POSTAL Book Package 2023

Electrical Engineering

Objective Practice Sets

Communication Systems

Contents

MADE EASY Publications

1 CHAPTER

Communication Systems

Fourier Analysis of Signals, Energy and Power Signals

Q.1 A signal is such that $x(t) = x(t + T_0/2)$, it is also given that it is even in nature. The Fourier series expansion has
(a) absent sine term
(b) absent cos term
(c) only odd harmonics
(d) odd term of cos as $\Sigma\, a_n \cos n\omega$

Q.2 Let $x(t)$ be a periodic signal with fundamental period T and Fourier series coefficient of Re$\{x(t)\}$ (where Re denotes the real part of signal) is

(a) $\dfrac{a_k + a_k^*}{2}$ (b) $\dfrac{a_k - a_{-k}^*}{2}$

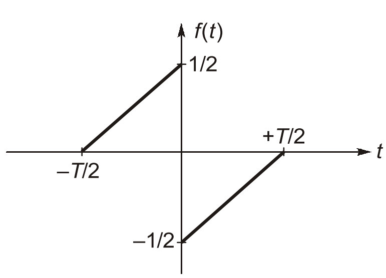
(c) $\dfrac{a_k^* + a_{-k}}{2}$ (d) $\dfrac{a_k^* - a_k}{2}$

Q.3 If $G(t)$ represents the Fourier transform of a signal $g(t)$ which is real and odd symmetric in time then
(a) $G(f)$ is complex
(b) $G(f)$ is imaginary
(c) $G(f)$ is real
(d) $G(f)$ is real and non-negative

Q.4 The amplitude spectrum of Gaussian pulse is
(a) uniform (b) a sine function
(c) Gaussian (d) an impulse function

Q.5 A signum function is
(a) zero for t greater than zero
(b) zero for t less than zero
(c) unity for t greater than zero
(d) $2u(t) - 1$

Q.6 A function $f(t)$ is shown in figure.

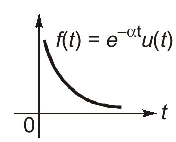


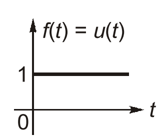
The Fourier transform $F(\omega)$ of $f(t)$ is
(a) real and even function of ω
(b) real and odd function of ω
(c) imaginary and odd function of ω
(d) imaginary and even function of ω

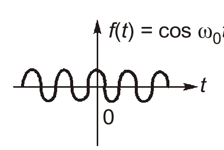
Q.7 What is the autocorrelation function of a rectangular pulse of duration T?
(a) A rectangular pulse of duration $2T$
(b) A rectangular pulse of duration T
(c) A triangular pulse of duration $2T$
(d) A triangular pulse of duration T

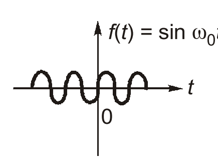
Q.8 In connection with properties of the Fourier transform, match **List-I (Function of Time)** with **List-II (Spectral Density Function)** and select the correct answer using the code given below the lists:

List-I

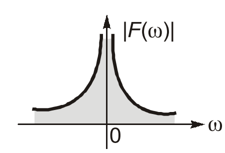
A. 

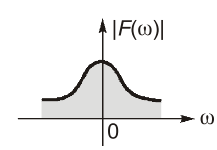
B. 

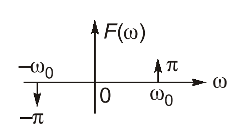
C. 

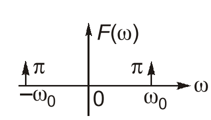
D. 

List-II

1. 

2. 

3. 

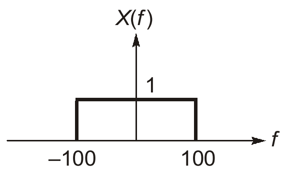
4. 

Codes:

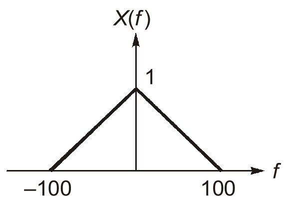
	A	B	C	D
(a)	1	3	2	4
(b)	2	1	4	3
(c)	1	3	4	2
(d)	2	1	3	4

Q.23 Frequency spectrum of signal $\frac{100}{\pi^2}\text{sinc}^2(100t)$ is

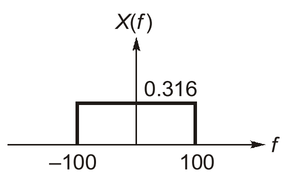
(a)



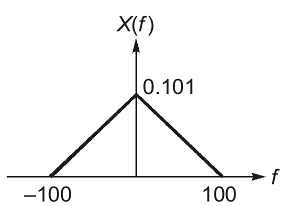
(b)



(c)



(d)



Q.24 Consider the following statements:
1. With the increase in signaling rate, the width of each pulse is reduced.
2. A signal can be band limited or time limited or both band limited and time limited simultaneously.
3. Differentiating the signal in time domain is equivalent to multiplying its Fourier transform by $(j2pf)$.
4. Compression in time domain results in expansion of frequency spectrum and vice-versa.

