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POSTAL BOOK PACKAGE 2025

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INSTRUMENTATION ENGINEERING

Objective Practice Sets

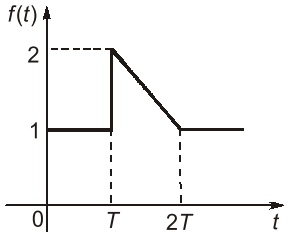
Signals and Systems

1 CHAPTER
Basics of Signals and Systems

MCQ and NAT Questions

Q.1 If a continuous time signal $x(t)$ can take on any value in the continuous interval $(-\infty, \infty)$, it is called
(a) Deterministic signal
(b) Random signal
(c) Analog signal
(d) Digital signal

Q.2 The function $f(t)$ shown in the figure can be represented as



(a) $u(t)+u(t-T)-\frac{(t-T)}{T}u(t-T)+\frac{(t-2T)}{T}u(t-2T)$

(b) $u(t)-u(t-T)+\frac{(t-T)}{T}u(t-T)-\frac{(t-2T)}{T}u(t-2T)$

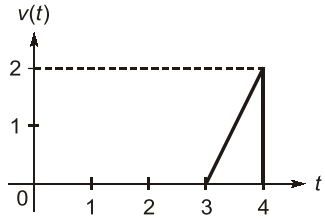
(c) $u(t)-u(t-T)-\frac{(t-T)}{T}u(t-T)-\frac{2(t-2T)}{T}u(t-2T)$

(d) $u(t)+u(t-T)+\frac{(t-T)}{T}u(t-T)-\frac{2(t-2T)}{T}u(t-2T)$

Q.3 Which of the following statements is/are true?
1. If $x(t)$ is a continuous time periodic signal with period T, then $y(t) = x(2t)$ will also be periodic with period $2T$.
2. Sum of two continuous time periodic signals may or may not be periodic.
3. Sum of two discrete time periodic signals may or may not be periodic.

(a) 2 and 3 only
(b) 1 and 3 only
(c) 1 and 2 only
(d) 2 only

Q.4 In the graph shown below, which one of the following express $v(t)$?



(a) $(2t + 6)[u(t-3) + 2u(t-4)]$
(b) $(-2t-6)[u(t-3) + u(t-4)]$
(c) $(-2t + 6)[u(t-3) + u(t-4)]$
(d) $(2t-6)[u(t-3) - u(t-4)]$

Q.5 Match **List-I** with **List-II** and select the correct answer using the code given below the Lists:

List-I	List-II
A. Even signal	1. $x(n)=\left(\frac{1}{4}\right)^n u(n)$
B. Causal signal	2. $x(-n) = x(n)$
C. Periodic signal	3. $x(t) = u(t)$
D. Energy signal	4. $x(n) = x(n + N)$

Codes:

	A	B	C	D
(a)	2	3	4	1
(b)	1	3	4	2
(c)	2	4	3	1
(d)	1	4	3	2

Q.6 Which one of the following relation is not correct?
(a) $f(t)\delta(t) = f(0)\delta(t)$

(b) $\int_{-\infty}^{\infty} f(t)\delta(t-\tau)\,dt = f(\tau)$

(c) $f(t) * \delta(t-\tau) = f(t-\tau)$

(d) $\int_{-\infty}^{\infty} \delta(at)\,dt = 1$

Q.7 Which of the following signals are periodic?

1. $\cos\left(\frac{\pi}{3}n\right)+\sin\left(\frac{\pi}{3}n\right)$

2. $\cos\left(\frac{1}{2}n\right)+\cos\left(\frac{1}{3}n\right)$
3. Even $\{\cos(4\pi t)u(t)\}$
4. Even $\{\sin(4\pi t)u(t)\}$

(a) 1 and 4 only (b) 1, 2 and 3 only
(c) 1 and 3 only (d) 1, 3 and 4 only

Q.8 The power in the signal

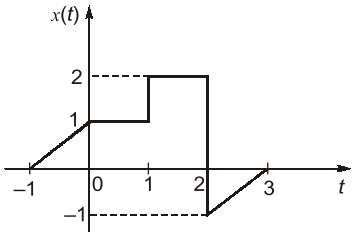
$$s(t)=8\cos\left(20\pi t-\frac{\pi}{2}\right)+4\sin(15\pi t) \text{ is}$$

(a) 40 (b) 41
(c) 42 (d) 82

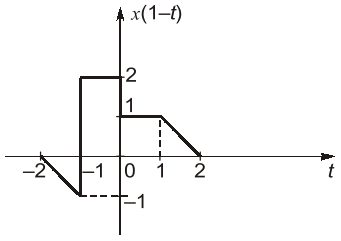
Q.9 **Statement (I):** The total energy of an energy signal falls between the limits 0 and ∞.
Statement (II): The average power of an energy signal is zero.

