

UNIVERSITY OF JORDAN
DEPARTMENT OF ELECTRICAL ENGINEERING
SIGNALS AND SYSTEMS
30 MARKS

23/4/2013

SECOND EXAM

DR. MAHMOUD AL-HUSARI

NAME: محمد الحسين

SERIAL No. 50
0119203

Please write your name in arabic

SERIAL No.

- SECTION: SECTION 1, SUN, TUE, THUS 09:00-10:00
 SECTION 2, SUN, TUE, THUS 11:00-12:00
 SECTION 3, MON, WED 09:30-11:00

12x1.5

Write your answers here

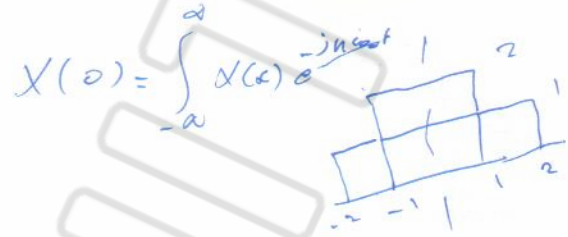
1	d	2	a	3	b	4	c	5	a	6	d	7	a
8	c	9	b	10	c	11	e	12	b	13	b	14	c
15	a	16	b	17	c	18	a	19	b	20	b	21	d
22	d												

18
30

1. Given that $X(\omega) = \frac{\cos(4\omega) \sin(2\omega)}{\omega}$, find the value of $\int_{-\infty}^{\infty} x(t) dt$

- a. 1
- b. zero
- c. 1/2
- d. infinity
- e. 2

$\cdot \frac{\sin 2\omega}{\omega}$



2. A signal $x(t)$ can be written as

$$x(t) = \frac{1}{2} + \cos t - \frac{1}{3} \cos 3t + \frac{1}{5} \cos 5t - \frac{1}{7} \cos 7t + \dots$$

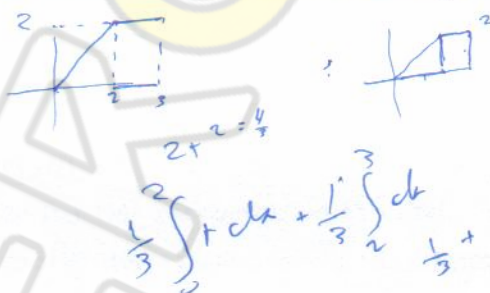
What is the power in the signal UP TO the fundamental harmonic?

- a. 5/4
- b. 5/8
- c. 3/4
- d. 3/8
- e. none of these

Handwritten notes: $x(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} X(\omega) e^{j\omega t} d\omega$
 $2\pi x(t) = \int_{-\infty}^{\infty} X(\omega) e^{j\omega t} d\omega$
 $2\pi x(-\frac{\pi}{2})$
 $\frac{\pi}{2} \quad \frac{2\pi}{3} = \frac{1}{3}$

3. Let $x(t) = \begin{cases} t, & 0 \leq t \leq 2 \\ 1, & 2 < t \leq 3 \end{cases}$, be a periodic function with fundamental period equal to 3. The average value of the signal is

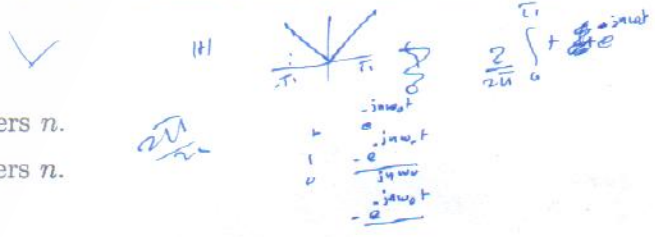
- a. 3
- b. 1
- c. none of these
- d. 2
- e. 6



Handwritten calculation: $\frac{2+2}{3} = \frac{4}{3}$
 $\frac{2}{3} + \frac{2}{3} = \frac{4}{3}$
 $\frac{2}{3} + \frac{2}{3} = \frac{4}{3}$
 $\frac{4}{6} + \frac{2}{6} = \frac{6}{6} = 1$

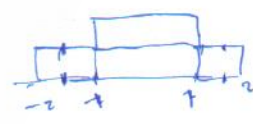
4. A periodic function is given over one period by $x(t) = |t|$, $-\pi < t < \pi$. Which of the following statements is correct for the trigonometric Fourier series of $x(t)$