Which of the above statements is/are **not** correct?
(a) 1 and 3 (b) 2 and 4
(c) 3 only (d) 2 only

Q.25 Assertion (A): The Parseval's theorem implies superposition of the average powers.
Reason (R): The interpretation of the Parseval's theorem is that the total average power of the signal $x(t)$ can be found by squaring and adding the heights of the amplitude lines in the spectrum of the periodic signal $x(t)$.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is **not** the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

Q.26 Assertion (A): If two signals are orthogonal they will also be orthonormal.
Reason (R): If two signals are orthonormal they also will be orthogonal.
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not a correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Answers **Fourier Analysis of Signals, Energy and Power Signals**

1. (d)	2. (a)	3. (b)	4. (c)	5. (d)	6. (c)	7. (c)	8. (b)	9. (b)
10. (b)	11. (b)	12. (d)	13. (d)	14. (a)	15. (a)	16. (c)	17. (a)	18. (b)
19. (d)	20. (b)	21. (b)	22. (b)	23. (d)	24. (d)	25. (a)	26. (d)	

Explanations **Fourier Analysis of Signals, Energy and Power Signals**

1. (d)

$$x(t) = x\left(t+\frac{T_0}{2}\right)$$

where T_0 is fundamental period.

$\Rightarrow x(t)$ is half wave symmetric,

it consists of only odd harmonics. ...(1)

Also, $x(t)$ is even, thus contains only cosine terms ...(2)

$\therefore x(t)$ contains only odd cosine terms.

$$x(t) = \sum_{n=0}^{\infty} a_n \cos nw,\ n = \text{odd}.$$

2. (a)

$$x(t) \longleftrightarrow a_k$$

$$x(t) = R_c(x(t)) + jI_m(x(t))$$

$$x^*(t) = R_c(x(t)) - jI_m(x(t))$$

$$x(t) \longleftrightarrow a_k$$

$$x^*(t) \longleftrightarrow a_k^*(t)$$

$$x(t) + x^*(t) \longleftrightarrow a_k + a_k^*$$

$$2R_c(x(t)) \longleftrightarrow a_k + a_k^*$$

$$R_c(x(t)) \longleftrightarrow \frac{a_k + a_k^*}{2}$$

3. (b)

Function, *g(t)*	Fourier Transform, *G(f)*
Real and odd	Imaginary and odd
Real and even	Real and even
Imaginary and odd	Real and odd
Imaginary and even	Imaginary and even

4. (c)

Amplitude spectrum of Gaussian pulse is Gaussian.

5. (d)

$$Sgn(t) = \begin{bmatrix} 1 & t>0 \\ -1 & t<0 \end{bmatrix}$$

$$Sgn(t) = 2u(t) - 1$$

6. (c)

Signal is odd, $x(t) = -x(-t)$

Signal is half symmetric

$$x(t) = x\left(t+\frac{T_0}{2}\right)$$

$\therefore$ contains odd harmonic.

Signal $f(t)$ is real and odd,

$\therefore F(\omega)$ is imaginary and odd.

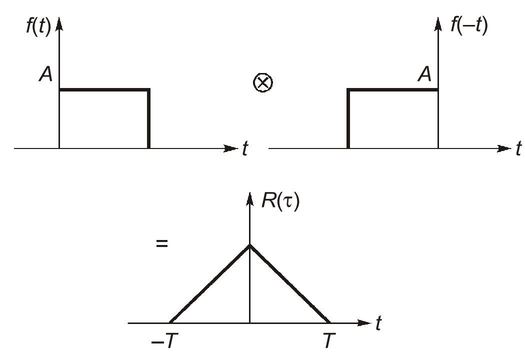
7. (c)

Autocorrelation,

$$R(\tau) = f(t) \otimes f(-t)$$

$$= \int_{-\infty}^{\infty} f(t)\cdot f(t-T)\,dt$$

i.e. convolution with the inverted version of signal itself.



8. (b)

$$F[e^{-at}u(t)] = \frac{1}{\sqrt{a^2+\omega^2}}e^{-j\tan^{-1}\frac{\omega}{a}}$$

$$F[u(t)] = \pi\delta(\omega) + \frac{1}{j\omega}$$

$$F[\cos\omega_0 t] = \pi\delta(\omega-\omega_0) + \pi\delta(\omega+\omega_0)$$

$$F[\sin\omega_0 t] = j\pi[\delta(\omega-\omega_0) - \delta(\omega+\omega_0)]$$

9. (b)

Operation	$x(t)$	$X(\omega)$/Fourier transform
• Time shift	$x(t-t_0)$	$e^{-j\omega t_0}X(\omega)$
• Time differerentiation	$\frac{d^n x(t)}{dt^n}$	$(j\omega)^n X(\omega)$
• Time integration	$\int_{-\infty}^{t} x(\tau)\,d\tau$	$\frac{1}{j\omega}X(\omega) + \pi X(0)\,\delta(\omega)$
• Frequency shift	$x(t)e^{j\omega_0 t}$	$X(\omega-\omega_0)$