5 Discrete Time System

Multiple Choice Questions

Q.1 Which one of the systems described by the following input-output relations is time invariant?

(a) $y(n) = nx(n)$ (b) $y(n) = x(n) - x(n-1)$

(c) $y(n) = x(-n)$ (d) $y(n) = x(n)\cos 2\pi f_0 n$

[ESE-2002]

Q.2 To which one of the following difference equations, the impulse response $h(n) = \delta(n+2) - \delta(n-2)$ corresponds?

(a) $y(n+2) = x(n) - x(n-2)$

(b) $y(n-2) = x(n) - x(n-4)$

(c) $y(n) = x(n+2) + x(n-2)$

(d) $y(n) = -x(n+2) + x(n-2)$ **[ESE-2004]**

Q.3 $x[n]$ is defined as

$$x[n] = \begin{cases} 0 & \text{for } n < -2 \text{ or } n > 4 \\ 1, & \text{otherwise} \end{cases}$$

Determine the value of n for which $x[-n-2]$ is guaranteed to be zero.

(a) $n < 1$ and $n > 7$ (b) $n < -4$ and $n > 2$

(c) $n < -6$ and $n > 0$ (d) $n < -2$ and $n > 4$

[ESE-2006]

Q.4 A signal represented by $x(t) = 5\cos 400\pi t$ is sampled at a rate 300 samples/s. The resulting samples are passed through an ideal low pass filter of cut-off frequency 150 Hz. Which of the following will be contained in the output of the LPF?

(a) 100 Hz

(b) 100 Hz, 150 Hz

(c) 50 Hz, 100 Hz

(d) 50 Hz, 100 Hz, 150 Hz **[ESE-2005]**

Q.5 The impulse response $h[n]$ of a linear time invariant system is given by $h[n] = u[n+3] + u[n-3] - 2u[n-7]$, the above system is

(a) stable but not causal

(b) stable and causal

(c) causal but unstable

(d) unstable and not causal

Q.6 The convolution $x(n)$ of two signals.

$$x_1(n) = \{1, -2, 1\} \text{ and } x_2(n) = \begin{cases} 1 : 0 \le n \le 5 \\ 0 : \text{otherwise} \end{cases}$$

(a) $x(n) = \{\underset{\uparrow}{1}, -1, 0, 0, 0, 0, -1, 1\}$

(b) $x(n) = \{1, -1, \underset{\uparrow}{0}, 0, 0, 0, -1, 1\}$

(c) $x(n) = \{1, -1, 0, \underset{\uparrow}{0}, 0, 0, -1, 1\}$

(d) None of these

Q.7 Consider the sequence

$x[n] = [-4 - j5, \underset{\uparrow}{1 + j2}, 4]$

the conjugate anti-symmetric part of the sequence is

(a) $[-4 - j2.5, \underset{\uparrow}{j2}, 4 - j2.5]$

(b) $[-j2.5, \underset{\uparrow}{1}, j2.5]$

(c) $[-j5, \underset{\uparrow}{j2}, 0]$

(d) $[-4, \underset{\uparrow}{1}, 4]$

Q.8 A discrete time signal is given below

$x[n] = \cos\frac{\pi n}{9} + \sin\left(\frac{\pi n}{7} + \frac{1}{2}\right)$ the period of the signal is

(a) Periodic with period $N = 126$
(b) Periodic with period $N = 32$
(c) Periodic with period $N = 252$
(d) Not periodic

Q.9 $x[n]$ and $h[n]$ are $\{1, -2, 3\}$ and $\{0, 0, 1, 1, 1, 1\}$
$\uparrow$ $\uparrow$
respectively. The convolution $y[n] = x[n] * h[n]$ is

(a) $\{1, -2, 4, 1, 1, 1\}$
$\uparrow$
(b) $\{0, 0, 3\}$
$\uparrow$
(c) $\{0, 0, 3, 1, 1, 1, 1\}$
$\uparrow$
(d) $\{0, 0, 1, -1, 2, 2, 1, 3\}$
$\uparrow$

Q.10 Statement 1 : $x[n] = \cos\left[\frac{1}{4}n\right]$ is non periodic.

Statement 2 : $x(t) = e^{j\left[\left(\frac{\pi}{2}\right)t - 1\right]}$ is periodic

Choose correct option:

(a) Both statement are true.
(b) Statement 1 is false, but statement 2 is true
(c) Statement 1 is true, but statement 2 is false
(d) Both statements are false.