- a. $a_n = 0$ for $n = 0, 1, 2, \dots$
- b. $a_n = 0$ for all odd integers n , but not for any even integers n .
- c. $a_n = 0$ for all even integers n , but not for any odd integers n .
- d. $a_n = 0$ for $n = 1, 2, 3, \dots$, but $a_0 \neq 0$.
- e. none of these



5. Consider the signal $x(t) = \text{rect}\left(\frac{t}{2}\right) + \text{rect}\left(\frac{t}{4}\right)$. Evaluate the integral $\int_{-\infty}^{\infty} X(\omega) e^{-j\frac{3}{2}\omega} d\omega$

- a. 2π
- b. 2
- c. none of these
- d. 1
- e. 4π



Handwritten calculation: $a_n = \frac{1}{2\pi} \int_0^{\pi} t \cos n\omega_0 t dt$

Handwritten integration steps: $\int t \cos n\omega_0 t dt = \frac{t \sin n\omega_0 t}{n\omega_0} + \frac{\cos n\omega_0 t}{n^2 \omega_0^2}$
 $\frac{t \sin n\omega_0 t}{n\omega_0} + \frac{\cos n\omega_0 t}{n^2 \omega_0^2}$
 $1 - \left(\frac{\cos n\pi}{n^2} \right)$

6. Consider the following statements regarding the signal $x(t) = \sin(3t) + e^{j\frac{2}{7}t}$

- S1: The exponential Fourier coefficients $C_{\pm 21} = \frac{1}{2j}$.
 - S2: The fundamental frequency of $x(t)$ is $\omega_0 = 2/7$.
- a. none of these
 - b. S1 and S2 are true
 - c. S1 is false but S2 is true
 - d. S1 is true but S2 is false**
 - e. S1 and S2 are false

7. Find the Fourier transform of $x(t) = \delta(t+1) + \delta(t-1)$

- a. $2 \cos(\omega)$**
- b. $2\pi \cos(\omega)$
- c. $\cos(\omega)$
- d. none of these
- e. $\pi \cos(\omega)$

8. When the signal

$$x(t) = 5 + \cos(12t + \pi/4)$$

is applied to a system, the output is

$$y(t) = 6 \sin(12t) + \cos(24t + \pi/4)$$

Which of the following statements is true

- S1: The system is LTI with $H(0) = 0$ and $|H(j12)| = 6$
 - S2: The system is not LTI because the cos function becomes a sin function
 - S3: The system is not LTI because the constant term disappears at the output
- a. All are false
 - b. S1 is false but both S2 and S3 are true
 - c. S2 only is true**
 - d. S3 only is true
 - e. S1 only is true

9. The Fourier transform of $x(t) = \text{sgn}(2t)$ is

- a. none of these
- b. $2/(j\omega)$**
- c. $2/(2j\omega)$
- d. $1/(2j\omega)$
- e. $1/(j\omega)$

10. For the trigonometric Fourier series of $x(t)$ defined over one period as $x(t) = t, -2 \leq t \leq 2$, the coefficient $b_1 =$

- a. $2/\pi$

Handwritten calculations for question 10:

$$b_n = \frac{2}{\pi} \int_0^{\pi} t \sin n\omega t \, d\omega$$

$$= \frac{2}{\pi} \left[-\frac{t \cos n\omega t}{n\omega} + \frac{\sin n\omega t}{n^2\omega^2} \right]_0^{\pi}$$

$$= \frac{2}{\pi} \left[-\frac{\pi \cos n\pi}{n\omega} + \frac{\sin n\pi}{n^2\omega^2} - \left(-\frac{0 \cos 0}{n\omega} + \frac{\sin 0}{n^2\omega^2} \right) \right]$$

$$= \frac{2}{\pi} \left[-\frac{\pi (-1)^n}{n\omega} + 0 - \left(-\frac{0}{n\omega} + 0 \right) \right]$$

$$= \frac{2}{\pi} \left[\frac{\pi (-1)^{n+1}}{n\omega} \right]$$

$$= \frac{2(-1)^{n+1}}{n}$$

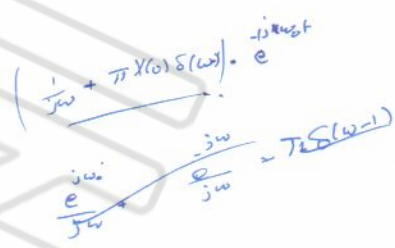
For $n=1$:

$$b_1 = \frac{2(-1)^{1+1}}{1} = 2$$

- b. zero
- c. $4/\pi$
- d. 1
- e. $\pi/4$

11. The Fourier transform of the signal $x(t) = u(t-1) * \delta(t-1)$ is

- a. $e^{-j\omega}/(j\omega) + \pi\delta(\omega-1)$
- b. $e^{-j2\omega}/(j\omega) + \pi\delta(\omega)$
- c. $e^{-j2\omega}/(j\omega) + \pi\delta(\omega-1)$
- d. none of these
- e. $e^{-j\omega}/(j\omega) + \pi e^{-j\omega}\delta(\omega)$



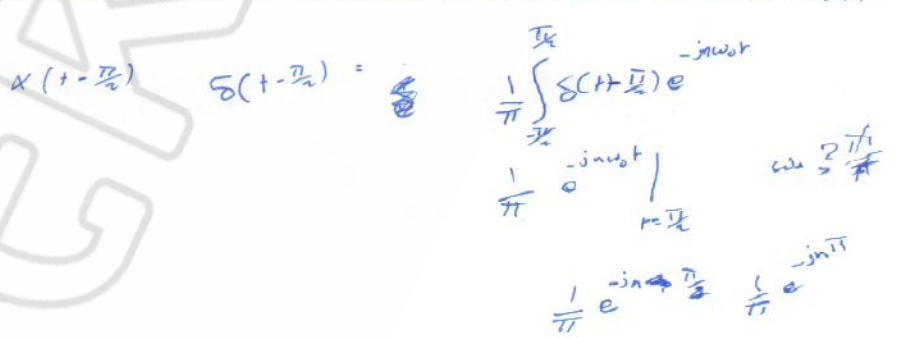
12. Consider the function $x(t) = \begin{cases} 2, & -2 \leq t \leq -1 \\ |t|, & -1 < t < 1 \\ -2, & 1 \leq t \leq 2 \end{cases}$. At $t=1$ the Fourier series converges to

- a. none of these
- b. $-1/2$
- c. zero
- d. -2
- e. -1



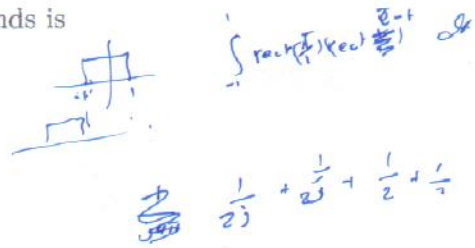
13. Given a periodic function $x(t) = \delta(t)$ with period π . The exponential Fourier series coefficient of $y(t) = x(t - \pi/2)$ is

- a. $\frac{1}{\pi} e^{j\pi n}$
- b. $\frac{1}{\pi} e^{-j\pi n}$
- c. $\frac{1}{\pi} e^{-j\frac{\pi}{2}n}$
- d. none of these
- e. $\frac{2}{\pi} e^{-j\frac{\pi}{2}n}$



14. The auto-correlation function of a rectangular pulse of duration 2 seconds is

- a. a triangular pulse of duration 4 seconds
- b. a rectangular pulse of duration 2 seconds
- c. a triangular pulse of duration 2 seconds
- d. a rectangular pulse of duration 4 seconds
- e. need more information



15. Consider the signal $x(t) = \sin 4\pi t + \cos 6\pi t$. One possible representation of the Fourier series coefficients is

- a. $c_n = \frac{1}{2}\delta[n+3] - \frac{1}{2j}\delta[n+2] + \frac{1}{2j}\delta[n-2] + \frac{1}{2}\delta[n-3]$
- b. $c_n = \frac{1}{2}\delta[n+6\pi] + \frac{1}{2j}\delta[n+4\pi] + \frac{1}{2j}\delta[n-4\pi] + \frac{1}{2}\delta[n-6\pi]$



c. none of these

d. $c_n = \frac{1}{2}\delta[n+2] - \frac{1}{2j}\delta[n+1] + \frac{1}{2j}\delta[n-1] + \frac{1}{2}\delta[n-2]$

e. $c_n = \frac{1}{2}\delta[n+3\pi] - \frac{1}{2j}\delta[n+2\pi] + \frac{1}{2j}\delta[n-2\pi] + \frac{1}{2}\delta[n-3\pi]$

