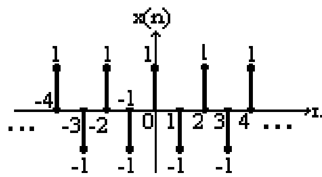
SIGNALS AND SYSTEMS IMPORTANT

80 MCQ PDF WITH SOLUTION

Q.1 The discrete-time signal x (n) = $(-1)^n$ is periodic with fundamental period

(A) 6 **(B) 4**
(C) 2 **(D)** 0

Ans: C Period = 2

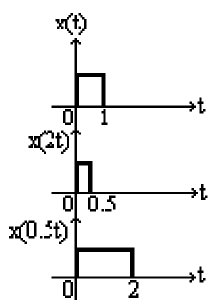


Q.2 The frequency of a continuous time signal x (t) changes on transformation from x (t) to x (α t), $\alpha > 0$ by a factor

(A) α. **(B)** $\frac{1}{\alpha}$.
(C) α^2. **(D)** √a .

Ans: A $x(t) \xrightarrow{\text{Transform}} x(at),\ a > 0$

a > 1 ⇒ compression in t, expansion in f by a.
a < 1 ⇒ expansion in t, compression in f by a.



Q.3 A useful property of the unit impulse 6 (t) is that

(A) 6 (at) = a 6 (t) . **(B)** 6 (at) = 6 (t).
(C) 6 (at) = $\frac{1}{a}$ 6 (t) . **(D)** $6(at) = [6(t)]^a$.

Ans: C Time-scaling property of 6(t):

6(at) = $\frac{1}{a}$ 6(t), a > 0

Q.4 The continuous time version of the unit impulse 6 (t) is defined by the pair of relations

(A) $6(t) = \begin{cases} 1 & t = 0 \\ 0 & t \neq 0 \end{cases}$. **(B)** $6(t) = 1, t = 0$ and $\int_{-\infty}^{\infty} 6(t)\,dt = 1$.

(C) $6(t) = 0, t \neq 0$ and $\int_{-\infty}^{\infty} 6(t)\,dt = 1$. **(D)** $6(t) = \begin{cases} 1, & t \geq 0 \\ 0, & t < 0 \end{cases}$.

Ans: C $6(t) = 0, t$ Ç $0 \rightarrow 6(t)$ Ç 0 at origin

$\int_{-œ}^{+œ} 6(t)\,dt = 1 \rightarrow$ Total area under the curve is unity.

[6(t) is also called Dirac-delta function]

Q.5 Two sequences $x_1(n)$ and $x_2(n)$ are related by $x_2(n) = x_1(-n)$. In the z- domain, their ROC's are

(A) the same. **(B)** reciprocal of each other.

(C) negative of each other. **(D)** complements of each other.

.

Ans: B $x_1(n) \overset{z}{\longleftrightarrow} X_1(z)$, RoC R_x

Reciprocals

$x_2(n) = x_1(-n) \overset{z}{\longleftrightarrow} X_1(1/z)$, RoC $1/R_x$

Q.6 The Fourier transform of the exponential signal $e^{jm_0 t}$ is

(A) a constant. **(B)** a rectangular gate.

(C) an impulse. **(D)** a series of impulses.

Ans: C Since the signal contains only a high frequency ω_o its FT must be an impulse at $\omega = \omega_o$

Q.7 If the Laplace transform of $f(t)$ is $\dfrac{\omega}{(s^2 + \omega 2)}$, then the value of $\lim\limits_{t \to \infty} f(t)$

(A) cannot be determined. **(B)** is zero.

(C) is unity. **(D)** is infinity.

Ans: B $f(t) \overset{L}{\longleftrightarrow} \dfrac{m}{s^2 + m^2}$

$$\lim_{t \to œ} f(t) = \lim_{s \to 0} s\,F(s) \quad \text{[Final value theorem]}$$

$$= \lim_{s \to 0} \frac{sm}{s^2 + m^2} = 0$$

Q.8 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)** $\dfrac{1 - e^{-at}}{a}$.

(C) $a\left(1-e^{-at}\right)$. **(D)** $1-e^{-at}$.

Ans: B

$h(t) = u(t); \quad x(t) = e^{-at} u(t), a > 0$

System response $y(t) = L^{-1}\left[\frac{1}{s}\cdot\frac{1}{s+a}\right]$

$= L^{-1}\frac{1}{a}\left[\frac{1}{s} - \frac{1}{s+a}\right]$

$= \frac{1}{a}(1 - e^{-at})$

Q.9 The z-transform of the function $\sum_{k=-\infty}^{0} \delta(n-k)$ has the following region of convergence

(A) $|z| > 1$ **(B)** $|z| = 1$

(C) $|z| < 1$ **(D)** $0 < |z| < 1$

Ans: C $x(n) = \sum_{k=-\infty}^{0} \delta(n-k)$

$x(z) = \sum_{k=-\infty}^{0} z^{-k} = \ldots.. + z^3 + z^2 + z + 1$ (Sum of infinite geometric series)

$= \frac{1}{1-z}, \quad |z| < 1$

Q.10 The auto-correlation function of a rectangular pulse of duration T is

(A) a rectangular pulse of duration T.
(B) a rectangular pulse of duration 2T.
(C) a triangular pulse of duration T.
(D) a triangular pulse of duration 2T.