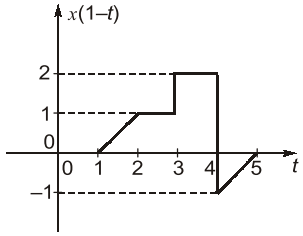
(a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is **NOT** the correct explanation of Statement (I)
(c) Statement (I) is true but Statement (II) is false
(d) Statement (I) is false but Statement (II) is true

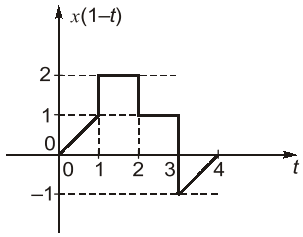
Q.10 If a plot of a signal $x(t)$ is as shown in the Figure.

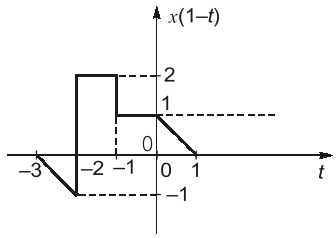


Then the plot of the signal $x(1-t)$ will be:

(a)


(b)


(c)


(d)


Q.11 The signal $x(t) = A\cos(\omega_0 t + \phi)$ is

(a) an energy signal
(b) a power signal
(c) an energy as well as a power signal
(d) neither an energy nor a power signal

Q.12 Double integration of a unit step function would lead to

(a) an impulse (b) a parabola
(c) a ramp (d) a doublet

Q.13 If $\int_{-\infty}^{\infty} e^{3\left(\frac{t}{2}-1\right)}.\sin\frac{\pi t}{8\beta}.\delta(2-t)=\frac{-1}{\sqrt{2}}$.

Then the maximum value of β is

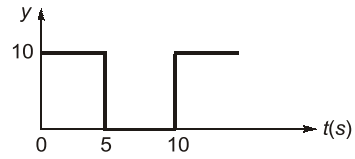
(a) –1 (b) $\frac{1}{5}$

(c) $\frac{1}{13}$ (d) $\frac{1}{21}$

Q.14 For a periodic waveform to be halfwave symmetric, it must be represented by a function satisfying

(a) $f(t) = f(t + T/2)$ (b) $f(t) = -f(t + T/2)$
(c) $f(t) = f - (-t)$ (d) $f(t) = f(-t)$

Q.15 In the given figure, the effective value of the waveform is



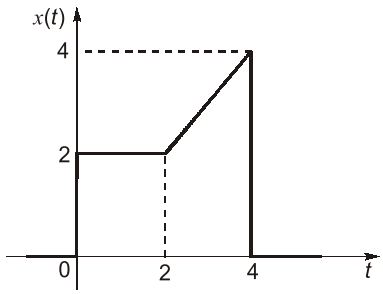
(a) 5.0 (b) 2.5
(c) $\sqrt{2.5}$ (d) $\sqrt{50}$

Q.24 For a power signal $f(n) = Au(n)$. The average power is given by 8 W, then the magnitude of A will be _____.

Q.25 The period of the signal

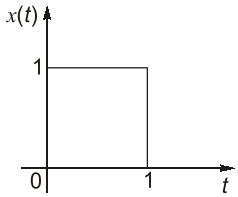
$$x[n] = \cos\frac{\pi}{4}n + \sin\left(\frac{\pi}{3}n + \frac{1}{2}\right) \text{ is } \_\_\_\_\_.$$

Q.26 Consider the following signal:



The signal $x(t)$ is expressed as,
$x(t) = 2u(t) + (t-2)\,u(t-2) - (t-t_0)\,u(t-4)$
If $u(t)$ is a unit step function, then the value of t_0 will be _____.

Q.27 An LTI system has step response $(1 - e^{-t})\,u(t)$. The response of the system for following input $x(t)$ at $t = 2$ is_____.



