POSTAL Book Package 2023

GATE • PSUs

Instrumentation Engineering

Objective Practice Sets

Signals and Systems

Contents

MADE EASY Publications

1 CHAPTER Basics of Signals and Systems

MCQ and NAT Questions

Q.1 If a function $f(t)\, u(t)$ is shifted to right side by t_0, then the function can be expressed as
(a) $f(t - t_0)\, u(t)$
(b) $f(t)\, u(t - t_0)$
(c) $f(t - t_0)\, u(t - t_0)$
(d) $f(t + t_0)\, u(t + t_0)$

Q.2 An impulse function consists, of
(a) entire frequency range with same relative phase
(b) infinite bandwidth with linear phase variations
(c) pure d.c.
(d) large d.c. along with weak harmonics.

Q.3 If $a(n)$ is the response of a linear, time-invariant, discrete-time system to a unit step input, then the response of the same system to a unit impulse input is
(a) $\frac{d}{dn}\left[a(n)\right]$
(b) $na(n)$
(c) $a(n) - a(n-1)$
(d) $a(n+1) - 2a(n) + a(n-1)$

Q.4 The unit impulse response of a linear time invariant system is the unit step function $u(t)$. For $t > 0$, the response of the system to an excitation $e^{-at}\, u(t)$, $a > 0$ will be
(a) ae^{-at} (b) $(1/a)(1 - e^{-at})$
(c) $a(1 - e^{-at})$ (d) $1 - e^{-at}$

Q.5 The unit step response of a system is given by $(1 - e^{-at})\, u(t)$, the impulse response is given by
(a) $e^{\alpha t}\, u(t)$ (b) $e^{-\alpha t}\, u(t)$
(c) $\frac{1}{\alpha} e^{-\alpha t} u(t)$ (d) $\alpha e^{-\alpha t}\, u(t)$

Q.6 A function $f(t)$ is an even function, if for all values of t
(a) $f(t) = f(-t)$ (b) $f(t) = -f(-t)$
(c) $f(t) = f(t + T/2)$ (d) $f(t) = -f(t + T/2)$
(T is the time-period of the function)

Q.7 The function $\delta(2n)$ is equal to
(a) $\delta(n)$ (b) $\frac{1}{2}\delta(n)$
(c) $2\delta(n)$ (d) $2\delta\left(\frac{n}{2}\right)$

Q.8 If $x_1(t) = 2 \sin \pi t + \cos 4\pi t$ and $x_2(t) = \sin 5\pi t + 3 \sin 13\pi t$, then
(a) $x_1(t)$ and $x_2(t)$ both are periodic.
(b) $x_1(t)$ and $x_2(t)$ both are not periodic.
(c) $x_1(t)$ is periodic, but $x_2(t)$ is not periodic.
(d) $x_1(t)$ is not periodic, but $x_2(t)$ is periodic.

Q.9 Energy signals are the signals with
(a) $0 < E < \infty$, $P = 0$ (b) $0 < E < \infty$, $P = \infty$
(c) $0 < P < \infty$, $E = \infty$ (d) $0 < P < \infty$, $E = 0$

Q.10 Power signals are the signals with
(a) $0 < E < \infty$, $P = 0$
(b) $0 < E < \infty$, $P = \infty$
(c) $0 < P < \infty$, $E = \infty$
(d) $0 < P < \infty$, $E = 0$

Q.11 A signum function is
(a) zero for t greater than zero
(b) zero of t less than zero
(c) unity for t less than zero
(d) $2\, u(t) - 1$

Q.12 The average value of the waveform $x(t) = 4 \cos 4t - 5 \sin 5t$ is
(a) 0 (b) $-\left(\frac{2}{\pi}\right)$
(c) $\frac{2}{\pi}$ (d) $\frac{20}{\pi}$

Q.13 If two signals are given as,

$$x_1(t) = e^{jt} \quad \text{and} \quad x_2(t) = e^{t(j+1)}$$

Then which one of the following statements is correct?
(a) Both $x_1(t)$ and $x_2(t)$ are periodic
(b) Only $x_1(t)$ is periodic
(c) Only $x_2(t)$ is periodic
(d) Neither $x_1(t)$ nor $x_2(t)$ is periodic

Multiple Select Questions (MSQs)

Q.41 For which of the following function(s) the time scaling operation will effect its original nature of the function:
(a) $\delta(t)$
(b) $u(t)$
(c) $r(t)$
(d) A rectangular pulse within finite duration.

Q.42 A discrete system with input $x[n]$ and output $y[n]$ are related by

$$y[n] = \sum_{n=-\infty}^{\infty} x[n]e^{-j\omega n}$$

The system is
(a) unstable
(b) stable
(c) time variant
(d) time invariant

Q.43 Consider a continuous time signal $x(t) = 2\cos\left(\frac{\pi t}{4}\right) * \delta\left(\frac{t}{2}-1\right)$. Then for which value of 't', signal $x(t)$ is zero.
(a) $t = 0$
(b) $t = 2$
(c) $t = 1$
(d) $t = 4$

Q.44 Consider a discrete-time periodic signal $x[n] = \begin{cases} 1, & 0 \le n \le 7 \\ 0, & 8 \le n \le 9 \end{cases}$ with period of $N = 10$. A function $y[n]$ is defined as $y[n] = x[n] - x[n-1]$, then the correct options regarding $y[n]$ are
(a) period $N = 10$
(b) period $N = 8$
(c) $y[n] = \{1,0,0,0,0,0,0,0,-1,0\}$ for one time period
(d) $y[n] = \{1,0,0,0,0,0,-1,0\}$ for one time period