Ans: D

$R_{XX}(\tau) = \frac{1}{T}\int_{-T/2}^{T/2} x(\tau)\, x(t+\tau)\, d\tau \Rightarrow$ triangular function of duration 2T.

Q.11 The Fourier transform (FT) of a function x (t) is X (f). The FT of $dx(t)/dt$ will be

(A) $dX(f)/df$. **(B)** $j2\pi f X(f)$.

(C) $jf X(f)$. **(D)** $X(f)/(jf)$.

Ans: B $x(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} X(f)\, e^{j\omega t}\, d\omega$

$\frac{dx}{dt} = \frac{1}{2\pi}\int_{-\infty}^{\infty} j\omega X(f)\, e^{j\omega t}\, d\omega$

$\therefore \frac{dx}{dt} \leftrightarrow j2\pi f X(f)$

Q.12 The FT of a rectangular pulse existing between $t = -T/2$ to $t = T/2$ is a

(A) sinc squared function. **(B)** sinc function.

(C) sine squared function. **(D)** sine function.

Ans: B $x(t) = \begin{cases} 1, & -\frac{T}{2} \text{ Ç } t \text{ Ç } \frac{T}{2} \\ 0, & \text{otherwise} \end{cases}$

$$X(jm) = \int_{-œ}^{+œ} x(t)\, e^{-jmt}\, dt = \int_{-T/2}^{+T/2} e^{-jmt}\, dt = \left.\frac{e^{-jmt}}{jm}\right|_{-T/2}^{+T/2}$$

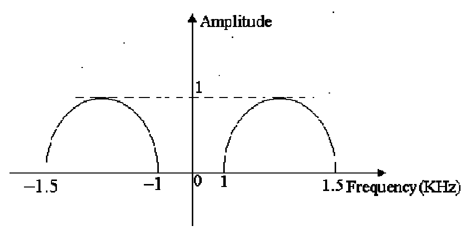
$$= -\frac{1}{jm}\left(e^{-jmT/2} - e^{jmT/2}\right) = \frac{2}{m}\; \frac{e^{jmT/2} - e^{-jmT/2}}{2j}$$

$$= \frac{2}{m} \sin\frac{mT}{2} = \frac{\sin(mT/2)}{mT/2}.T$$

Hence X(jm) is expressed in terms of a sinc function.

Q.13 An analog signal has the spectrum shown in Fig. The minimum sampling rate needed to completely represent this signal is

(A) 3 KHz.
(B) 2 KHz.
(C) 1 KHz.
(D) 0.5 KHz.



Ans: C For a band pass signal, the minimum sampling rate is twice the bandwidth, which is 0.5 kHz here.

Q.14 A given system is characterized by the differential equation:
$\frac{d^2y(t)}{dt^2} - \frac{dy(t)}{dt} - 2y(t) = x(t)$. The system is:

(A) linear and unstable. **(B)** linear and stable.
(C) nonlinear and unstable. **(D)** nonlinear and stable.

Ans:A $\frac{d^2y(t)}{dt^2} - \frac{dy(t)}{dt} - 2y(t) = x(t)$, $x(t) \longrightarrow \boxed{h(t)} \longrightarrow y(t)$
system

The system is linear . Taking LT with zero initial conditions, we get
$s^2Y(s) - sY(s) - 2Y(s) = X(s)$

or, $H(s) = \frac{Y(s)}{X(s)} = \frac{1}{s^2 - s - 2} = \frac{1}{(s-2)(s+1)}$

Because of the pole at s = +2, the system is unstable.

Q.15 The system characterized by the equation $y(t) = ax(t) + b$ is

(A) linear for any value of b. **(B)** linear if b > 0.
(C) linear if b < 0. **(D)** non-linear.

Ans: D The system is non-linear because x(t) = 0 does not lead to y (t) = 0, which is a violation of the principle of homogeneity.

Q.16 Inverse Fourier transform of $u(\omega)$ is

(A) $\frac{1}{2}\delta(t)+\frac{1}{\pi t}$. **(B)** $\frac{1}{2}\delta(t)$.

(C) $2\delta(t)+\frac{1}{\pi t}$. **(D)** $\delta(t)+\mathrm{sgn}(t)$.

Ans: A x(t) = u(t) $\xleftrightarrow{FT}$ X(jm) = n $\frac{6(m)}{}$ + $\frac{1}{Jm}$

Duality property: X(jt) $\longleftrightarrow$ 2n x(-m)

u(m) $\longleftrightarrow$ $\frac{1}{2}$6(t) + $\frac{1}{nt}$

Q.17 The impulse response of a system is $h(n) = a^n u(n)$. The condition for the system to be BIBO stable is

(A) a is real and positive. **(B)** a is real and negative.

(C) $|a| > 1$. **(D)** $|a| < 1$.

Ans: D Sum S = $\sum_{n=-œ}^{+œ}$ |h(n)| = $\sum_{n=-œ}^{+œ}$ | a^n u(n) |

$\leq \sum_{n=0}^{+œ} |a|^n$ (∵ u(n) = 1 for n Ç 0)

$\leq \frac{1}{1-|a|}$ if |a| < 1.

