POSTAL
BOOK PACKAGE
2025

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ELECTRICAL ENGINEERING

Objective Practice Sets

Communication Systems

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1 CHAPTER

Fourier Analysis of Signals, Energy and Power Signals

Q.1 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) $\frac{a_k + a_k^*}{2}$ (b) $\frac{a_k - a_{-k}^*}{2}$

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

Q.2 If $G(f)$ 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

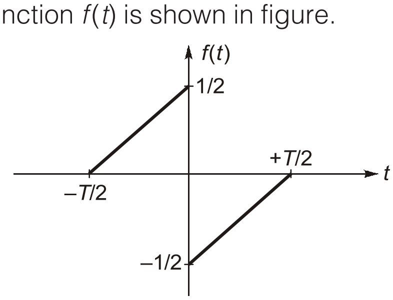
Q.3 The amplitude spectrum of Gaussian pulse is

(a) uniform (b) a sine function
(c) Gaussian (d) an impulse function

Q.4 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.5 A function $f(t)$ is shown in figure.



The Fourier transform $F(\omega)$ of $f(t)$ is

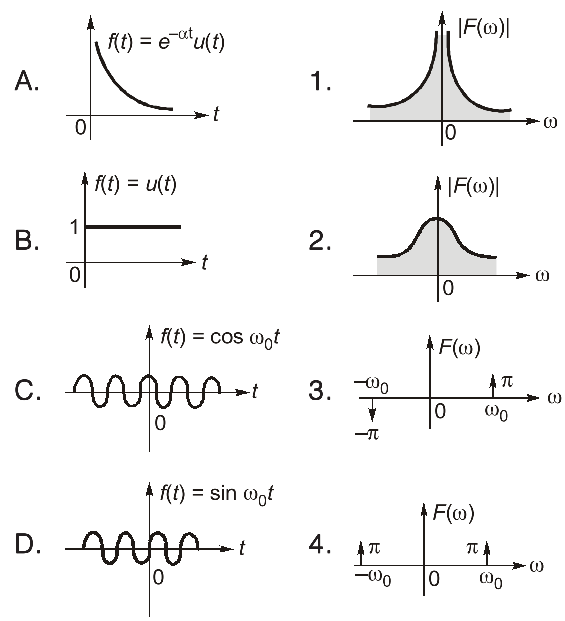
(a) real and even function of ω
(b) real and odd function of ω
(c) imaginary and odd function of ω
(d) imaginary and even function of ω

Q.6 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.7 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 **List-II**



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.8 Match **List-I (Operations on $x(t)$)** with **List-II ($X(\omega)$/Fourier transform)** and select the correct answer using the codes given below the lists:

List-I	List-II
A. Time shift	1. $\frac{1}{j\omega}X(\omega) + \pi X(0)\,\delta(\omega)$
B. Time differentiation	2. $e^{-j\omega t_0}X(\omega)$
C. Time integration	3. $X(\omega - \omega_0)$
D. Frequency shift	4. $(j\omega)^n X(\omega)$

Answers — Fourier Analysis of Signals, Energy and Power Signals

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

Explanations — Fourier Analysis of Signals, Energy and Power Signals

1. (a)

$$x(t) \longleftrightarrow a_k$$

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

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

$$x(t) \longleftrightarrow a_k$$

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

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

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

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

2. (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

3. (c)

Amplitude spectrum of Gaussian pulse is Gaussian.

4. (d)

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

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

5. (c)

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

Signal is half symmetric

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

∴ contains odd harmonic.

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

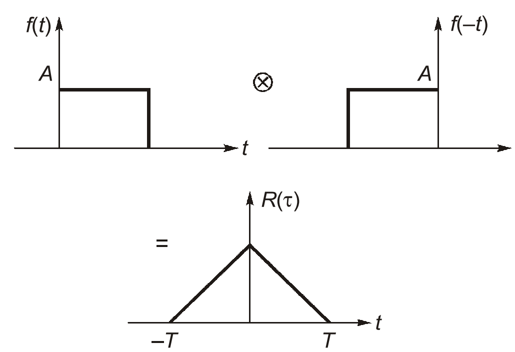
∴ $F(\omega)$ is imaginary and odd.

6. (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.



7. (b)

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

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

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

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

8. (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	$x(t) e^{j\omega_0 t}$	$X(\omega - \omega_0)$

10. (b)

$$\text{Power} = \sum_{n=-\infty}^{\infty} |C_n| = \frac{1}{T}\int_{-T/2}^{T/2} |f(t)|^2\, dt$$

$$= |C_{-2}|^2 + |C_2|^2 + |C_1|^2 + |C_{-1}|^2 + |C_0|^2$$

$$= 2^2 + 2^2 + 8^2 + 8^2 + 0^2 = 136$$