■■■■

Answers — Basics of Signals and Systems

1.	(c)	2.	(a)	3.	(c)	4.	(b)	5.	(d)	6.	(a)	7.	(a)
8.	(a)	9.	(a)	10.	(c)	11.	(d)	12.	(a)	13.	(b)	14.	(c)
15.	(a)	16.	(d)	17.	(d)	18.	(a)	19.	(d)	20.	(c)	21.	(a)
22.	(b)	23.	(a)	24.	(b)	25.	(b)	26.	(b)	27.	(b)	28.	(d)
29.	(a)	30.	(a)	31.	(c)	32.	(a)	33.	(–2)	34.	(8)	35.	(4)
36.	(2)	37.	(4)	38.	(24)	39.	(0)	40.	(0.232)	41.	(a, c, d)	42.	(b, c)
43.	(a, d)	44.	(a, c)										

Explanations — Basics of Signals and Systems

1. (c)

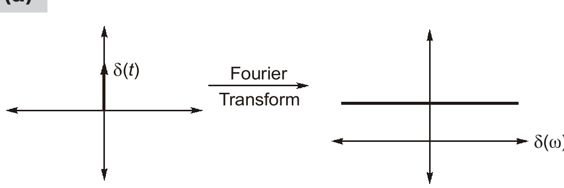
Since $f(t)u(t) = f(t)$ for $t > 0$ also we know $u(t - t_0) = 1$, for $t > t_0$

Here in right side shifting that means $t_0 > 0$

$\therefore$ by property on shifting right side,

$$f(t)\,u(t) = \xrightarrow[\text{shifting RHS by } t_0]{\text{on}} f(t-t_0)\,u(t-t_0)$$

2. (a)



3. (c)

For discrete time system,

$$d(n) = u(n) - u(n-1)$$

For continuous time system,

$$\delta(t) = \frac{d}{dt}u(t)$$

4. (b)

Since, for unit impulse, response is unit step i.e. transfer function is integrator.

$$\therefore \quad y(t) = \int_{-\infty}^{t} e^{-at}\,u(t)\,dt\,;\; u(t) = \begin{cases} 1, & t > 0 \\ 0, & \text{elsewhere} \end{cases}$$

$$= \int_{0}^{t} e^{-at}\,dt = \frac{1}{a}(1-e^{-at})$$

5. (d)

$$\delta(t) = \frac{d}{dt}u(t)$$

$$\text{Impulse response} = \frac{d}{dt}((1-e^{-\alpha t})u(t))$$

$$= \frac{d}{dt}(u(t) - u(t)e^{-\alpha t})$$

$$= \delta(t) - \delta(t)e^{-\alpha t} + \alpha e^{-\alpha t}u(t)$$

$\because$ $f(t)\,\delta(t) = f(0)\,\delta(t)$

$\therefore$ Impulse response $= \alpha e^{-\alpha t}u(t)$

6. (a)

For even function, $f(t) = f(-t)$

For odd function, $f(t) = -f(-t)$

7. (a)

Properties :

For continuous system

$$\delta(at) = \frac{1}{|a|}\delta(t)$$

For discrete system

$$\delta[an] = \delta[n]$$

8. (a)

$$x_1(t) = 2\sin\pi t + \cos 4\pi t$$

$\therefore$ $\omega_1 = \frac{\pi}{1}$

$$\omega_2 = \frac{4\pi}{1}$$

$$\omega_0 = \text{HCF}(\omega_1, \omega_2)$$

$$= \text{HCF}\left(\frac{\pi}{1}, \frac{4\pi}{1}\right) = \pi$$

$\therefore$ $T = \frac{2\pi}{\omega_0} = \frac{2\pi}{\pi} = 2$

$$x_2(t) = \sin 5\pi t + 3\sin 13\pi t$$

$$\omega_1 = \frac{5\pi}{1}; \quad \omega_2 = \frac{13\pi}{1}$$

$$\omega_0 = \text{HFC}(5\pi, 13\pi)$$

$$\omega_0 = \pi$$

$\therefore$ $T = \frac{2\pi}{\omega_0} = \frac{2\pi}{\pi} = 2$

$\therefore$ Both are periodic.

9. (a)

Energy signal: $E \neq \infty$, $P = 0$,

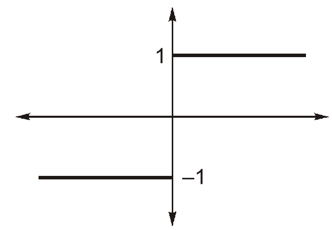
where E is energy and P is average power.

10. (c)

Power signal : $E = \infty$, $P \neq \infty$

11. (d)

Signum function is



$$2u(t) - 1 = \begin{cases} 1, & t > 0 \\ -1, & t < 0 \end{cases}$$

$$u(t) = 1, \quad t > 0$$

$$= 0, \quad \text{elsewhere}$$

12. (a)

The collective signal is periodic with period

$$= \text{LCM}\left(\frac{\pi}{2}, \frac{2\pi}{5}\right) = 2\pi\,.$$

Average value of a sinusoidal signal = 0.

$$V_{avg.} = \frac{1}{T}\int_0^T (v_1(t) + v_2(t))\,dt$$

$$= \frac{1}{T}\int_0^T (v_1(t)\,dt + \frac{1}{T}\int_0^T v_2(t)\,dt$$

$$= V_{avg_1} + V_{avg_2} = 0$$

13. (b)

Only complex exponential are periodic.

$x_2(t) = e^{t(j+1)} = e^{jt}\left(e^{t}\right)$

(because of this term x_2(t) is non-periodic)

14. (c)

If a continuous time signal can take on any value in the continuous interval $(-\infty, \infty)$ then this signal is known as analog signal.

15. (a)

For the given $f(t)$