Q.18 If R_1 is the region of convergence of x (n) and R_2 is the region of convergence of y(n), then the region of convergence of x (n) convoluted y (n) is

(A) R_1+R_2. **(B)** R_1-R_2.

(C) $R_1 \cap R_2$. **(D)** $R_1 \cup R_2$.

Ans:C x(n) $\xleftrightarrow{z}$ X(z), RoC R_1

y(n) $\xleftrightarrow{z}$ Y(z), RoC R_2

x(n) * y(n) $\xleftrightarrow{z}$ X(z).Y(z), RoC at least R_1 fi R_2

Q.19 The continuous time system described by $y(t) = x(t^2)$ is

(A) causal, linear and time varying.
(B) causal, non-linear and time varying.
(C) non causal, non-linear and time-invariant.
(D) non causal, linear and time-invariant.

Ans: D

$y(t) = x(t^2)$

$y(t)$ depends on $x(t^2)$ i.e., future values of input if $t > 1$.

$\therefore$ System is anticipative or non-causal

$\alpha\, x_1(t) \rightarrow y_1(t) = \alpha\, x_1(t^2)$

$\beta\, x_2(t) \rightarrow y_2(t) = \beta\, x_2(t^2)$

$\therefore \alpha\, x_1(t) + \beta\, x_2(t) \rightarrow y(t) = \alpha x_1(t^2) + \beta\, x_2(t^2) = y_1(t) + y_2(t)$ $\because$

System is Linear

System is time varying. Check with $x(t) = u(t) - u(t\text{-}z) \rightarrow y(t)$ and

$x_1(t) = x(t-1) \rightarrow y_1(t)$ and find that $y_1(t) \neq y(t-1)$.

Q.20 If G(f) represents the Fourier Transform of a signal g (t) which is real and odd symmetric in time, then G (f) is

(A) complex. **(B)** imaginary.
(C) real. **(D)** real and non-negative.

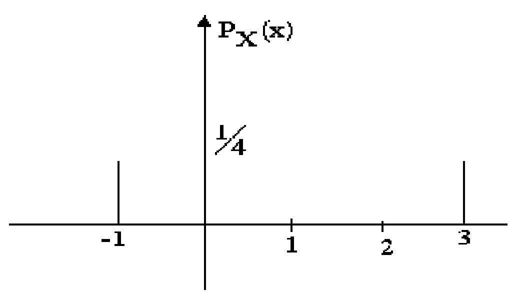
Ans: B $g(t) \xleftrightarrow{FT} G(f)$

g(t) real, odd symmetric in time

$G^*(jm) = -\,G(jm)$; $G(jm)$ purely imaginary.

Q.21 For a random variable x having the PDF shown in the Fig., the mean and the variance are, respectively,

(A) $\frac{1}{2}$ and $\frac{2}{3}$.
(B) 1 and $\frac{4}{3}$.
(C) 1 and $\frac{2}{3}$.
(D) 2 and $\frac{4}{3}$.



Ans:B Mean $= \mu_x(t) = \int_{-\infty}^{+\infty} x\, f_{x(t)}(x)\, dx$

$$= \int_{-1}^{3} x\, \frac{1}{4}\, dx = \frac{1}{4}\, \frac{x^2}{2}\Big|_{-1}^{3} = \frac{9}{2} - \frac{1}{2}\, \frac{1}{4} = 1$$

Variance $= \int_{-\infty}^{+\infty} (x - \mu_x)^2\, f_x(x)\, dx$

$$= \int_{-1}^{3} (x-1)^2\, \frac{1}{4}\, d(x-1)$$

$$= \frac{1}{4}\frac{(x-1)^3}{3}\Big|_{-1}^{3} = \frac{1}{12}[8+8] = \frac{4}{3}$$

Q.22 If white noise is input to an RC integrator the ACF at the output is proportional to

(A) $\exp\left\{\frac{-|\tau|}{RC}\right\}$. **(B)** $\exp\left\{\frac{-\tau}{RC}\right\}$.

(C) $\exp(|\tau| RC)$. **(D)** $\exp(-\tau RC)$.

Ans: A

$$R_N(1) = \frac{N_0}{4RC}\exp - \frac{|1|}{RC}$$

Q.23 $x(n) = a^{|n|}, |a| < 1$ is

(A) an energy signal.
(B) a power signal.
(C) neither an energy nor a power signal.
(D) an energy as well as a power signal.

Ans: A

$$\text{Energy} = \sum_{n=-\infty}^{+\infty} x^2(n) = \sum_{n=-\infty}^{\infty} a^{2|n|} = \sum_{n=-\infty}^{\infty} (a^2)^{|n|} = 1 + 2\sum_{n=1}^{\infty} a^2$$

$= \text{finite since } |a| < 1$

$\therefore$ This is an energy signal.

Q.24 The spectrum of x (n) extends from $-m_o$ to $+m_o$, while that of h(n) extends from $-2m_o$ to $+2m_o$. The spectrum of $y(n) = \sum_{k=-\infty}^{\infty} h(k)\, x(n-k)$ extends from

(A) $-4m_o$ to $+4m_o$. **(B)** $-3m_o$ to $+3m_o$.

