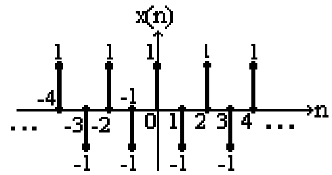
SIGNAL AND SYSTEM IMPORTANT 30 MCQ PDF WITH SOLUTION

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

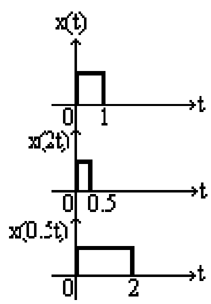


Q.2 The frequency of a continuous time signal x (t) changes on transformation from x (t) to x (α t), $\alpha > 0$ by a factor

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

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

a > 1 $\Rightarrow$ compression in t, expansion in f by a.
a < 1 $\Rightarrow$ 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.

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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 $\frac{\omega}{(s^2 + \omega^2)}$, then the value of $\lim_{t \to \infty} f(t)$

(A) cannot be determined. **(B)** is zero.
(C) is unity. **(D)** is infinity.

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

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

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

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)** $\frac{1-e^{-at}}{a}$.

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

Ans: B

$h(t) = u(t)$; $x(t) = e^{-at}u(t)$, 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 $x(n) = \sum_{k=-\infty}^{0}\delta(n-k)$

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

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

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 $(t) = \frac{1}{2n} ƒ_{-œ}^{œ} X(f)\, e^{jmt}\, dm$

$$\frac{dx}{dt} = \frac{1}{2n} ƒ_{-œ}^{œ} jm\, X(f)\, e^{jmt}\, dm$$

$\therefore \frac{dx}{dt} \leftrightarrow j\, 2n\, f\, X(f)$

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

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

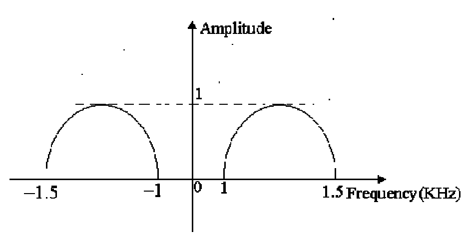
$$= -\frac{1}{jm}\left(e^{-jmT/2} - e^{jmT/2}\right) = \frac{2}{m}\left(\frac{e^{jmT/2} - e^{-jmT/2}}{2j}\right)$$

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

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 0.5kHz 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 $\frac{d^2y(t)}{dt^2} - \frac{dy(t)}{dt} - 2y(t) = x(t)$, $x(t) \rightarrow \underbrace{\boxed{h(t)}}_{\text{system}} \rightarrow y(t)$

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)** $\delta(t) + \text{sgn}(t)$.

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

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 $S = \sum_{n=-\infty}^{+\infty} |h(n)| = \sum_{n=-\infty}^{+\infty} |a^n u(n)|$

$\leq \sum_{n=0}^{+\infty} |a|^n \quad (\because u(n) = 1 \text{ for } n \geq 0)$

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

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 $x(n) \overset{z}{\longleftrightarrow} X(z)$, RoC R_1

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

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

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 <u>non-causal</u>

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

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

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

System is <u>Linear</u>

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

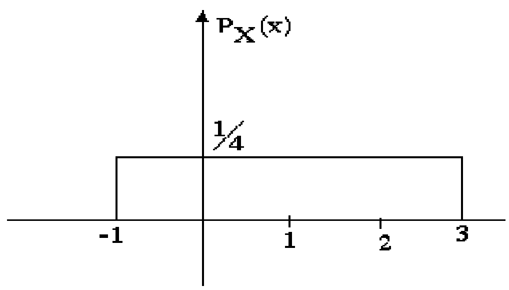
Ans:B $g(t) \xleftrightarrow{FT} G(f)$

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

Ans: A

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

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

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

= finite since $|a| < 1$

$\therefore$ This is an energy signal.

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

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

(C) $-2\omega_o$ to $+2\omega_o$. **(D)** $-\omega_o$ to $+\omega_o$

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

Q.25 The signals $x_1(t)$ and $x_2(t)$ are both bandlimited to $(-\omega_1, +\omega_1)$ and $(-\omega_2, +\omega_2)$ respectively. The Nyquist sampling rate for the signal $x_1(t)\, x_2(t)$ will be

(A) $2\omega_1$ if $\omega_1 > \omega_2$. **(B)** $2\omega_2$ if $\omega_1 < \omega_2$.

(C) $2(\omega_1 + \omega_2)$. **(D)** $(\omega_1 + \omega_2)/2$.

Ans: C Nyquist sampling rate = 2(Bandwidth) = $2(\omega_1 - (-\omega_2)) = 2(\omega_1 + \omega_2)$

Q.26 If a periodic function f(t) of period T satisfies $f(t) = -f\left(t + T/2\right)$, 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 $\dfrac{\left(e^{-2} - 2\right)z}{\left(z - e^{-2}\right)\left(z - 2\right)}$ 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) $A(s) = \frac{1}{s}$ but $B(j\omega) \neq \frac{1}{j\omega}$.

(C) $A(s) \neq \frac{1}{s}$ but $B(j\omega) = \frac{1}{j\omega}$.

(D) $A(s) \neq \frac{1}{s}$ but $B(j\omega) \neq \frac{1}{j\omega}$.

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

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

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