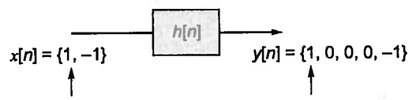
Q.11 Consider:

1. $y[n] = x[2 - n]$ is non-causal
2. $y[n] = x[n] \cos\omega_0 n$ is causal
3. $y[n] = \text{sgn}[x[n]]$ is non-causal

Which of the above is false?

(a) only 1 (b) only 2
(c) only 3 (d) None

Q.12 Given the finite length input $x[n]$ and the corresponding finite length output $y[n]$ of an LTI system as shown below, the impulse response $h[n]$ of the system is



(a) $h[n] = \{1, 0, 0, 1\}$
$\uparrow$
(b) $h[n] = \{1, 0, 1\}$
$\uparrow$
(c) $h[n] = \{1, 1, 1, 1\}$
$\uparrow$
(d) $h[n] = \{1, 1, 1\}$
$\uparrow$ **[GATE-2010]**

Q.13 A discrete time linear shift-invariant system has an impulse response $h[n]$ with $h[0] = 1$, $h[1] = -1$, $h[2] = 2$, and zero otherwise. The system is given an input sequence $x[n]$ with $x[0] = x[2] = 1$ and zero otherwise. The number of nonzero samples in the output sequence $y[n]$, and the value of $y[2]$ are, respectively

(a) 5, 2 (b) 6, 2
(c) 6, 1 (d) 5, 3

[GATE-2008]

Q.14 Two discrete time systems with impulse responses $h_1[n] = \delta[n-1]$ and $h_2[n] = \delta[n-2]$ are connected in cascade. The overall impulse response of the cascaded system is

(a) $\delta[n-1] + \delta[n-2]$ (b) $\delta[n-4]$
(c) $\delta[n-3]$ (d) $\delta[n-1]\,\delta[n-2]$

[GATE-2010]

Q.15 A signal has frequency of 2500 Hz and is sampled at the rate of 6000 Hz. What among therse should be the cut-off frequency of filter for successful recovery of just main signal?

(a) 2000 Hz (b) 1000 Hz
(c) 3000 Hz (d) 6000 Hz

Q.16 Step response of discrete time LTI system is given as $S(n) = \left(\frac{1}{2}\right)^n u(n)$. then the impulse response of the system will be

(a) $1, \frac{1}{2}, \frac{1}{4}, \ldots$ (b) $-1 - \frac{1}{2}, -\frac{1}{4}, \ldots$
(c) $1, -\frac{1}{2}, -\frac{1}{4}, \ldots$ (d) 1, 1, 1, 1,...

Numerical Data Type Questions

Q.17 The lengths of two discrete time sequence $x_1(n)$ and $x_2(n)$ are 5 and 7, respectively. The maximum length of a sequence $x_1(n) * x_2(n)$ is _____.

[ESE-2005]

Q.18 A sinusoid $x(t)$ of unknown frequency is sampled by an impulse train of period 20 ms. The resulting sample train is next applied to an ideal low-pass filter with a cut-off at 25 Hz. The filter output is seen to be a sinusoid of frequency 20 Hz. This means that $x(t)$ has a minimum frequency of _____Hz.

[GATE-2014]

Q.19 For the signal $f(t) = 3\sin 8\pi t + 6\sin 12\pi t + \sin 14\pi t$, the minimum sampling frequency (in Hz) satisfying the Nyquist criterion is ____.

[GATE-2014]

Try Yourself

T1. Consider the integral $y(t) = \int_{-\infty}^{\infty} e^{-t}\delta(2t-1)\,dt$.

The value of integral is _____.

[Ans: (d)]

T2. A system with input $x(n)$ has output

$$y(n) = \sum_{k=0}^{\infty} 3^k x(n-k)$$

The impusle response of system will be

(a) $h(n) = 3^n u(n)$
(b) $h(n) = 3^n u(n+2)$
(c) $h(n) = 3^{n+2} u(n+2)$
(d) $h(n) = 3^n u(n-2)$

[Ans: (a)]

T3. Consider an LTI System with impulse response $h[n]$.

If the system has input

$$x_1(n) = \delta(n) + \delta(n-1) + \delta(n-2)$$

then output is

$$y_1(n) = \cos n$$

If the system has input

$$x_2(n) = \delta(n-1) + \delta(n-2)$$

the output is

$$y_2(n) = \sin n$$

The impulse response of system will be

(a) $h(n) = \cos n - \sin n$
(b) $h(n) = \cos(n) - \sin(n-1)$
(c) $h(n) = \cos n + \sin n$
(d) $h(n) = \cos(n) + \sin(n-1)$

[Ans: (a)]

T4. A band pass filter has a bandwidth of 3 MHz and lower cut off of 2 MHz. What is the value of min sampling frequency?

[Ans: (10 MHz)]