(C) $-2m_o$ to $+2m_o$. **(D)** $-m_o$ to $+m_o$

.

Ans: D Spectrum depends on $H(e^{jm}) \longrightarrow X(e^{jm})$ Smaller of the two ranges.

Q.25 The signals $x_1(t)$ and $x_2(t)$ are both bandlimited to $(-m_1, +m_1)$ and $(-m_2, +m_2)$ respectively. The Nyquist sampling rate for the signal $x_1(t)\, x_2(t)$ will be

(A) $2m_1$ if $m_1 > m_2$. **(B)** $2m_2$ if $m_1 < m_2$.

(C) $2(m_1 + m_2)$. **(D)** $\frac{(m_1+m_2)}{2}$.

Ans: C Nyquist sampling rate = 2(Bandwidth) = $2(m_1 - (-m_2)) = 2(m_1 + m_2)$

Q.26 If a periodic function f(t) of period T satisfies $f(t) = -f\left(t + \frac{T}{2}\right)$, then in its Fourier series expansion,

(A) the constant term will be zero.
(B) there will be no cosine terms.
(C) there will be no sine terms.
(D) there will be no even harmonics.

Ans:

$$\frac{1}{T}\int_0^T f(t)\,dt = \frac{1}{T}\left[\int_0^{T/2} f(t)\,dt + \int_{T/2}^{T} f(t)\,dt\right] = \frac{1}{T}\left[\int_0^{T/2} f(t)\,dt + \int_0^{T/2} f(\tau + T/2)\,d\tau\right] = 0$$

Q.27 A band pass signal extends from 1 KHz to 2 KHz. The minimum sampling frequency needed to retain all information in the sampled signal is

(A) 1 KHz. **(B)** 2 KHz.
(C) 3 KHz. **(D)** 4 KHz.

Ans: B
Minimum sampling frequency = 2(Bandwidth) = 2(1) = 2 kHz

Q.28 The region of convergence of the z-transform of the signal $2^n u(n) - 3^n u(-n-1)$

(A) is $|z| > 1$. **(B)** is $|z| < 1$.
(C) is $2 < |z| < 3$. **(D)** does not exist.

Ans:

$$2^n u(n) \longleftrightarrow \frac{1}{1-2z^{-1}}, \quad |z| > 2$$

$$3^n u(-n-1) \longleftrightarrow \frac{1}{1-3z^{-1}}, \quad |z| < 3$$

$\therefore$ ROC is $2 < |z| < 3$.

Q.29 The number of possible regions of convergence of the function $\dfrac{(e^{-2} - 2)z}{(z - e^{-2})(z - 2)}$ is

(A) 1. **(B)** 2.
(C) 3. **(D)** 4.

Ans: C
Possible ROC's are $|z| > e^{-2}$, $|z| < 2$ and $e^{-2} < |z| < 2$

Q.30 The Laplace transform of u(t) is A(s) and the Fourier transform of u(t) is $B(j\omega)$. Then

(A) $B(j\omega) = A(s)\big|_{s=j\omega}$. **(B)** $A(s) = \dfrac{1}{s}$ but $B(j\omega) \neq \dfrac{1}{j\omega}$.
(C) $A(s) \neq \dfrac{1}{s}$ but $B(j\omega) = \dfrac{1}{j\omega}$. **(D)** $A(s) \neq \dfrac{1}{s}$ but $B(j\omega) \neq \dfrac{1}{j\omega}$.

Ans: B $u(t) \overset{L}{\Longleftrightarrow} A(s) = \dfrac{1}{s}$

$$u(t) \overset{F.T}{\Longleftrightarrow} B(jm) = \frac{1}{jm} + n\,6(m)$$

. $A(s) = \frac{1}{s}$ but $B(jm)$ Ç $\frac{1}{jm}$

Q.31 Given a unit step function u(t), its time-derivative is:

(A) a unit impulse.
(B) another step function.
(C) a unit ramp function.
(D) a sine function.

Ans: A

Q.32 The impulse response of a system described by the differential equation $\frac{d^2 y}{dt^2} + y(t) = x(t)$ will be

(A) a constant.
(B) an impulse function..
(C) a sinusoid.
(D) an exponentially decaying function.

Ans: C

Q.33 The function $\frac{\sin(\pi u)}{(\pi u)}$ is denoted by:

(A) sin c(nu).
(B) sin c(u).
(C) signum.
(D) none of these.

Ans: C

Q.34 The frequency response of a system with h(n) = 6(n) - 6(n-1) is given by

(A) 6(m) - 6(m - 1).
(B) $1 - e^{jm}$.
(C) u(m) – u(m -1).
(D) $1 - e^{-jm}$.

Ans: D

Q.35 The order of a linear constant-coefficient differential equation representing a system refers to the number of

(A) active devices.
(B) elements including sources.
(C) passive devices.
(D) none of those.

Ans: D

Q.36 z-transform converts convolution of time-signals to

(A) addition.
(B) subtraction.
(C) multiplication.
(D) division.

Ans: C

Q.37 Region of convergence of a causal LTI system

(A) is the entire s-plane.
(B) is the right-half of s-plane.
(C) is the left-half of s-plane.
(D) does not exist.

