, $h_3[n] = -\delta[n-1]$ and $h_4[n] = \delta[n-2]$ as shown in the figure below. Determine the response $y[n]$ of the system for a given input $x[n] = u[n]$. (5)



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

A) $$x(n) = \begin{cases} 1 + \frac{n}{3}; & -3 \le n \le -1 \\ 1; & 0 \le n \le 3 \\ 0; & otherwise \end{cases}$$

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 $y(n) = x(n) * h(n)$ where (3)

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

C) Using partial expansion, calculate the inverse Z-transform of (4)
$X(z) = \frac{z}{2z^2 - 3z + 1}$
for the following ROCs:

(i) $|z| > 1$

(ii) $|z| < \frac{1}{2}$

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

A) $x(t) = 0.2\cos(50\pi t) - 0.3\cos(150\pi t)$.

(i) Determine the frequencies present in $x(t)$.

(ii) Determine whether the signal can be exactly recovered from its sampled version if sampled at a rate of 200Hz.

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

$$x(n) = \{1, 1, 1, 1, 0.5, 0.5\}$$
$$\uparrow$$

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 $y(n) = x(n) + n\,x(n+1)$. Which of the following is true about this system? Justify your answer. (4)

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

b) Linear Time-variant 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, $y(n) = x(n) + x(n-1)$. Determine the frequency response $H(w)$ and the impulse response $h(n)$ of the system. (4)

A)

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

$$x(n) = \begin{cases} 1 & 0 \le n \le 6 \\ & \end{cases}$$

w *Otherwise*

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

5) Analyze and find out for what range of values of the parameter a ' the LSI system given below is stable (Justify your answer). (3)

A) $h(n) = a^n\, u(n)$

B) Determine the ROC associated with the Z-transform $X(z)$ for each of the following sequences: (4)

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

(ii) $x(n) = \left(-\frac{1}{2}\right)^n u(n) + 2\left(\frac{1}{4}\right)^n u(n)$

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

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