Multiple Select Questions (MSQs)

Q.28 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.29 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.30 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.31 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 $y[n] = \xi[n] - \xi[n-1]$, 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.** (d)	**4.** (d)	**5.** (a)	**6.** (d)	**7.** (c)
8. (a)	**9.** (b)	**10.** (a)	**11.** (b)	**12.** (b)	**13.** (b)	**14.** (b)
15. (d)	**16.** (a)	**17.** (a)	**18.** (c)	**19.** (a)	**20.** (–2)	**21.** (8)
22. (4)	**23.** (2)	**24.** (4)	**25.** (24)	**26.** (0)	**27.** (0.232)	**28.** (a, c, d)
29. (b, c)	**30.** (a, d)	**31.** (a, c)				

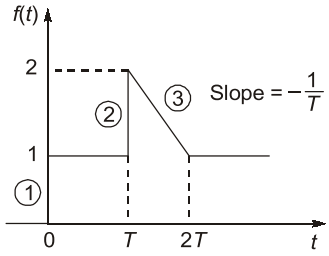
Explanations Basics of Signals and Systems

1. (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.

2. (a)

For the given $f(t)$



Step (1) = $u(t)$ = $u(t)$ both steps are of unity magnitude

Step (2) = $u(t-T) = u(t-T)$

Hence ramp (3) = $\frac{-1}{T}\{r(t-T)-r(t-2T)\}$

$= \frac{-1}{T}\{(t-T)u(t-T)-(t-2T)u(t-2T)\}$

Since, $r(t) = tu(t)$

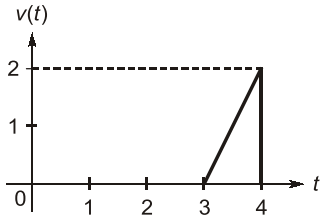
Hence,

$$f(t) = u(t)+u(t-T)-\frac{(t-T)}{T}u(t-T)+\frac{(t-2T)}{T}u(t-2T)$$

3. (d)

- If $x(t)$ is periodic with time period T, then $y(t) = x(2t)$ will be periodic with time period $T/2$.
- Sum of two discrete time periodic signals is always periodic.

4. (d)



v(t) consist 1 Ramp and 1 negative step,

Hence Ramp (1) having slope = 2

So Ramp (1) = $2\{r(t-3)-r(t-4)\}$

step (2) = $-2u(t-4)$

So, $v(t) = 2r(t-3)-2r(t-4)-2u(t-4)$

$= 2(t-3)\,u(t-3)-2(t-4)u(t-4)-2u(t-4)$

$= 2(t-3)\,u(t-3)-2(t-3)u(t-4)$

$= (2t-6)\{u(t-3)-u(t-4)\}$

5. (a)

- Even signal $x(n) = x(-n)$
- Causal system is one in which output at any time depends only on present and/or past values of input.
- Periodic signal is one which satisfies $x(n) = x(n+N)$; $N \rightarrow$ Fundamental period.
- Energy signal is absolutely summable i.e. $x(n)$

$$= \left|\left(\frac{1}{4}\right)^n u(n)\right| < \infty$$

6. (d)

$$\int_{-\infty}^{\infty}\delta(at)\,dt = \frac{1}{a}$$

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

7. (c)

1. $\cos\left(\frac{\pi}{3}n\right)+\sin\left(\frac{\pi}{3}n\right) \Rightarrow$ periodic

   Period = $\frac{2\pi\times 3}{\pi} = 6$

2. $\cos\left(\frac{1}{2}n\right)+\cos\left(\frac{1}{3}n\right) \Rightarrow$ non-periodic

3. Even $\{\cos(4\pi t)u(t)\}$

   $= \frac{\cos(4\pi t)\,u(t)+\cos(-4\pi t)u(-t)}{2}$

   $= \frac{\cos 4\pi t}{2} \Rightarrow$ Periodic

4. Even $\{\sin(4\pi t)u(t)\}$

   $= \frac{\sin(4\pi t)u(t)+\sin(-4\pi t)u(-t)}{2} \Rightarrow$ non-periodic

8. (a)

Given: $s(t) = 8\cos\left(20\pi t-\frac{\pi}{2}\right)+4\sin(15\pi t)$

$s(t) = 8\sin 20\pi t + 4\sin 15\pi t$

When both the sinusoidal signal having different frequency. Then overall power $(P) = P_1 + P_2$

$$P = \frac{8^2}{2}+\frac{4^2}{2} = 40$$