Ans: B

Q.38 The DFT of a signal x(n) of length N is X(k). When X(k) is given and x(n) is computed from it, the length of x(n)

(A) is increased to infinity **(B)** remains N

(C) becomes 2N – 1 **(D)** becomes N^2

Ans: A

Q.39 The Fourier transform of u(t) is

(A) $\frac{1}{j2\pi f}$. **(B)** j2nf.

(C) $\frac{1}{1+j2\pi f}$. **(D)** none of these.

Ans: D

Q.40 For the probability density function of a random variable X given by $f_x(x) = 5e^{-Kx}u(x)$, where u(x) is the unit step function, the value of K is

(A) $\frac{1}{5}$ **(B)** $\frac{1}{25}$

(C) 25 **(D)** 5

Ans: D

Q.41 The system having input x(n) related to output y(n) as $y(n) = \log_{10}|x(n)|$ is:

(A) nonlinear, causal, stable. **(B)** linear, noncausal, stable.

(C) nonlinear, causal, not stable. **(D)** linear, noncausal, not stable.

Ans: A

Q.42 To obtain x(4 – 2n) from the given signal x(n), the following precedence (or priority) rule is used for operations on the independent variable n:

(A) Time scaling < Time shifting < Reflection.

(B) Reflection < Time scaling < Time shifting.

(C) Time scaling < Reflection < Time shifting.

(D) Time shifting < Time scaling < Reflection.

Ans: D

Q.43 The unit step-response of a system with impulse response h(n) = 6(n) – 6(n – 1) is:

(A) 6(n – 1). **(B)** 6(n).

(C) u(n – 1). **(D)** u(n).

Ans: B

Q.44 If $\phi(\omega)$ is the phase-response of a communication channel and ω_c is the channel frequency, then $-\left.\frac{d\phi(\omega)}{d\omega}\right|_{\omega=\omega_c}$ represents:

(A) Phase delay
(B) Carrier delay
(C) Group delay
(D) None of these.

Ans: C

Q.45 Zero-order hold used in practical reconstruction of continuous-time signals is mathematically represented as a weighted-sum of rectangular pulses shifted by:

(A) Any multiples of the sampling interval.
(B) Integer multiples of the sampling interval.
(C) One sampling interval.
(D) 1 second intervals.

Ans: B

Q.46 If $x(t) \overset{\Im}{\leftrightarrow} X(s)$, then $\Im\left[\frac{dx(t)}{dt}\right]$ is given by:

(A) $\frac{dX(s)}{ds}$.
(B) $\frac{X(s)}{s} - \frac{x^{-1}(0)}{s}$.
(C) $sX(s) - x(0^{-})$.
(D) $sX(s) - sX(0)$.

Ans: C

Q.47 The region of convergence of the z-transform of the signal $x(n) = \{2, 1, 1, \underset{\underset{n=0}{\uparrow}}{2}\}$ is

(A) all z, except z = 0 and z = ∞
(B) all z, except z = 0.
(C) all z, except z = ∞.
(D) all z.

Ans: A

Q.48 When two honest coins are simultaneously tossed, the probability of two heads on any given trial is:

(A) 1
(B) $\frac{3}{4}$
(C) $\frac{1}{2}$
(D) $\frac{1}{4}$

Ans: D

Q.49 Let $u[n]$ be a unit step sequence. The sequence $u[N-n]$ can be described as

(A) $x[n] = \begin{cases} 1, & n < N \\ 0, & \text{otherwise} \end{cases}$
(B) $x[n] = \begin{cases} 1, & n \le N \\ 0, & \text{otherwise} \end{cases}$
(C) $x[n] = \begin{cases} 1, & n > N \\ 0, & \text{otherwise} \end{cases}$
(D) $x[n] = \begin{cases} 1, & n \ge N \\ 0, & \text{otherwise} \end{cases}$

Ans (B) $x[n] = \begin{cases} 1, & n \le N \\ 0, & \text{otherwise} \end{cases}$

Here the function $u(-n)$ is delayed by N units.

Q.50 A continuous-time periodic signal $x(t)$, having a period T, is convolved with itself. The resulting signal is

(A) not periodic
(B) periodic having a period T
(C) periodic having a period $2T$
(D) periodic having a period $T/2$

Ans (B) periodic having a period T
Convolution of a periodic signal (period T) with itself will give the same period T.

Q.51 If the Fourier series coefficients of a signal are periodic then the signal must be

(A) continuous-time, periodic
(B) discrete-time, periodic
(C) continuous-time, non-periodic
(D) discrete-time, non-periodic

Ans B) discrete-time, periodic
This is the property of the discrete-time periodic signal.

Q.52 The Fourier transform of a signal $x(t) = e^{2t}u(-t)$ is given by

(A) $\frac{1}{2-j\omega}$.
(B) $\frac{2}{1-j\omega}$
(C) $\frac{1}{j2-\omega}$
(D) $\frac{2}{j2-\omega}$

Ans (A) $\frac{1}{2-j\omega}$

FT $u(t) = \frac{1}{j\omega}$. Therefore, FT of $u(-t) = \frac{1}{-j\omega}$. If a function $x(t)$ is multiplied by e^{2t}, then its FT will be $F(j\omega)\big|_{j\omega \to j\omega - 2}$. Hence the answer.