16. The value of phase (in radians) at $\omega = 1$ rad/s of the signal $x(t) = 10\delta(t-2)$ is

- a. -0.5
- b. -2
- c. 1
- d. 10
- e. -0.2

-90
 $-90 \frac{2\pi}{\pi}$
 $-\frac{\pi}{4}$
 -90

$e^{-j\omega t}$
 $e^{-j2\omega}$

17. The inverse Fourier transform of $X(\omega) = \frac{1}{1+\omega^2}$ is

- a. e^{-t}
- b. none of these
- c. $\frac{1}{2}e^{-|t|}$
- d. $\frac{1}{2}e^{|t|}$
- e. $\frac{1}{2}e^{-|t|}u(t)$

$\frac{1}{1+\omega^2}$

$\frac{1}{1+t^2}$

$\frac{1}{2}e^{-|t|}$

$\int_0^\infty e^{-t} e^{-j\omega t} dt$

$\frac{e^{-t(1+j\omega)}}{-(1+j\omega)}$

$\frac{1}{1+j\omega}$

18. The input signal $x(t) = \cos(t)$ is applied to a system with frequency response $H(\omega) = \frac{2}{1+j\omega}$, the output signal will be

- a. $2\cos(t)$
- b. $\sqrt{2}\cos(t)$
- c. $\sqrt{2}\cos(t + \pi/4)$
- d. $\sqrt{2}\cos(t - \pi/4)$
- e. none of these

$\cos t \rightarrow \left(\frac{2}{1+j\omega}\right)$

$\left(\frac{2}{1+j\omega}\right) \cdot (\pi\delta(\omega-1) + \pi\delta(\omega+1))$

$\frac{2\pi\delta(\omega-1)}{1+j\omega} + \frac{2\pi\delta(\omega+1)}{1+j\omega}$

19. The frequency response function of a system described by the differential equation

$$2\frac{d^2y(t)}{dt^2} + 3y(t) = 4\frac{dx(t)}{dt}$$

is

- a. $\frac{4}{2j\omega^2 + 3}$
- b. none of these
- c. $\frac{4j\omega}{3 - 2\omega^2}$
- d. $\frac{4j\omega}{2j\omega^2 + 3}$
- e. $\frac{4}{2(j\omega)^2 + 3}$

20. If the Fourier transform of $x(t)$ is $X(\omega)$, then the Fourier transform of $4x(8 - 4t)$ is

- a. none of these
- b. $X\left(\frac{-\omega}{4}\right) e^{j\omega 8}$
- c. $X\left(\frac{\omega}{8}\right) e^{j\omega 4}$
- d. $X\left(\frac{-\omega}{4}\right) e^{-j\omega 2}$
- e. $X\left(\frac{\omega}{4}\right) e^{-j\omega 8}$

Handwritten notes for Q20:

$$4x(8-4t)$$

$$\frac{4}{4} X\left(\frac{-\omega}{4}\right) e^{j\omega 8}$$

$$X\left(\frac{-\omega}{4}\right) e^{j\omega 8}$$

21. Let the signal $x(t)$ be periodic with period $T = 4$ and the Fourier coefficients $c_n = e^{jn}$, $-3 \leq n \leq 3$ and zero otherwise. What is the power of the signal $x(t)$?

- a. 7/4
- b. 3
- c. 4
- d. 7
- e. 3/4

Handwritten notes for Q21:

$$\frac{1}{2\pi} \int_{-3}^3 S(\omega) d\omega$$

$$S(\omega) = 2\pi \sum |c_n|^2$$

$$\frac{1}{2\pi}$$

22. Consider the system with impulse response $h(t) = te^{-3t}u(t)$. What is the average value of the output if the input is

$$x(t) = 3 + 2 \cos(t + \pi/3) + \sin(2t + \pi/4)$$

- a. zero
- b. 1/3
- c. none of these
- d. 1/9
- e. 1

Handwritten notes for Q22:

$$3 + 2 \dots$$

$$e^{-3t}$$

$$\frac{1}{3 + j\omega}$$

$$\frac{-j}{13 + j\omega^2}$$

$$\Rightarrow \frac{2}{9 + \omega^2} \quad \frac{1}{4 + \omega^2}$$

$$X(\omega) = \int_{-\infty}^{\infty} x(t) e^{-j\omega t} dt$$

$$X(0) = \int_{-\infty}^{\infty} x(t) dt$$

$$\frac{S(f)}{9 + f^2}$$