Q.53 For the function $H(j\omega) = \frac{1}{2 + 2j\omega + (j\omega)^2}$, maximum value of group delay is

(A) 1
(B) 1/2
(C) 2
(D) 3

Ans None of the given answers is correct.

Q.54 A continuous-time signal $x(t)$ is sampled using an impulse train. If $X(j\omega)$ is the Fourier transform of $x(t)$, the spectrum of the sampled signal can be expressed as

(A) $\sum_{k=-\infty}^{\infty} X(j\omega + k\omega_s)\delta(\omega)$
(B) $\sum_{k=-\infty}^{\infty} X(jk\omega) * \delta(\omega + k\omega_s)$
(C) $\sum_{k=-\infty}^{\infty} X(j\omega) * \delta(\omega + k\omega_s)$
(D) $\sum_{k=-\infty}^{\infty} X(j\omega)\delta(\omega + k\omega_s)$

Ans (A) $\sum_{k=-\infty}^{\infty} X(j\omega + k\omega_s)\delta(\omega)$

Since the spectrum consists of various harmonics $k = -\infty$ to ∞ and discretely spread at an interval of fundamental frequency f_s. Hence the answer.

Q.55 The region of convergence of a causal finite duration discrete-time signal is

(A) the entire z-plane except $z = 0$
(B) the entire z-plane except $z = \infty$
(C) the entire z-plane
(D) a strip in z-plane enclosing $j\omega$-axis

Ans (A) The entire z-plane except $z = 0$

$X(z) = \sum_{n=n_1}^{n_2} x[n]z^{-n}$. This sum should converge provided each term in the sum is finite. However, if there is a non-zero causal component for $n_2>0$, then $X(z)$ will have a term involving z^{-1} and thus ROC cannot include $z = 0$.

Q.56 Let $H(e^{j\omega})$ be the frequency response of a discrete-time LTI system, and $H_I(e^{j\omega})$ be the frequency response of its inverse. Then,

(A) $H(e^{j\omega})H_I(e^{j\omega}) = 1$ **(B)** $H(e^{j\omega})H_I(e^{j\omega}) = \delta(\omega)$
(C) $H(e^{j\omega}) * H_I(e^{j\omega}) = 1$ **(D)** $H(e^{j\omega}) * H_I(e^{j\omega}) = \delta(\omega)$

Ans (A) $H(e^{j\omega})H_I(e^{j\omega}) = 1$

Since $H(e^{j\omega})$ and $H_I(e^{j\omega})$ are the inverse of each other, their product should equal 1.

Q.57 The transfer function of a stable system is $H(z) = \frac{1}{1-0.5z^{-1}} + \frac{1}{1-2z^{-1}}$.
Its impulse response will be

(A) $(0.5)^n u[n] + (2)^n u[n]$ **(B)** $-(0.5)^n u[-n-1] + (2)^n u[n]$
(C) $(0.5)^n u[n] - (2)^n u[-n-1]$ **(D)** $-(0.5)^n u[-n-1] - (2)^n u[-n-1]$

Ans (C) $(0.5)^n u[n] - (2)^n u[-n-1]$

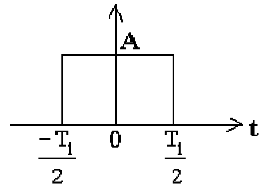
(A) and (C) are the possible IFTs of the given system function. However, the system is stable; therefore (C) is the only correct answer.

Q.58 The probability cumulative distribution function must be monotone and

(A) increasing **(B)** decreasing
(C) non-increasing **(D)** non-decreasing

Ans (D) non-decreasing
The probability cumulative distribution function increases to 1 monotonically and there after remains constant.

Q.59 The average power of the following signal is



(A) $\frac{A^2}{2}$ **(B)** A^2

(C) AT_1^2 **(D)** A^2T_1

Ans: (D)

$$W = \int_{-T_1/2}^{T_1/2} x(t)^2\,dt = A^2T_1$$

Q.60 Convolution is used to find:

(A) The impulse response of an LTI System

(B) Frequency response of a System

(C) The time response of a LTI system

(D) The phase response of a LTI system

Ans: (C)

Time response $$y(n) = x(n) * h(n) = \sum_{k=-\infty}^{k=\infty} x(k)h(n-k)$$

Q.61 The Fourier Transform of a rectangular pulse is

(A) Another rectangular pulse **(B)** Triangular pulse

(C) Sinc function **(D)** Impulse.

Ans: (C)

This can be seen by putting the value of pulse function in the definition of Fourier transform.

Q.62 The property of Fourier Transform which states that the compression in time domain is equivalent to expansion in the frequency domain is

(A) Duality. **(B)** Scaling.

(C) Time Scaling. **(D)** Frequency Shifting.

Ans: (B)

Substituting the square pulse function $f(t)$ in

$$F(j\omega) = \int_{-\infty}^{\infty} f(t)e^{j\omega t}\,dt$$

gives the sinc function.

Q.63 What is the Nyquist Frequency for the signal

$x(t)$ =3 cos 50nt +10 sin 300nt – cos100nt ?

(A) 50 Hz **(B)** 100 Hz

(C) 200 Hz **(D)** 300 Hz

Ans: (D) Here the highest frequency present in the signal is $\omega_m = 300\pi$ or $f_m = 150$ Hz. Therefore the Nyquist frequency $f_s = 2f_m = 300$ Hz.

Q.64 The step response of a LTI system when the impulse response $h(n)$ is unit step $u(n)$ is

(A) $n+1$ **(B)** n

(C) $n-1$ **(D)** n^2

Ans: (A)

$$y(n) = x(n) * h(n) = u(n) * u(n) = \sum_{k=-\infty}^{\infty} u(k)u(n-k) = \sum_{k=0}^{6} u(k)u(n-k)$$

$$y(0) = 1, y(1) = 2, y(2) = 3, \ldots, y(n) = (n+1)$$

$$y(n) = (n+1)\ .$$

Q.65 The Laplace transform of $u(t)$ is

(A) $\frac{1}{s}$ **(B)** s^2

(C) $\frac{1}{s^2}$ ***(D)*** s

Ans: (A)

Substituting $f(t) = u(t)$ in the relation $F(s) = \int_o^{\infty} f(t)e^{-st}\,dt$ gives the answer.

Q.66 The function which has its Fourier transform, Laplace transform, and Z transform unity is

(A) Gausian **(B)** impulse

(C) Sinc **(D)** pulse

Ans: (B)

Substituting $f(t) = \delta(t)$ in the definitions of Fourier, Laplace and Z-transform, we get the transforms in each case as 1.

Q.67 The Z transform of $\delta(n-m)$ is

(A) z^{-n} **(B)** z^{-m}

(C) $\frac{1}{z-n}$ **(D)** $\frac{1}{z-m}$

Ans: (B)

The Z-transform of a delayed function $f(n-m)$ is z^{-m} times the Z-transform of the function $f(n)$.

Q.68 If the joint probability pdf of $f(x,y) = \frac{1}{4},\ 0 \le x,\ y \le 2,\ P(x+y \le 1)$ is

(A) $\frac{1}{8}$ **(B)** $\frac{1}{16}$

(C) $\frac{1}{4}$ **(D)** $\frac{1}{2}$

Ans: (A)

$$P(x+y)=\int_0^1\int_0^{1-y}\frac{1}{4}dxdy=\frac{1}{4}\int_0^1 x\Big|_0^{1-y}dy=\frac{1}{4}\int_0^1(1-y)dy=\frac{1}{8}.$$

Q.69 The period of the signal $x(t)=10\sin 12\pi t+4\cos 18\pi t$ is

(A) $\frac{\pi}{4}$ **(B)** $\frac{1}{6}$

(C) $\frac{1}{9}$ **(D)** $\frac{1}{3}$

Ans: (D)

There are two waveforms of frequencies 6 and 9, respectively. Hence the combined frequency is the highest common factor between 6 and 9,i.e., 3. Hence period is 1/3.

Q.70 The autocorrelation of a rectangular pulse is

(A) another rectangle pulse **(B)** Square pulse

(C) Triangular pulse **(D)** Sinc pulse

Ans: (C)

Autocorrelation involves the integration of a constant which gives a ramp function. Hence the triangular pulse.

Q.71 If the Fourier series coefficients of a signal are periodic then the signal must be

(A) continuous-time, periodic **(B)** discrete-time, periodic

(C) continuous-time, non periodic **(D)** discrete-time, non perodic

Ans: (B)

It is the property of the discrete-time periodic signal.

Q.72 The area under the curve $\int_{-\infty}^{\infty}\delta(t)dt$ is

(A) ∞ **(B)** unity

(C) 0 **(D)** undefined

Ans: (B)

By definition of delta function, $\int_{-\infty}^{\infty}\delta(t)=1$

Q.73 A transmission is said to be_______________if the response of the system is exact replica of the input signal.

(A) LTI **(B)** Distorted

(C) Distortionless **(D)** Causal

Ans: (C)

Since $y(n)=x(n)$.

Q.74 Laplace Transform of t^n is always equal to

(A) $\frac{n}{s^n}$ **(B)** $\frac{n!}{s^n}$

(C) $\frac{n!}{s^{n+1}}$ **(D)** All

Ans: (C)

$$\pounds\, t^n = \int_0^\infty t^n e^{-st} dt = \frac{n!}{s^{n+1}}$$

Q.75 For a stable system

(A) $|z| < 1$ **(B)** $|z| = 1$

(C) $|z| > 1$ **(D)** $|z| \neq 1$

Ans: (A)

For the system to be stable, the ROC should include the unit circle.

Q.76 The region of convergence of a causal finite duration discrete time signal is

(A) The entire 'z' plane except z = 0

(B) The entire 'z' plane except z = ∞

(C) The entire 'z' plane

(D) A strip in z-plane

Ans: (A)

The ROC of the causal finite duration will have negative power of z. The ROC is the entire z-plane except z = 0.

Q.77 The CDF for a certain random variable is given as

$$F_X(x) = \begin{cases} 0, & -\infty < x \le 0 \\ kx^2, & 0 < x \le 10 \\ 100k, & 10 < x < \infty \end{cases}$$

The value of k is

(A) 100 **(B)** 50

(C) 1/50 **(D)** 1/100

Ans: (D)

From the given F(x), we get

$$\frac{dF(x)}{dx} = 0 + 2kx + 0 = 2kx$$

$$\therefore \int_0^{10} 2kx\,dx = 1$$

or $100k = 1 \rightarrow k = 1/100$

Q.78 The group delay function $\tau(\omega)$ is related to phase function $\phi(\omega)$ as

(A) $\tau(\omega) = \frac{-d}{d\omega}\phi(\omega)$ **(B)** $\tau(\omega) = \frac{d}{d\omega^2}\phi(\omega)$

(C) $\tau(\omega) = \frac{d^2}{d\omega^2}\phi(\omega)$ **(D)** $\tau(\omega) = \frac{d}{d\omega}\phi(\omega)$

Ans: (A): By definition.

Q.79 Two sequences $x_1(n)$ and $x_2(n)$ are related by $x_2(n) = x_1(-n)$. In the Z-domain, their ROCs are

(A) same **(B)** reciprocal of each other
(C) negative of each other **(D)** complement of each other

Ans: (B)

ROC of $Z[x_2(n)]$ is outside the circle of radius r2 while ROC of $Z[x_1(-n)]$ is inside the circle of radius r1 such that r2 = 1/ r1.

Q.80 The autocorrelation of a sinusoid is

(A) Sinc pulse **(B)** another sinusoid
(C) Rectangular pulse **(D)** Triangular pulse

Ans: (B)

$$\phi_{XX}(t) = \int_{-\infty}^{\infty} x(\tau)x(\tau - t)d\tau$$
$$= \int_{-\infty}^{\infty} A\sin\omega\tau \times A\sin\omega(\tau - t)d\tau$$
$$= \frac{A^2}{2}\int_{-\infty}^{\infty} [(\cos t - \cos 2\omega\tau.\cos t - \sin 2\omega\tau.\sin t]d\tau$$
$$= \frac{A^2}{2}K\left[\int_{-\pi}^{\pi} [(\cos t - \cos 2\omega\tau.\cos t - \sin 2\omega\tau.\sin t]d\tau\right]$$
$$= \frac{A^2}{2}K\left[\int_{-\pi}^{\pi} [\cos t]d\tau\right] = K'\cos t$$

Thus the autocorrelation is a sinusoid.

Q.81 Which of the following is true for the system represented by $y(n) = x(-n)$

(A) Linear **(B)** Time invariant
(C) Causal **(D)** Non Linear

Ans.: (A)

The given function is of the form $y = mx$. Hence linear.

Q.82 The Fourier transform of impulse function is

(A) $\delta(\omega)$ **(B)** $2\pi\omega$
(C) 1 **(D)** $\text{sinc} f$

Ans: (C)

FT of $\delta(t) = \int_{-\infty}^{\infty} \delta(t)e^{-j\omega t}dt = 1$

Q.83 Convolution is used to find

(A) amount of similarity between the signals

(B) response of the system
(C) multiplication of the signals
(D) Fourier transform

Ans: (B)

Convolution of the input signal $x(n)$ and the impulse response $h(n)$ is given by

$y(n) = x(n) * h(n) = \sum_{k=-\infty}^{\infty} x(k)h(n-k)$, where $y(n)$ is the response of the system.

Q.84 The final value of $x(t) = \left[2 + e^{-3t}\right]u(t)$ is

(A) 2 **(B)** 3

(C) e^{-3t} **(D)** 0

Ans: (A)

Final value = $\mathrm{Lt}_{t\to\infty} x(t) = \mathrm{Lt}_{t\to\infty}\left[2 + e^{-3t}\right]u(t) = 2$.

Q.85 Discrete time system is stable if the poles are

(A) within unit circle **(B)** outside unit circle
(C) on the unit circle **(D)** None

Ans: (A)

The ROC should include the unit circle.

Q.86 The z transform of $-u(-n-1)$ is

(A) $\frac{1}{1-z}$ **(B)** $\frac{z}{1-z}$

(C) $\frac{1}{1-z^{-1}}$ ***(D)*** $\frac{z}{1-z^{-1}}$

Ans: (C)

$$z[-u(-n-1)] = -\sum_{n=-1}^{-\infty}[u(-n-1)]z^{-n} = -[z + z^2 + z^3 + \ldots] = \frac{z}{z-1} = \frac{1}{1-z^{-1}}$$

Q.87 The area under Gaussian pulse $\int_{-\infty}^{\infty} e^{-\pi t^2} dt$ is

(A) Unity **(B)** Infinity
(C) Pulse **(D)** Zero

Ans: (A)

$$\int_{-\infty}^{\infty} e^{-\pi t^2} dt = \int_{-\infty}^{\infty} e^{-x} 2\pi\sqrt{\frac{x}{\pi}}dx = 2\sqrt{\pi}\int_{-\infty}^{\infty}\sqrt{x}e^{-x}dx = 1.$$

Q.88 The spectral density of white noise is

(A) Exponential **(B)** Uniform
(C) Poisson **(D)** Gaussian

Ans: (B)

The distribution of White noise is homogeneous over all frequencies. Power spectrum is the Fourier transform of the autocorrelation function. Therefore, power spectral density of white noise is uniform.